Total Exploration and Production Liban Sal

Block 4 (Lebanon) offshore exploration drilling

Environmental impact assessment – Volume 1

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RSK GENERAL NOTES

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BLOCK 4 EXPLORATION DRILLING EIA – EXECUTIVE SUMMARY

Introduction

Total Exploration & Production Liban Sal (TEP Liban) intends to carry out exploration drilling activities in Block 4 of the Levant sedimentary basin in offshore Lebanese waters. The proposed drilling activities comprise one exploration well, a possible second exploration well and, potentially, one appraisal well, depending on the results of the previous exploration wells. Therefore, a maximum of three wells may be drilled during the exploration phase. Block 4 and the priority area, in which all three wells would be drilled, are shown in Figure ES1.

This document summarises the results of the environmental impact assessment (EIA) of the project (a maximum of three wells in total). It has been produced by a team consisting of personnel from in-country accredited consultancy Dar Al-Handasah (Dar) and international consultancy RSK Environment Ltd (RSK), on behalf of TEP Liban. Impacts to the social components are also included within the EIA process.

If a hydrocarbon discovery is made that can be commercially exploited, and the project goes to the next phase of development, a further EIA will be conducted to assess the impacts of the production phase.

Screening is the first stage in the EIA process. It determines whether an EIA is required for a project. TEP Liban submitted on 16 July 2018 a screening application for Block 4 to the Ministry of Environment, through the Lebanese Petroleum Administration (LPA) and the Ministry of Energy and Water (MoEW). On 29 August 2018 the LPA informed TEP Liban that according to the Ministry of Environment, an EIA would be required for the proposed Block 4 exploration drilling project.

A scoping report was submitted in May 2019 as part of the scoping stage of the EIA process. Scoping is a high-level assessment of anticipated interactions between project activities and environmental, socio-economic and cultural heritage receptors. The scoping report was opened for disclosure and revised after the consultation period to include: (1) updates from the stakeholder engagement (including public meetings), and (2) a scope of work for the EIA. Such scoping report was submitted to the MoE through the LPA on 28 June 2019. The MoE approved the scoping report provided that the EIA gives responses to the comments that were raised.

An EIA report document (Rev 0 of this document) was first produced in line with the MoE's scoping report comments, as far as available information allowed. At this stage, the EIA was published via a website for consultation purposes (from 4 September to 4 October 2019) and the results of the EIA process were presented at two public meetings in September 2019. The EIA was then updated, where necessary, in response to comments received during that process. Revision 1 of the EIA was submitted to the MoE on 31 October 2019. After submission, a number of comments on the EIA were received from the MoE. Responses and clarifications were provided to these comments, and where necessary, modifications were made to the EIA. Consequently, the EIA report was approved by the MoE on the 18 February 2020 provided that the comments listed in the Technical Committee Report 18/2/2020 are complied with. In addition, it was requested that a compiled and comprehensive version of the EIA report be submitted, reflecting the comments received from the MoE. This document (Revision 2) has been compiled in response to this request, so that it constitutes the final compiled version of the EIA as approved by the MoE.

Overview of the exploration drilling campaign

TEP Liban plans to start drilling the first exploration well in Block 4 in February 2020.

A mobile offshore drilling unit (MODU) will be mobilised to Block 4 and the first exploration well (B4-1) will be drilled pseudo-vertically (deviating slightly from truly vertical) at the proposed location shown in Figure ES1, about 20 km from shore, in 1520 m of water. The target reservoir (gas) is around 4400 m below mean sea level.

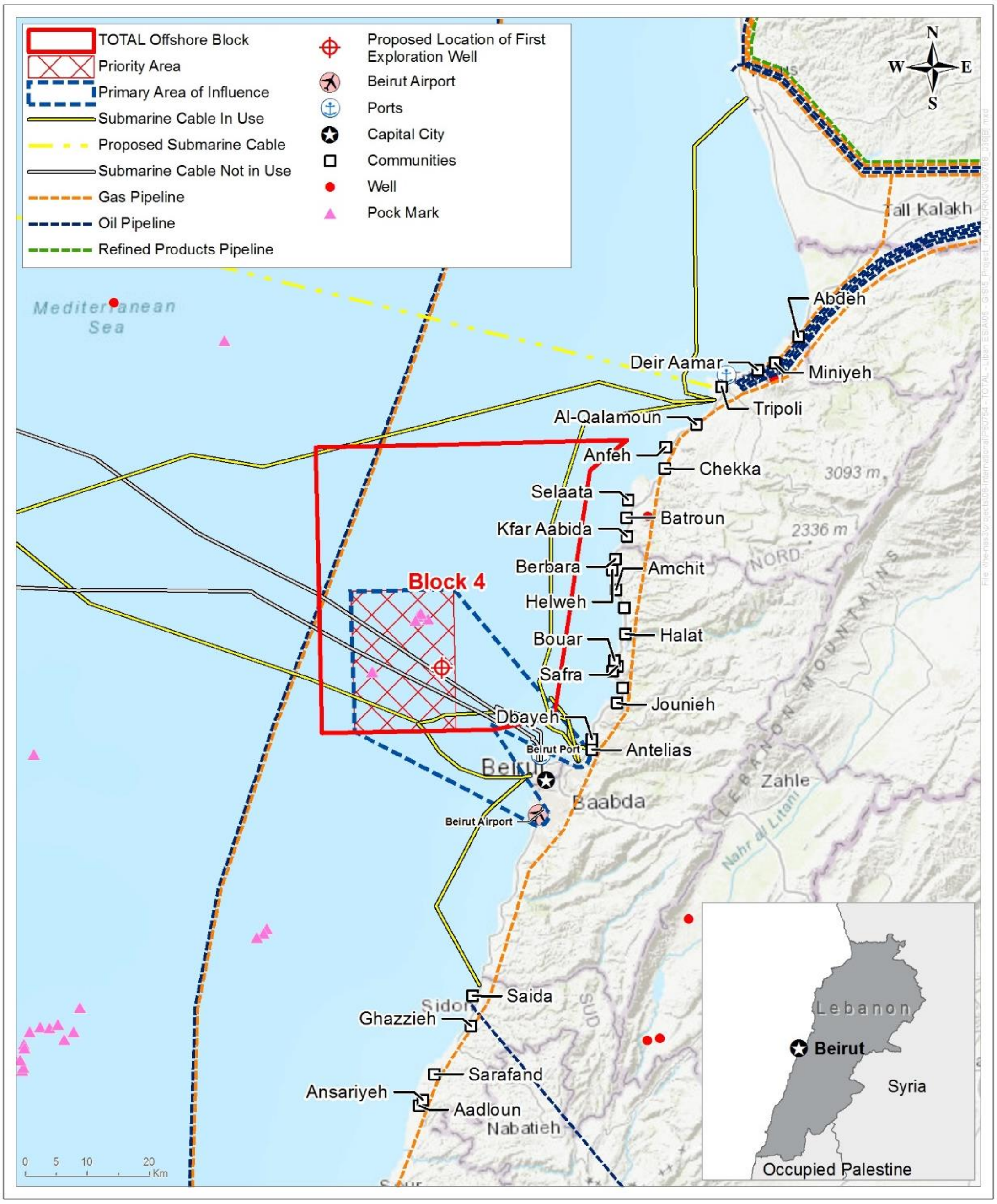

Figure ES1: Location of Block 4 offshore Lebanon, including the priority area and first exploration well site for drilling operations

The drilling programme for the first exploration well is planned to last around 60 days. The drilling operations for any subsequent wells are anticipated to be of similar duration, though may extend up to three months. Impacts from all three wells are included within this EIA.

Drilling operations will be supported from a logistics base that will be within the existing commercial Port of Beirut. Facilities at the logistics base will include:

- a pipe yard
- warehousing
- a linear jetty with laydown area and mobile cranes for vessels operations
- a drilling-fluids mixing plant and cement bulk plant
- areas for offices, canteen, vehicles, marshalling areas, cargo containers, waste transfer and temporary storage (no waste treatment).

A contractor will build and operate the logistics base. The duration of the logistics base will be dependent on the success of the of the B4-1 well and any subsequent wells.

Two to three project vessels will be used during the exploration drilling work: one vessel will be permanently at the drill site providing safety and security surveillance, the other vessel(s) will transfer supplies, materials, equipment and waste between the MODU and the logistics base (estimated 8–10 return trips in total per week) during the drilling period. Helicopter transfers of personnel will take place from Beirut Rafic Hariri International Airport to the MODU (estimated 10 return trips per week). Two helicopters will support the operation, each with a capacity of 8 to 12 passengers.

Figure ES2 provides a guide to the duration of each of the activities associated with the drilling programme and the location at which they will take place. The drilling duration shown as 2–3 months is intended to cover the duration for any of the wells, while it is anticipated that the first well will involve only around 60 days of drilling.

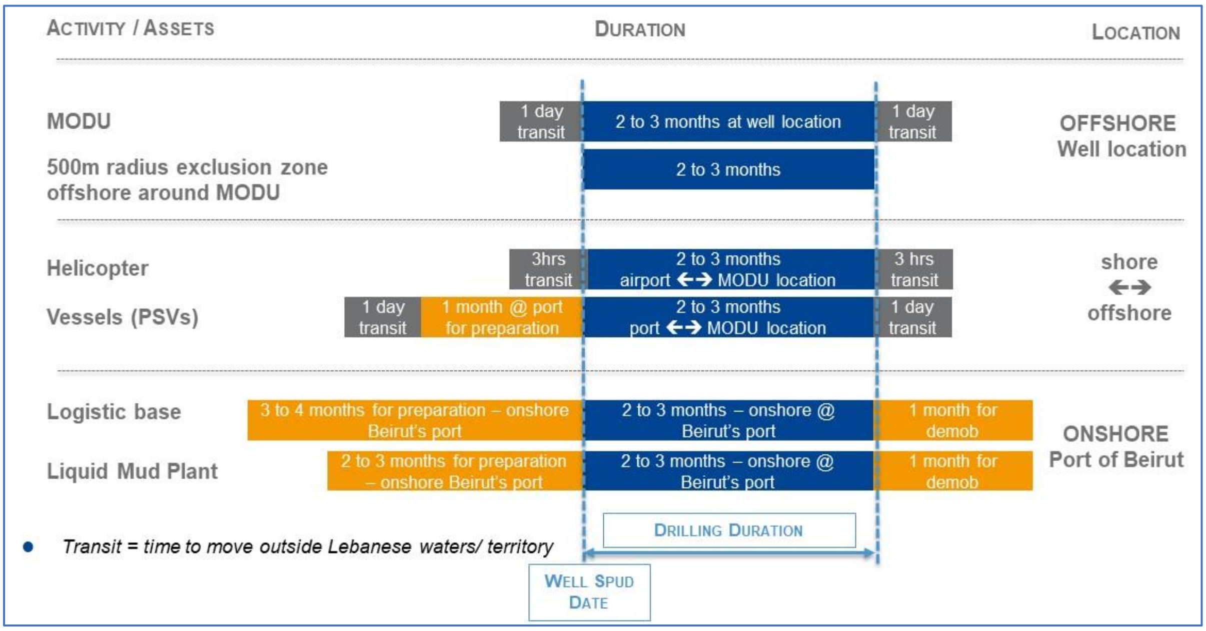

Figure ES2: Duration and location of each project activity

Objectives of the EIA

The objectives of the EIA process are to

- identify the legal and regulatory requirements and other standards relevant to the project (national legislation and regulations, international agreements and TOTAL's corporate requirements)
- identify sensitive environmental, socio-economic and cultural heritage receptors in the project's area of influence
- inform stakeholders and obtain their views and opinions (potentially affected communities/people and other interested parties)
- determine project aspects and activities that could result in environmental, socio-economic or cultural heritage impacts, along with scoring of impact significance
- develop mitigation measures to reduce potential negative impacts to acceptable levels and enhance any beneficial environmental, socio-economic and cultural heritage impacts arising from the project
- determine residual project impacts, along with scoring of residual impact significance
- ensure that mitigation measures are incorporated into management plans that will be implemented by the project sponsor and its contractors and subcontractors during the exploration drilling programme.

Study area

The area of influence (AOI) for each environmental and social receptor has been identified based on requirements in the MoE and LPA's draft 'Sector-specific EIA Guidelines for Oil and Gas Reconnaissance and Exploration Drilling Activities in Lebanon'. The extent of the AOI differs depending upon the type of impact being considered and the attributes of the potentially affected receptors.

Baseline data has been collected with a focus on these AOIs, though information has been collected from a broader study area to aid in providing context. Where different areas are used, this is discussed in the respective section of the EIA report.

Legal and administrative framework

The Block 4 exploration drilling activities will be carried out in accordance with the environmental and social requirements of

- national legislation and regulations
- applicable international conventions and agreements to which Lebanon is a party
- TOTAL's corporate commitments
- international best practice.

Key legislation and guidance for this project includes

- Environmental Impact Assessment Decree 8633/2012
- draft 'Sector-specific EIA Guidelines for Oil and Gas Reconnaissance and Exploration Drilling Activities in Lebanon' (MoE and LPA, 2019)
- Strategic Environmental Assessment (SEA) for Exploration and Production Activities Offshore Lebanon (MoEW, 2019).

Other relevant legislation includes the Offshore Petroleum Resources Law (Law 132/2010); the Petroleum Activities Regulations (Decree 10289/2013); the Exploration and Production Agreement Decree (Decree 43, Annex 2, 2017); the Environment Protection Law (Law 444/2002); the Procedure for Reviewing of Scoping and EIA Reports (Decision 261/1 of 2015); the Law on Strengthening Transparency in the Petroleum Sector (Law 84/2018); and the Right of Access to Information (Law 28/2017).

Public participation

The EIA process includes public participation, the main goal of which is to identify the views and opinions of potentially affected people and other interested parties. Stakeholder feedback is used to focus the impact assessment and, where appropriate, influence project design and execution. Stakeholder engagement for this project has being undertaken in accordance with the requirements of Lebanese legislation, TOTAL policies for stakeholder engagement and international best practice. A project-specific stakeholder engagement plan (SEP) for Block 4 was developed to support meaningful and effective engagement throughout the EIA process.

Public participation and stakeholder engagement meetings were undertaken during the scoping phase and the baseline data collection phase. Whereas public participation targets the general public, stakeholder engagement targets specific groups and individuals who may be impacted by the project, have influence over it or have an interest in it, including authorities, international and national agencies, civil society and non-governmental organisations (NGOs), academia, businesses and potentially affected groups.

Stakeholder questions, concerns and comments were similar across the two phases and from the different stakeholder groups (national level, regional level and local level). However, local level stakeholders identified issues around social topics such as employment and livelihoods whereas national and regional level stakeholders raised more questions and concerns relating to environmental topics. The stakeholder issues and comments received to date are addressed in this EIA.

The report-back phase stakeholder engagement on the EIA report began in early September 2019. The aim of the engagement was to ensure that stakeholders were informed about and comprehend the outcome of the EIA, particularly the identified impacts and mitigation measures. Comments provided by stakeholders during this phase have been responded to within this EIA. Stakeholder engagement will continue after final EIA submission.

Summary of surrounding environment

To identify potential impacts of the project on receptors, an understanding of the existing (baseline) pre-project conditions is required.

The following studies/surveys have been carried out for the Block 4 exploration drilling campaign and used to inform the EIA:

- social baseline study – bibliographic review and primary data collection
- offshore environmental baseline study – bibliographic review
- offshore environmental baseline survey – water and sediment sampling and chemical, physical and biological analysis; seabed video surveillance (marine fauna and archaeological observation); onboard watch for marine fauna (marine mammals, seabirds and reptiles) and other sea users.

Environmental receptors that could be affected by the project include

- air quality – the Eastern Mediterranean is affected by various sources of air pollution, including long-range airborne pollutants and particles from dust storms
- seawater quality – offshore seawater has low turbidity, is oligotrophic in terms of nutrients and uncontaminated and is considered representative of conditions typical for offshore locations for the Eastern Mediterranean, while coastal seawater is highly contaminated with anthropogenic pollution in certain places
- sediment quality – the offshore sediments comprise brownish mud dominated by fine particles and are considered to be typical of the deep sea sediments in the Eastern Mediterranean with low contamination except for certain heavy metals, coastal sediments have higher concentrations of heavy metals, hydrocarbons and nutrients
- coastal habitats – seagrass beds and vermetid[1] reefs are features of Lebanon's coastal waters and contribute to criteria for coastal proposed marine protected areas
- deep-water benthic communities – dominated by fauna associated with deep-water sediments of the Eastern Mediterranean, the assemblage is considered relatively impoverished in terms of species abundance and diversity, reflecting the low levels of organic matter and nutrient enrichment
- plankton communities – primary phytoplankton productivity offshore is low due to the oligotrophic water column and stratification, zooplankton abundances are low but with moderate to high diversity
- fish – Lebanon's waters contain more than 100 fish species of commercial importance, a number of threatened fish, shark and ray species are also present
- marine mammals – several species are reported from the Eastern Mediterranean region and include species of whale and dolphin and the Mediterranean monk seal (critically endangered in the Mediterranean). Overall, marine mammal abundances are low in Lebanon's waters, with the bottlenose dolphin being the most commonly sighted species.
- turtles – green turtle, leatherback turtle and loggerhead turtle are present in Lebanese waters, with foraging areas and migration routes along the coast. Nesting sites for green and loggerhead turtles are found on sandy shorelines in south Lebanon.
- birds – gulls were the most commonly sighted bird species during the offshore environmental baseline survey in Block 4, shearwaters, skuas, duck and herons were also sighted
- protected areas – the closest nationally designated site to the Block 4 priority area is Palm Islands Nature Reserve to the north. The closest sites of conservation interest to the Block 4 priority area are Beirut Port Outer Platform proposed marine protected area and three sites identified by OCEANA as deep-sea sites for conservation (Jouneih Canyon, Saint Georges Canyon and Beirut Escarpment).

Socio-economic receptors that could be affected by the project include

- social conditions (safety and security) in local communities – coastal communities adjacent to Block 4, communities in the vicinity of the logistics base in the Port of Beirut, communities along the helicopter transfer route and in the vicinity of Beirut Rafic Hariri International Airport, and communities along project vehicle transport routes
- fisheries – the fishing industry in Lebanon is artisanal, relying on a traditional, small-scale fleet of motorised wooden vessels. Legislation restricts fishing grounds to within six nautical miles of the shore. Fishing vessels do not use the Port of Beirut. Those engaged in fishing generally do so on a full-time basis with no alternative livelihood activities or social security arrangements.

[1] Vermetid reefs are formed by worm snails. The shells of Vermetid snails are extremely irregular, and do not resemble the average snail shell. They usually grow cemented onto a hard surface or cemented together in colonies.

- tourism – within the coastal zone tourism represents a major contributor to the local economy. Beirut hosts the majority of tourists, although beach resorts, beaches, bathing sites, recreational sailing marinas and scuba-diving sites are present along the coast. One particular recreational activity that takes place along the entire coast of Lebanon is sea angling, which occurs throughout all seasons but is most common during the summer.
- shipping – the Port of Beirut is one of the largest ports in the Eastern Mediterranean and is an important international trading station with the surrounding Arab countries. There are a significant number of shipping routes along the southern boundary of Block 4 and up through the western section of the block.
- archaeological and cultural resources – archaeological review of seabed video surveillance during the offshore environmental baseline survey did not identify any archaeological features in the Block 4 priority area. Several cultural heritage sites with significant historical importance were identified in the coastal zone, including antiquities, such as underwater cities, ancient breakwaters and Phoenician walls. The antiquities at Aamchit are the closest offshore site to the Block 4 priority area.
- infrastructure – Lebanon has a relatively extensive network of physical infrastructure comprising roads, ports, electricity supply, water supply and telecommunications. A growing population and the influx of displaced persons have placed pressure on already-stressed and ageing infrastructure.
- public health – Lebanon like many countries in the Middle East, is undergoing an epidemiological transition marked by an increasingly ageing population suffering from chronic and non-communicable diseases. The Syrian crisis and resulting influx of displaced persons has increased the demand for health care services and significantly increased government's costs in order to meet the increased demand.
- general economy – Lebanon's macro-economic structure is heavily dependent on the services sector, with real estate constituting the largest services sector. Economic growth has slowed since 2011 and the start of the Syrian crisis.
- education and training – high levels of education were reported in all the sample communities, educational levels amongst some groups such as fishermen (particularly elderly) were reported to be lower than amongst the population at large.

Potential impacts of the project

Potential impacts were identified using the preliminary impact identification matrix outlined in the 'Update on the Strategic Environmental Assessment (SEA) for Exploration and Production Activities Offshore Lebanon (MoEW, 2019)' as guidance.

Table ES1 summarises the key potential impacts resulting from the Block 4 exploration drilling campaign. A comprehensive, systematic review and scoring of all potential impacts from the drilling campaign is provided in Chapter 6 of the EIA. By complying with international best practice on impact avoidance or mitigation and Lebanese legislative requirements, the residual impacts from routine activities are expected to have minor or negligible levels of significance. The exception is from the discharge of water-based cuttings and drilling fluids at the seabed during drilling of the Block 4 upper well sections which has been categorised as moderate residual impact significance[2]. Cuttings and fluids cannot be returned to the rig during this part of the work as these well sections are drilled without a marine riser in place. Impacts on the water column are associated with discharge of the inert, insoluble drilling products barite and bentonite and turbidity effects on marine fauna.

[2] There is also an option for future wells in Block 4 to use high-performance water based drilling fluids (HPWBDF) in the lower well sections. In this case there will be discharge of water-based cuttings and drilling fluids from the riserless well sections, plus discharge of HPWBDF cuttings from lower well sections. This option has also been assigned a moderate residual impact significance.

Table ES1: Potential impacts from the Block 4 exploration drilling campaign

	Air quality	Climate change	Sediment quality/ composition	Water quality	Benthos	Fish	Plankton	Seabirds	Cetaceans, turtles and seals	Sensitive marine habitats	Coastal habitats	Terrestrial ecology	Archaeological and cultural resources	Infrastructure	Social conditions (security/safety)	Education and training	General economy	Fisheries	Shipping	Tourism	Public health
Routine activities																					
MODU mobilisation, installation, plug and abandonment and demobilisation	X	X	X	X	X	X	X		X	X			X					X	X		
Cuttings discharge during drilling Option 1 – use of NADF in lower hole sections Discharge of drill cuttings and WBDFs from riserless top hole sections only (option selected for well B4-1 and option for possible future exploration / appraisal wells in Block 4)			X	X	X	X				X			X	X				X	X	X	
Cuttings discharge during drilling Option 2 – use of a HPWBDF in lower hole sections Discharge of drill cuttings and WBDFs from riserless top hole sections and discharge of HPWBDF cuttings from lower well sections (option for possible future exploration / appraisal wells in Block 4)			X	X	X	X	X		X	X								X	X	X	
Ship to shore of NADF cuttings and fluids (only applicable to Option 1 above)	X	X												X				X	X	X	
Cementing discharges during drilling			X		X																
Pipe dope discharges during drilling				X		X	X											X			
BOP testing discharges during drilling				X		X	X											X			
Discharge of sanitary waste from MODU and support/supply vessels				X		X	X											X			

	Air quality	Climate change	Sediment quality/ composition	Water quality	Benthos	Fish	Plankton	Seabirds	Cetaceans, turtles and seals	Sensitive marine habitats	Coastal habitats	Terrestrial ecology	Archaeological and cultural resources	Infrastructure	Social conditions (security/safety)	Education and training	General economy	Fisheries	Shipping	Tourism	Public health
Discharge of food waste from MODU and support/supply vessels (no discharge permitted for B4-1 well as < 12 nm from land. Discharge permitted for possible future exploration / appraisal wells if > 12 nm from land.)				X		X	X											X			
Desalination unit discharges from MODU				X		X	X											X			
Discharge of drainage water (deck drainage, fire water, bilge water and slop water) from MODU and support/supply vessels				X		X	X											X			
Uplift and discharge of cooling water from MODU				X		X	X											X			
Discharge of ballast from MODU and support/supply vessels				X		X	X											X			
Generation of solid waste on MODU and support/ /supply vessels	None providing waste managed properly																				
Operation of incinerator onboard MODU (not applicable to well B4-1 as no incinerator on MODU, may be applicable to possible future exploration / appraisal wells depending on MODU selection)	X	X																			
MODU and support/supply vessel power generation resulting in air emissions	X	X																			
Well test of possible future appraisal well (not applicable to well B4-1)	X	X																			
Underwater noise from vertical seismic profile (VSP) activities						X			X									X			
Underwater noise from MODU and support/supply vessel operations						X			X									X			
Support activities (movement of support vessels)														X				X	X	X	

	Air quality	Climate change	Sediment quality/ composition	Water quality	Benthos	Fish	Plankton	Seabirds	Cetaceans, turtles and seals	Sensitive marine habitats	Coastal habitats	Terrestrial ecology	Archaeological and cultural resources	Infrastructure	Social conditions (security/safety)	Education and training	General economy	Fisheries	Shipping	Tourism	Public health
Light spill from MODU						X		X	X											X	
Chemicals transfer and storage	None providing chemicals managed properly																				
Logging using radioactive sealed sources (also applicable to onshore storage and transport of radioactive sealed sources)	None under normal operations																				
Logistics base operation														X	X	X	X			X	X
Logistics base operation – emissions to air	X	X																			X
Logistics base operation – discharge of drainage water				X																	
Logistics base operation – noise generation												X								X	X
Logistics base operation – waste management	None providing waste managed properly													X	X						X
Logistics base operation – chemicals management	None providing chemicals managed properly																				
Helicopter transfers to Beirut International Airport								X			X	X		X						X	X
Potential accidental event scenarios																					
Dropped object from MODU (lifting)			X		X																
Loss of chemical containment onboard MODU			X	X	X	X	X											X			
Radioactive source lost in hole			X																		
Riser rupture, release of drilling fluid to sea			X	X	X	X	X											X			
Shallow gas blowout, release of gas into water column	X		X	X	X	X	X											X	X		
Blowout – release of condensate and gas	X			X		X	X	X	X		X		X	X	X		X	X	X	X	X
Collision of third-party ship with MODU – release of third-party fuel inventory, possible damage to MODU and riser				X		X	X	X	X	X								X	X		

	Air quality	Climate change	Sediment quality/ composition	Water quality	Benthos	Fish	Plankton	Seabirds	Cetaceans, turtles and seals	Sensitive marine habitats	Coastal habitats	Terrestrial ecology	Archaeological and cultural resources	Infrastructure	Social conditions (security/safety)	Education and training	General economy	Fisheries	Shipping	Tourism	Public health
Helicopter crash on MODU deck – release of aviation fuel to sea				X			X														
Loss of containment during offshore materials transfer to MODU – release of drilling fluids or marine diesel to sea			X	X	X	X	X											X			
Loss of rig stability (rig capsize) due to severe metocean conditions with release of fuel inventory				X		X	X	X	X	X	X		X	X	X		X	X	X	X	X
Earthquake resulting in loss of well integrity and release of hydrocarbons to sea				X		X	X	X	X	X	X		X	X	X		X	X	X	X	X
Loss of containment during materials transfer to supply vessels at logistics base quay side – release of drilling fluids/diesel to sea				X																X	

The impacts presented in the EIA can be grouped as follows.

Mobilisation, installation and demobilisation

Impacts from mobilisation, installation and demobilisation of the MODU are largely associated with rig operational activities and the associated emissions (engine exhausts), noise (from engines and dynamic positioning) and wastewater discharges (sanitary wastewater, macerated food waste, desalination unit discharges, drainage, cooling water and ballast water). There is also potential for impacts on shipping and fisheries from the physical presence of the MODU and its safety zone[3].

A drillship has been selected for the B4-1 drilling programme. If a semi-submersible rig is used for future exploration / appraisal wells, there is the potential for anchoring impacts on seabed sediments and benthic communities, and any unknown archaeological features on the seabed.

Drilling operations

The drilling operations will result in discharges to the marine environment, i.e. cuttings and drilling fluids and small volumes of cement, pipe dope and blowout preventer test fluids.

The Block 4 wells will be drilled in five sections which become progressively narrower in diameter with depth drilled.

The first two hole sections will be drilled “riserless” (there is no potential for the recovery of the cuttings generated during the drilling of these sections) and the cuttings and drilling fluids will be deposited on the seabed directly around the well site. These hole sections will be drilled using seawater and water-based drilling fluids.

For the remaining three hole sections, a marine riser will be in place and cuttings and drilling fluids will be brought back up to the MODU. There are two options with respect to drilling fluid use in these lower hole sections:

- Option 1: Use of a non-aqueous drilling fluid (NADF) to ensure compatibility with the geological formations encountered. In this case cuttings and drilling fluids will not be discharged. They will be shipped to shore for treatment and disposal.
- Option 2: Use of a high-performance water-based drilling fluid (HPWBDF). In this case cuttings will be discharged to sea from the rig. The drilling fluids would be separated from the cuttings on the rig and re-used in subsequent well sections.

Option 1 has been selected for the first B4-1 exploration well as the geological formations downhole are currently not well known and NADF provides enhanced borehole stability. Any subsequent wells in Block 4 will utilise either Option 1 or 2 depending on the findings from the first well.

Disposal of cuttings and water-based drilling fluids at sea will potentially impact seawater and sediment quality, benthic communities, water column communities (fish and plankton) and sensitive marine habitats, as well as fisheries and infrastructure (submarine cables). The land-based disposal of cuttings will have air emission impacts associated with vessel transportation and potential impacts on land-based receptors. It should be noted that for the first well in the Block 4 drilling programme NADF cuttings will be exported to Cyprus for treatment and disposal at the

[3] 500 m safety zone will be in place around the MODU.

Innovating Environmental Solutions Center (IESC) treatment facility. This facility is permitted separately by the authorities in Cyprus and this disposal route is outside the scope of this EIA.

If vertical seismic profile[4] of the Block 4 wells is carried out, it will introduce impulsive underwater noise to the area for a very short period of time that may affect marine fauna, particularly whales, dolphins and turtles. Drilling activities on the MODU will also be a source of continuous lower levels of underwater noise.

Well testing of the Block 4 first exploration well will not be carried out. If well testing of a future well takes place, this will have associated emissions from flaring of test fluids with potential effects on air quality.

MODU operations can affect archaeological and cultural resources (during well spud and from semi-submersible drilling rig anchors) and the physical presence of the MODU and its safety zone can interfere with shipping, fisheries and potentially tourism (from changes to sea views from the shore).

Support activities

The onshore logistics base has the potential for air and noise-related impacts from operation of the drilling fluids mixing plant / bulk facility and any associated generator(s) and from loading/unloading operations, as well as possible impacts on the Port of Beirut infrastructure. In terms of positive impacts, operation of the logistics base has the potential to result in local employment and training opportunities (although they are limited at this exploration phase).

The movement of supply vessels between the MODU and the logistics base has the potential for impacts on marine fauna (underwater noise impacts), water quality (from vessel operational wastewater discharges), shore-based infrastructure (Port of Beirut), shipping, fisheries and tourism (recreational activities).

Helicopter crew transfers could have potential noise impacts on sensitive coastal habitats, local communities and tourism.

Accidental events and transboundary impacts

Unplanned or accidental events are considered separately from planned routine activities, as they only arise as a result of a technical failure, human error or natural phenomena such as a seismic event.

Representative scenarios of accidental events that may occur during the Block 4 exploration drilling campaign are shown in Table ES1 and presented in more detail in Chapter 6 of the EIA. Spill drift modelling of two large-scale hydrocarbon releases (well blowout with release of condensate and an instantaneous release of a large volume of marine diesel fuel in Block 4) has been conducted as part of the EIA study. The results indicate that the northern coast of Lebanon and Syria could be reached by some residual oil.

Controls and actions to reduce the likelihood of a spill/release incident are a key part of the mitigation and are described in Chapter 6. TEP Liban has developed an oil spill contingency plan

[4] VSP relates to measurements made using geophones inside the wellbore and a source (airgun array), at the surface near the well. This methodology generally obtains higher-resolution geological information than a surface-towed seismic survey.

that focuses on optimising response at sea in order to minimise coastal and transboundary impacts.

Cumulative impacts

Cumulative impacts consider the additive impact of the primary activity (i.e., the current project) with any local third-party activities.

TEP Liban's drilling programme in Block 4 will be the first offshore exploration drilling activity in Lebanon. The only other offshore block in Lebanese waters that has currently been awarded is Block 9, also to TEP Liban. Block 4 and Block 9 are approximately 45 km apart, cumulative impacts from any future simultaneous activities in these blocks are therefore not anticipated.

No other future projects are known to be taking place in the Block 4 area.

Management and implementation of mitigations

Processes are required to ensure that both TEP Liban and relevant contractors implement commitments derived from the EIA during the exploration drilling campaign.

A commitments register has been compiled that lists all the mitigation measures identified in the EIA. These commitments have been tracked through to Environmental and Social Management Plans (ESMPs) developed for the drilling campaign. The ESMPs form part of TEP Liban's Health, Safety and Environment Management System (HSE MS).

The ESMPs form the basis for subsequent detailed management plans prepared and implemented by the MODU, drilling fluids and cementing contractors; the logistics base contractor; and support/supply vessel contractor who will be requested to comply with the relevant environmental and social requirements set out in TEP Liban's ESMPs.

Contractors will also be required to have their own HSE management systems in place.

Conclusion

This EIA report has provided an assessment of environmental and social impacts associated with TEP Liban's offshore exploration drilling activities in Block 4.

Alternatives to proposed project activities have been considered; the proposed location of the B4-1 exploration well has been selected based on the most direct drilling route to promising hydrocarbon reserves; the drilling rig will be designed specifically to operate in the deep-water environment of Lebanon Block 4 and will include features for high-efficiency operation; and discharges from the drilling activities will be MARPOL 73/78 compliant.

The location of the onshore project logistics base has been selected based on the principle of minimal disruption to existing infrastructure, with the Port of Beirut being the closest and most suitable choice offering the required capacities without further extending its footprint.

During the EIA, all applicable environmental and socio-economic receptors were identified, their sensitivity towards proposed project activities assessed and mitigation measures considered, where impact avoidance was not feasible. In summary, all identified impacts in this EIA are expected to be manageable with acceptable residual effects after mitigation.

The proposed offshore exploration drilling project proposed by TEP Liban is the first project of this type submitted for approval in Lebanon and therefore if exploration is successful it may have potential beneficial impacts on the national economy of Lebanon.

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تقييم الأثر البيئي لأعمال الحفر الاستكشافي في البلوك 4 – الملخّص التنفيذي

مقدّمة

تعتزم شركة TOTAL Exploration & Production Liban Sal (TEP Liban) إجراء أعمال حفر استكشافي في البحر في البلوك 4 (الرقعة رقم 4) ضمن حوض المشرق الرسوبي في المياه البحرية اللبنانية. تشمل الأعمال المُقترَحة حفر بئر استكشافي أوّل، وبئر استكشافي آخر مُحتمَل، وبئر تقييمي مُحتمَل، تبعًا لنتائج البئرَيْن السابقَيْن. بالتالي، قد يتمّ حفر ثلاثة آبار كحدّ أقصى في مرحلة التنقيب. يوضِح الرسم ES1 البلوك 4 ومنطقة التركيز حيث قد يتمّ حفر الآبار الثلاثة.

يلخّص هذا المستند نتائج دراسة تقييم الأثر البيئي (EIA) للمشروع (مجموع 3 آبار كحدّ أقصى). وقد تمّ إعداده من قِبَل فريق مؤلّف من ممثّلين من الاستشاري المُعتمَد في البلد، دار الهندسة للتصميم والاستشارات الفنّية (شاعر ومشاركوه)، بالتعاون مع الشركة الاستشارية الدولية RSK Environment Ltd، نيابةً عن شركة TEP Liban. يُذكَر أنَّ الآثار الاجتماعية مشمولة أيضًا ضمن دراسة تقييم الأثر البيئي.

في حال تمّ العثور على مواد هيدروكربونية قابلة للاستثمار التجاري وانتقلَ المشروع إلى المرحلة التالية من التطوير، تُجرى دراسة إضافية لتقييم الآثار الناتجة عن مرحلة الإنتاج.

المرحلة الأولى في الدراسة هي "تصنيف المشروع" (screening) الذي يحدّد ما إذا كان المشروع يحتاج إلى إجراء تقييم للأثر البيئي. قدّمت شركة TEP Liban في 16 تمّوز/يوليو 2018 طلبًا لإجراء مسح للبلوك 4 وأرسلته إلى وزارة البيئة، عن طريق هيئة إدارة قطاع البترول في لبنان ووزارة الطاقة والمياه. وفي 29 آب/أغسطس 2018، قامت الهيئة بإبلاغ شركة TEP Liban بأنّه وفقًا لوزارة البيئة، يحتاج مشروع الحفر الاستكشافي المُقترَح في البلوك 4 إلى إجراء دراسة لتقييم الأثر البيئي.

وتمّ تقديم تقرير تحديد نطاق دراسة تقييم الأثر البيئي في أيّار/مايو 2019. تجدر الإشارة إلى أنّ "تحديد النطاق" (Scoping) هو كناية عن تقييم أوّلي للآثار المتوقّعة بين أعمال المشروع والمُستقبِلات البيئية والاجتماعية–الاقتصادية والتراثية–الثقافية/الحضارية. تمّ تعميم التقرير ومراجعته بعد فترة المشاورات لإدراج: (1) المعطيات المُستخلَصة من مشاركة الأطراف المعنيّة (بما في ذلك الاجتماعات العامة)، و(2) نطاق عمل دراسة تقييم الأثر البيئي. وتمّ تقديم هذا التقرير إلى وزارة البيئة عن طريق هيئة إدارة قطاع البترول في 28 حزيران/يونيو 2019. فوافقَت وزارة البيئة على تقرير تحديد النطاق بشرط أن تُعطي دراسة تقييم الأثر البيئي أجوبةً على الملاحظات والتعليقات التي طُرِحَت.

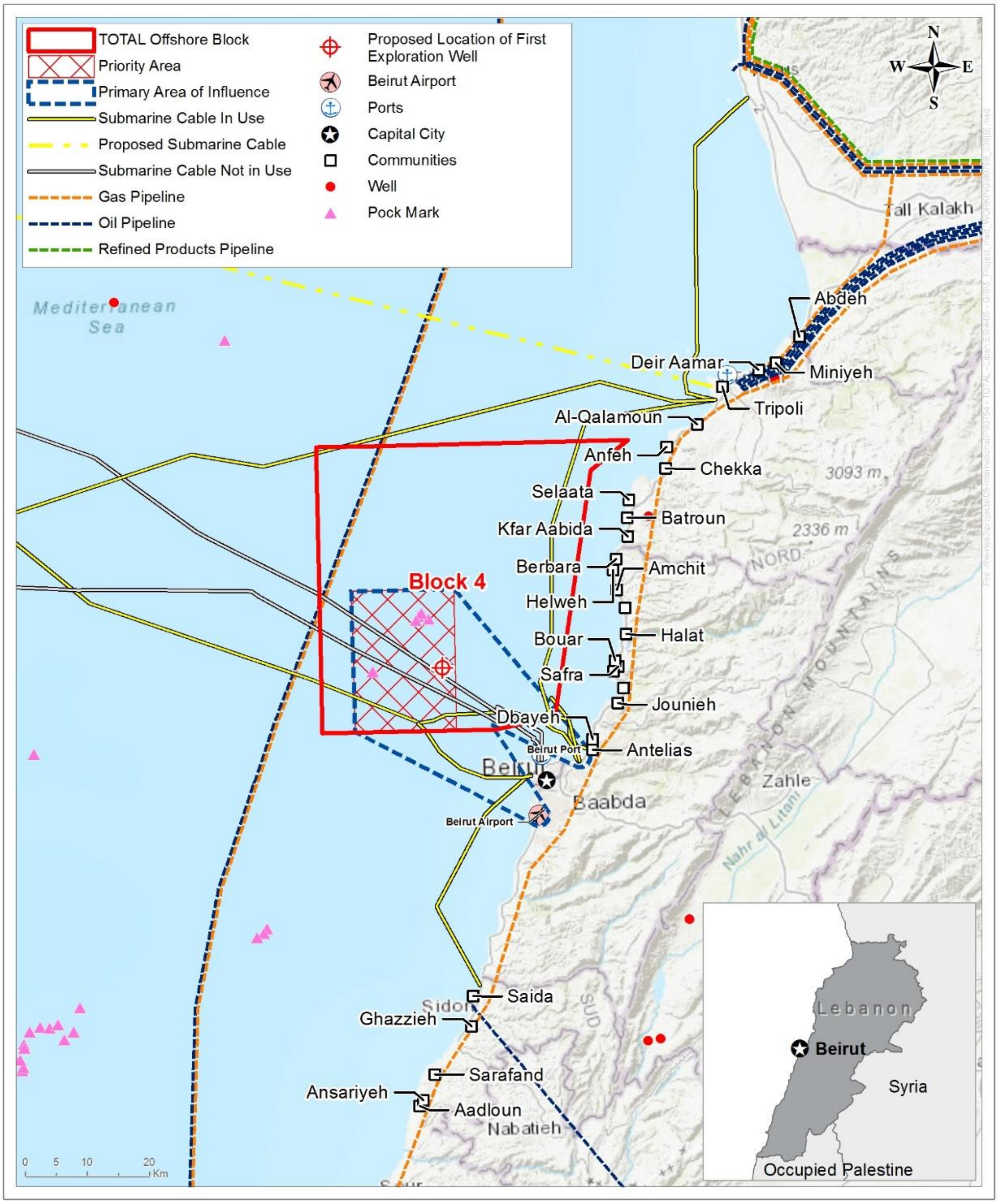
تمّ إعداد وثيقة تقرير تقييم الأثر البيئي (النسخة الأساسية Rev0 من هذه الوثيقة) أوّلًا وفقًا لملاحظات وتعليقات وزارة البيئة على تقرير تحديد النطاق، وبقدر ما سمحَت به المعلومات المتوفّرة. في هذه المرحلة، تمّ نشر نسخة عن تقرير تقييم الأثر

البيئي عبر موقع إلكتروني مخصّص لأغراض المشاورة (من 4 أيلول/سبتمبر حتّى 4 تشرين الأوّل/أكتوبر 2019)، كما استُعرِضَت نتائج عملية تقييم الأثر البيئي خلال اجتماعَيْن عامَّيْن عُقِدا في شهر أيلول/سبتمبر 2019. ثمّ جرى تحديث دراسة تقييم الأثر البيئي، عند الاقتضاء، في ضوء الملاحظات والتعليقات التي وردَت خلال تلك العملية. وتمّ تقديم النسخة المنقّحة الأولى من دراسة تقييم الأثر البيئي إلى وزارة البيئة في 31 تشرين الأوّل/أكتوبر 2019. وبعد التقديم، وردَ عددٌ من التعليقات والملاحظات من وزارة البيئة على دراسة تقييم الأثر البيئي. وتمّ تقديم الردود والتوضيحات على هذه الملاحظات والتعليقات، وأُجريَت التعديلات اللازمة على التقرير. وعليه، وافقَت وزارة البيئة على تقرير تقييم الأثر البيئي في 18 شباط/فبراير 2020 بشرط الامتثال للملاحظات والتعليقات الواردة في تقرير اللجنة الفنّية 2020/2/18. بالإضافة إلى ذلك، طُلِبَ تقديم نسخة كاملة وشاملة لتقرير دراسة تقييم الأثر البيئي، مع مراعاة التعليقات والملاحظات الواردة من وزارة البيئة. وتمّ توليف هذه الوثيقة (النسخة المنقّحة الثانية) استجابةً لهذا الطلب، بحيث تشكّل النسخة الكاملة النهائية لدراسة تقييم الأثر البيئي بالصيغة التي وافقَت عليها وزارة البيئة.

لمحة عامة عن حملة أعمال الحفر الاستكشافي

تخطّط شركة TEP Liban للبدء بحفر البئر الاستكشافي الأوّل في البلوك 4 في شباط/فبراير 2020.

تُقام وحدة حفر متنقّلة في البحر (MODU) في البلوك 4، ويتمّ حفر البئر الاستكشافي الأوّل (B4-1) بشكلٍ شبه عمودي (مع انحراف طفيف عن الاتّجاه العمودي التام) في الموقع المُقترَح كما يظهر في الرسم ES1، على بُعد حوالى 20 كلم من الشاطئ، وعلى مسافة 1520 مترًا في المياه. يبلغ عمق الخزّان المُستهدَف (غاز) حوالى 4400 متر دون متوسّط مستوى سطح البحر.



الرسم ES1: موقع البلوك 4 قبالة الساحل اللبناني، بما في ذلك منطقة التركيز وموقع البئر الاستكشافي الأوّل لعمليات الحفر

من المخطّط أن يستمرّ برنامج الحفر للبئر الاستكشافي الأوّل لحوالى 60 يومًا. ومن المتوقّع أنّ عمليات الحفر للآبار اللاحقة ستستغرق المدّة نفسها تقريبًا، لكنّها قد تصل إلى ثلاثة أشهر. يُشار إلى أنّ دراسة تقييم الأثر البيئي هذه تشمل الآثار التي قد تنتج عن الآبار الثلاثة.

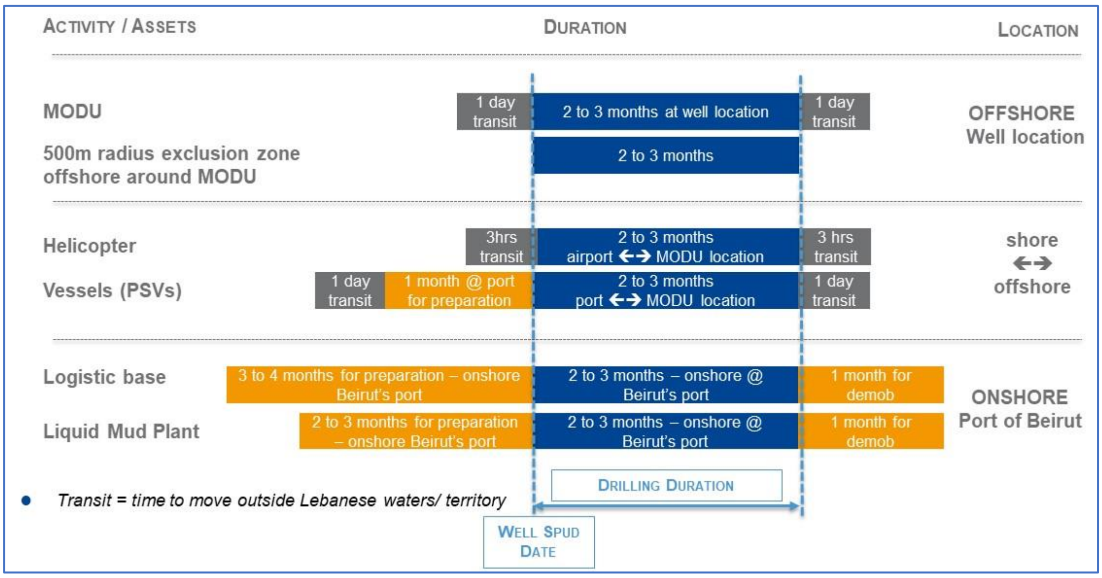
يتمّ دعم عمليات الحفر من خلال قاعدةٍ لوجستية ضمن مرفأ بيروت التجاري. وتشمل المرافق في القاعدة اللوجستية ما يلي:

- واحة أنابيب
- مخازن
- رصيف مع مساحة لتخزين وتجميع المعدّات والمواد، ورافعات متنقّلة لعمليات البواخر
- محطّة خلط سوائل الحفر ومرافق التجميع
- مساحات مخصّصة للمكاتب والمقصف والمركبات ومساحات الفرز وحاويات الشحن ومناطق لنقل النفايات والتخزين المؤقّت (لا معالجة للنفايات)

يتولّى مُقاوِلٌ بناء القاعدة اللوجستية وتشغيلها. وسوف تعتمد مدّة القاعدة اللوجستية على نجاح البئر B4-1 وأيّ آبار لاحقة.

يتمّ استخدام باخرتَين أو ثلاث بواخر للمشروع أثناء أعمال الحفر الاستكشافي: باخرة في موقع الحفر بشكل دائم للإشراف على السلامة والأمن، في حين تُخصَّص الباخرة (أو البواخر) الأخرى لنقل الإمدادات والمواد والمعدّات والنفايات بين وحدة الحفر المتنقّلة في البحر (MODU) والقاعدة اللوجستية (يُقدَّر العدد الإجمالي لرحلات الذهاب والإياب بـ8-10 رحلات في الأسبوع) خلال فترة الحفر. وسيتمّ نقل الموظّفين بطائرات الهليكوبتر من مطار رفيق الحريري الدولي إلى وحدة الحفر المتنقّلة (يُقدَّر عدد رحلات الذهاب والإياب بـ10 رحلات في الأسبوع). ويتمّ دعم العمليات بواسطة طائرتَين مروحيتَين، تتّسع كلّ منهما لـ 8 إلى 12 راكبًا.

يعرض الرسم ES2 دليلًا حول مدّة الأعمال المرتبطة ببرنامج الحفر وموقعها. مدّة الحفر المذكورة (بين شهرَيْن و3 أشهر) تشمل المدّة المخصّصة لكلّ بئر، علمًا أنّه من المتوقّع أن يستغرق البئر الأوّل حوالى 60 يومًا فقط للحفر.



الرسم ES2: مدّة وموقع كلّ نشاط من أنشطة المشروع

أهداف دراسة تقييم الأثر البيئي

أهداف دراسة تقييم الأثر البيئي هي:

- تحديد المتطلّبات القانونية والتنظيمية والمعايير الأخرى التي تنطبق على المشروع (القوانين والأنظمة المرعيّة في البلد، والاتّفاقات الدولية، والشروط والمتطلّبات الخاصّة بشركة TOTAL)؛
- تحديد المُستقبِلات الحسّاسة المرتبطة بالسياق البيئي والاجتماعي–الاقتصادي والتراثي الثقافي/الحضاري، وتحديدًا في مجال التأثير المرتبط بالمشروع؛
- إبلاغ الأطراف المعنيّة والحصول على وجهات نظرهم وآرائهم (الفئات/الأشخاص الذين قد يتأثّرون بالمشروع والجهات المهتمّة الأخرى)؛
- تحديد جوانب وأعمال المشروع التي قد تؤدّي إلى آثار بيئية أو اجتماعية–اقتصادية أو تراثية/حضارية، بالإضافة إلى تحديد درجة أهمية الآثار؛
- اقتراح تدابير للحدّ من الآثار السلبية المُحتمَلة وإيصالها إلى مستويات مقبولة، وتعزيز أيّ آثار إيجابية من الناحية البيئية أو الاجتماعية–الاقتصادية أو الثقافية/الحضارية؛
- تحديد الآثار المتبقّية، وتقييم درجة أهمية هذه الآثار؛
- الحرص على إدراج الإجراءات التخفيفية ضمن خطة الإدارة البيئية التي ستُنفَّذ من قِبَل الجهة الراعية للمشروع والمُقاوِلين والمُقاوِلين الفرعيين خلال برنامج الحفر الاستكشافي.

منطقة الدراسة

تمّ تحديد مجال التأثير لكلٍّ من المُستقبِلات البيئية والاجتماعية (receptors) بناءً على الشروط التي تنصّ عليها "المبادئ التوجيهية لتقييم الأثر البيئي لعملية المسح الأوّلي للنفط والغاز وأعمال الحفر الاستكشافي في لبنان". ويختلف نطاق مجال التأثير تبعًا لنوع الآثار التي يتمّ درسها وخصائص المُستقبِلات التي من المُحتمَل أن تتأثّر بالمشروع.

وتمّ جمع البيانات المرجعية مع التركيز على هذه المجالات، على الرغم من أنّه قد تمّ جمع المعلومات من منطقةٍ أوسع في أحيان كثيرة من أجل المساعدة في دراسة السياق العام. وعند استخدام مجالات مختلفة، نوقِشَ ذلك في القسم الخاصّ ضمن تقرير دراسة تقييم الأثر البيئي.

الإطار القانوني والإداري

يتمّ تنفيذ أعمال الحفر الاستكشافي في البلوك 4 (الرقعة رقم 4) وفقًا للشروط البيئية والاجتماعية المنصوص عليها في:

- القوانين والأنظمة الوطنية
- الاتّفاقيات والاتّفاقات الدولية المرعيّة التي تكونُ الدولة اللبنانية طرفًا فيها
- الالتزامات الخاصّة بشركة TOTAL
- أفضل الممارسات المُتعارَف عليها دوليًا

النصوص القانونية والتوجيهية الأساسية بالنسبة إلى هذا المشروع تشمل:

- مرسوم أصول تقييم الأثر البيئي ٨٦٣٣ تاريخ ٢٠١٢
- "المبادئ التوجيهية لتقييم الأثر البيئي لعملية المسح الأوّلي للنفط والغاز وأعمال الحفر الاستكشافي في لبنان" (وزارة البيئة وهيئة إدارة قطاع البترول في لبنان، 2019)
- التقييم البيئي الاستراتيجي لأنشطة الاستكشاف والإنتاج في المياه البحرية اللبنانية (وزارة الطاقة والمياه، 2019)

وتشمل التشريعات الأخرى المرتبطة أيضًا بهذا المشروع: قانون الموارد البترولية في المياه البحرية (قانون رقم 132 تاريخ 2010)، والأنظمة والقواعد المتعلّقة بالأنشطة البترولية (المرسوم رقم ١٠٢٨٩ تاريخ ٢٠١٣)، ومرسوم اتّفاقية الاستكشاف والإنتاج (الملحق رقم ٢ التابع للمرسوم رقم ٤٣ تاريخ ٢٠١٧)، وقانون حماية البيئة (القانون رقم ٤٤٤ تاريخ ٢٠٠٢)، وآلية مراجعة تقارير تحديد نطاق تقييم الأثر البيئي وتقارير تقييم الأثر البيئي (القرار 1/261 تاريخ 2015)، وقانون دعم الشفافية في قطاع البترول (قانون رقم 84 تاريخ 2018)، وقانون الحقّ في الوصول إلى المعلومات (قانون رقم 28 تاريخ 2017).

المشاركة العامة

تشتمل دراسة تقييم الأثر البيئي على مشاركة عامة، هدفها الرئيسي هو الاطّلاع على وجهات نظر وآراء الفئات التي قد تتأثّر بالمشروع وغيرها من الأطراف المعنيّة. يُستخدَم هذا المردود لإضفاء المزيد من التركيز على دراسة تقييم الآثار، ولإجراء ما يلزم من تعديلات من ناحية تصميم المشروع وتنفيذه عند الاقتضاء. في هذا المشروع، تمّت عملية مشاركة الأطراف المعنيّة وفقًا للشروط التي تنصّ عليها التشريعات اللبنانية، والسياسات الخاصّة بشركة TOTAL في هذا المجال، وأفضل الممارسات المُتعارَف عليها دوليًا. وتمّ وضع خطّة لمشاركة الأطراف المعنيّة لمشروع البلوك 4 تحديدًا، من أجل دعم المشاركة الهادفة والفعّالة خلال عملية تقييم الأثر البيئي.

أُجريَت اجتماعات المشاركة العامة واجتماعات مشاركة الأطراف المعنيّة خلال مرحلة تحديد النطاق ومرحلة جمع البيانات المرجعية. المشاركة العامة تتوجّه إلى عامة الناس، في حين أنّ مشاركة الأطراف المعنيّة تتوجّه إلى مجموعات محدّدة وأشخاص محدّدين قد يتأثّرون بالمشروع أو قد يؤثّرون عليه أو قد يكونون مهتمّين به أو لديهم مصلحة فيه، بما في ذلك

السلطات والهيئات الدولية والوطنية والمجتمع المدني والمنظّمات غير الحكومية والجهات الأكاديمية والشركات والفئات التي يُحتمَل أن تتأثّر بالمشروع.

كانت أسئلة الأطراف المعنيّة وهواجسهم وتعليقاتهم متشابهة في المرحلتَيْن وفي مختلف المجموعات (المستوى الوطني والمستوى الإقليمي والمستوى المحلّي). لكنَّ الأطراف المعنيّة على المستوى المحلّي عبّرت عن مسائل تتعلّق بمواضيع اجتماعية، مثل فُرَص العمل وسُبُل كسب العيش، في حين أنّ الأطراف المعنيّة على المستوى الوطني والإقليمي ركَّزت أكثر على المواضيع البيئية في أسئلتها وهواجسها. وتتناول هذه الدراسة المسائل والتعليقات التي وردت حتّى الآن من الأطراف المعنيّة.

بدأت مشاركة الأطراف المعنيّة بشأن تقرير تقييم الأثر البيئي في أوائل شهر أيلول/سبتمبر 2019. كانَ الهدف من المشاركة التأكّد من إطلاع الأطراف المعنيّة على نتيجة دراسة تقييم الأثر البيئي وفهمها، وخاصّةً الآثار المحدّدة والإجراءات التخفيفية. وتمّ الردّ على تعليقات الأطراف المعنيّة خلال هذه المرحلة ضمن هذه النسخة من تقييم الأثر البيئي. وستستمرّ مشاركة الأطراف المعنيّة بعد تقديم دراسة تقييم الأثر البيئي النهائية.

ملخّص عن وصف البيئة المحيطة بالمشروع

من أجل تحديد الآثار المُحتمَلة على المُستقبِلات (receptors)، يجب فهم البيئة المحيطة بالمشروع قبل المشروع.

أُجرِيَت الدراسات/الاستطلاعات التالية لحملة الحفر الاستكشافي في البلوك 4 واستُخدِمَت لتوجيه عملية تقييم الأثر البيئي:

- دراسة الوضع البيئي الاجتماعية المحيط بالمشروع – مراجعة بيبليوغرافية وجمع البيانات الأوّلية
- دراسة الوضع البيئي البحري المحيط بالمشروع – مراجعة بيبليوغرافية
- مسح للبيئة البحرية المحيطة بالمشروع – أخذ عيّنات المياه والرواسب وتحليلها الكيميائي والفيزيائي والبيولوجي، ومراقبة قاع البحر بالفيديو (الحيوانات البحرية والمراقبة الأثرية)، ومراقبة الحيوانات البحرية على متن وحدة الحفر (الثدييات البحرية والطيور البحرية والزواحف)، وغيرها من الكائنات الموجودة في البيئة البحرية

تشمل المُستقبِلات البيئية التي قد تتأثّر بالمشروع:

- جودة الهواء – تتأثّر منطقة شرق البحر المتوسّط بمصادر مختلفة لتلوّث الهواء، بما في ذلك الملوّثات الطويلة المدى المحمولة في الجوّ والجزيئات الناتجة عن العواصف الغبارية
- جودة مياه البحر – تُعتبَر المياه في عرض البحر منخفضة العكورة وتحتوي على نسبة قليلة من المغذّيات وهي غير ملوّثة وتمثّل الظروف النموذجية للمواقع البحرية في منطقة شرق البحر المتوسّط، في حين أنّ مياه البحر الساحلية تعاني من تلوّث شديد في بعض المناطق من جرّاء الأنشطة البشرية

- جودة الرواسب – الرواسب البحرية تشمل الطين البنيّ اللون الذي تكثُر فيه الجزيئات الدقيقة، وهذه الرواسب تمثّل الخصائص النموذجية لرواسب أعماق البحر في منطقة شرق البحر المتوسّط، مع تلوّث منخفض باستثناء بعض المعادن الثقيلة، علمًا أنّ الرواسب الساحلية تتّصف بنِسَب أعلى من التلوّث بالمعادن الثقيلة والهيدروكربونات والمغذّيات
- الموائل الساحلية – تُعتبَر أحواض الأعشاب البحرية والشعاب الفرميتيدية[1] من خصائص المياه الساحلية اللبنانية، وهي تساهم في تحديد المعايير الخاصّة بالمناطق البحرية المحمية المُقترَحة في الساحل
- البيئات القاعية في المياه العميقة – تكثُر فيها الحيوانات المرتبطة برواسب المياه العميقة في منطقة شرق البحر المتوسّط، وتُعتبَر البيئة فقيرة نسبيًا من حيث وفرة الأجناس وتنوّعها، ما يدلّ على انخفاض مستويات المواد العضوية والمغذّيات
- العوالق – الإنتاجية الأوّلية للعوالق النباتية في البحر منخفضة بسبب العمود المائي القليل التغذية والتقسيم الطبقي، في حين أنّ العوالق الحيوانية قليلة الوفرة لكنّ تنوّعها معتدل إلى مرتفع
- الأسماك – تحتوي المياه اللبنانية على أكثر من 100 نوع من الأسماك التي لها أهمية تجارية، بالإضافة إلى عدد من أنواع الأسماك وأسماك القرش والأسماك الغضروفية المهدّدة بالانقراض
- الثدييات البحرية – يُشار إلى وجود العديد من الأنواع في منطقة شرق البحر المتوسّط، وتشمل أنواعًا من الحيتان والدلافين وفقمة الراهب المتوسّطية (المهدّدة بالانقراض بشدّة في البحر الأبيض المتوسّط). بالإجمال، تُعتبَر الثدييات البحرية قليلة في مياه لبنان، علمًا أنّ الدلافين المختنقة هي النوع الأكثر شيوعًا
- السلاحف – السلاحف الخضراء والسلاحف الجلدية الظهر والسلاحف الضخمة الرأس موجودة في المياه اللبنانية، حيث تمتدّ مناطق العَلَف ومسارات التنقُّل الخاصّة بهذه السلاحف على طول الساحل. وتوجد مواقع تعشيش السلاحف الخضراء والسلاحف الضخمة الرأس على السواحل الرملية في جنوب لبنان
- الطيور – النوارس كانَت من أكثر أنواع الطيور التي تمَّت مشاهدتها خلال المسح المرجعي للبيئة البحرية في البلوك 4، كما شوهِدَت أيضًا طيور الجلم والكركر والبطّ والبلشونيات
- المناطق المحمية – الموقع المُصنَّف وطنيًا الأقرب إلى منطقة التركيز التابعة للبلوك 4 هو محمية جزر النخيل الطبيعية في الشمال. أمّا المواقع التي يجب الحفاظ عليها والتي تُعتبَر الأقرب إلى منطقة التركيز التابعة للبلوك 4 فهي المنطقة البحرية المحمية المُقترَحة عند المنصّة الخارجية لمرفأ بيروت وثلاثة مواقع مُحدَّدة من قِبَل OCEANA باعتبارها مواقع في أعماق البحر تستوجب الحماية (أخدود جونيه، وأخدود مار جرجس، ومنحدر بيروت)

تشمل المُستقبِلات الاجتماعية–الاقتصادية التي قد تتأثّر بالمشروع:

- الظروف الاجتماعية (السلامة والأمن) في المجتمعات المحلّية – المجتمعات الساحلية المُحاذِية للبلوك 4 والمجتمعات الواقعة في جوار مرفأ بيروت، والمجتمعات الواقعة على امتداد طريق النقل الخاصّ بطائرات الهليكوبتر وبالقرب من مطار رفيق الحريري الدولي، والمجتمعات المواقعة على امتداد مسارات النقل للمركبات الخاصّة بالمشروع

[1] تتألّف الشعاب الفرميتيدية من القواقع الدودية. وتُعتبَر أصداف القواقع الفرميتيدية غير منتظمة إلى حدّ كبير، كما أنّها لا تشبه أصداف القواقع الاعتيادية.

- مصايد الأسماك – يتّخذ قطاع صيد الأسماك في لبنان طابعًا حِرَفيًا، ويعتمد على أسطول تقليدي صغير من البواخر الخشبية المُزوَّدة بمحرّك. القانون يحصر مناطق الصيد بستة أميال بحرية من الساحل، وبواخر صيد الأسماك لا تستخدم مرفأ بيروت. تجدر الإشارة أيضًا إلى أنّ العاملين في مجال صيد الأسماك متفرّغون لذلك ولا يملكون أيّ أنشطة بديلة لكسب العيش أو أيّ ترتيبات للضمان الاجتماعي
- السياحة – ضمن المنطقة الساحلية، تشكّل السياحة مُساهِمًا رئيسيًا في الاقتصاد المحلّي. تستضيف بيروت غالبية السيّاح، على الرغم من وجود منتجعات شاطئية وشواطئ وأحواض سباحة ومرافئ للإبحار الترفيهي ومواقع للغوص على طول الساحل. ويُعتبَر الصيد بالصنّارة نشاطًا ترفيهيًا يُمارَس على طول الساحل اللبناني وفي جميع الفصول، وبشكل خاصّ في فصل الصيف
- الشحن – يُعتبَر مرفأ بيروت أحد أكبر المرافئ في منطقة شرق البحر المتوسّط، كما أنّه محطّة تجارية دولية هامّة بالنسبة إلى البلدان العربية المحيطة. يوجد عدد هامّ من مسارات الشحن بمحاذاة الحدود الجنوبية للبلوك 4 وصولًا إلى القسم الغربي من البلوك
- الموارد الأثرية والحضارية – من خلال المراجعة الأثرية التي أُجريَت بواسطة مراقبة قاع البحر بالفيديو أثناء المسح للبيئة البحرية، لم يتمّ العثور على أيّ معالم أثرية في منطقة البلوك 4. تمّ تحديد عدّة مواقع تراثية ذات أهمية تاريخية في المنطقة الساحلية، بما في ذلك الآثار، مثل المُدُن تحت الماء ومصدّات الأمواج القديمة والأسوار الفينيقية. وتُعتبَر الآثار في عمشيت أقرب موقع بحري بالنسبة إلى منطقة البلوك 4
- البنى التحتية – يملك لبنان شبكة واسعة نسبيًا من البنى التحتية التي تشمل الطرقات والمرافئ وإمدادات الكهرباء وإمدادات المياه والاتّصالات. وأدّى تزايُد عدد السكّان وتوافد النازحين إلى فرض ضغط على البنى التحتية المتقادمة والتي كانت تعاني من الضغط في الأساس
- الصحّة العامة – يمرّ لبنان، مثل العديد من بلدان الشرق الأوسط، بمرحلة "تحوُّل وبائي"، ومن أبرز خصائص هذه المرحلة ازدياد أعداد السكّان المسنّين الذين يعانون من الأمراض المزمنة وغير المعدية. وأدَّت الأزمة السورية وما نجم عنها من توافد للنازحين إلى زيادة الطلب على خدمات الرعاية الصحّية، فازدادَت تكاليف الحكومة بشكل ملحوظ لتلبية هذا الطلب المتزايد
- الاقتصاد العام – يعتمد هيكل الاقتصاد الكلّي في لبنان بشكل كبير على قطاع الخدمات، حيث يشكّل القطاع العقاري أكبر قطاعٍ في مجال الخدمات. وتجدر الإشارة إلى أنّ النموّ الاقتصادي قد تراجع منذ العام 2011 وبدء الأزمة السورية
- التعليم والتدريب – تبيَّنَ وجود مستويات عالية من التحصيل العلمي في جميع المجتمعات التي شملَتها العيّنة، مع الإشارة إلى أنّ مستويات التحصيل العلمي بين بعض المجموعات، مثل الصيّادين (لا سيّما الكبار في السنّ)، تُعتبَر أدنى من معدّل المستوى العامّ للسكّان

الآثار المُحتمَلة للمشروع

تمّ تحديد الآثار المُحتمَلة باستخدام الجدول الأوّلي لتحديد الآثار الوارد في "تحديث التقييم البيئي الاستراتيجي لأنشطة الاستكشاف والإنتاج في المياه البحرية اللبنانية (وزارة الطاقة والمياه، 2019)" كدليل توجيهي.

يلخّص الجدول ES-1 الآثار الرئيسية المُحتمَلة الناتجة عن حملة الحفر الاستكشافي في البلوك 4. ويحتوي الفصل 6 من دراسة تقييم الأثر البيئي على مراجعة شاملة ومنهجية وتقييمية لكافة الآثار المُحتمَلة لأعمال الحفر. ومن خلال الالتزام بأفضل الممارسات المُتعارَف عليها دوليًا لتجنّب الآثار أو التخفيف منها والالتزام بالشروط القانونية اللبنانية، من المتوقّع أن تكون الآثار المتبقّية الناتجة عن الأنشطة الروتينية محدودة أو ضئيلة. الاستثناء هو من تفريغ العيّنات الفتاتية المائية وسوائل الحفر في قاع البحر أثناء حفر طبقات البئر العليا في البلوك 4 التي تمّ تصنيفها باعتبارها تحمل آثارًا متبقّية ذات أهمية متوسّطة[2]. لا يمكن إعادة العيّنات الفتاتية والسوائل إلى جهاز الحفر خلال هذا الجزء من العمل لأنّ هذه الطبقات تُحفَر بدون أنبوب صاعد بحري. أمّا الآثار على العمود المائي فترتبط بتصريف منتجات الحفر الخاملة، غير القابلة للذوبان، الباريت والبنتونيت، بالإضافة إلى تأثيرات التعكّر على الحيوانات البحرية.

الجدول ES1: الآثار المُحتمَلة نتيجة حملة أعمال الحفر الاستكشافي في البلوك 4

	جودة الهواء	التغيّر المناخي	جودة/تكوين الرواسب	جودة المياه		القاعيّات	الأسماك	العوالق	الطيور البحرية	الحيتانيات والسلاحف وزعنفيات	الموائل البحرية الحسّاسة	الموائل الساحلية	الإيكولوجيا البرّية	الموارد الأثرية والحضارية	البنى التحتية	الظروف الاجتماعية	التعليم والتدريب	الاقتصاد العام	مصايد الأسماك	الشحن	السياحة	الصحّة العامة
الأنشطة الروتينية																						
إقامة وحدة الحفر المتنقّلة في البحر (MODU) وتركيبها وسدّ البئر وتركه وتفكيك الوحدة	X	X	X	X		X	X	X		X	X			X					X	X		
تسرّب العيّنات الفتاتية أثناء الحفر الخيار 1 – استخدام سوائل الحفر غير المائية في الطبقات السفلية تسرّب العيّنات الفتاتية الناجمة عن الحفر وسوائل الحفر المائية من الطبقات العليا الخالية من الصواعد فقط (الخيار المحدّد			X	X		X	X				X			X	X				X	X	X	

[2] يوجد أيضًا خيار للآبار المستقبلية في البلوك 4، ويقضي هذا الخيار باستخدام سوائل الحفر المائية العالية الأداء في طبقات الآبار السفلية. في هذه الحالة، سيكون هناك تسرّب للعيّنات الفتاتية وسوائل الحفر المائية من طبقات الآبار الخالية من الصواعد، بالإضافة إلى تسرّب عيّنات سوائل الحفر المائية العالية الأداء من طبقات الآبار السفلية. وتمّ تصنيف هذا الخيار أيضًا باعتباره يحمل آثارًا متبقّية ذات أهمية متوسّطة.

	جودة الهواء	التغيّر المناخي	جودة/تكوين الرواسب	جودة المياه		القاعيّات	الأسماك	العوالق	الطيور البحرية	الحيتانيات والسلاحف وزعنفيات	الموائل البحرية الحسّاسة	الموائل الساحلية	الإيكولوجيا البرّية	الموارد الأثرية والحضارية	البنى التحتية	الظروف الاجتماعية	التعليم والتدريب	الاقتصاد العام	مصايد الأسماك	الشحن	السياحة	الصحّة العامة
للبئر B4-1 والخيار المُحتمَل للآبار الاستكشافية/التقييمية المستقبلية المُحتمَلة في البلوك 4)																						
تسرّب العيّنات الفتاتية أثناء الحفر الخيار 2 – استخدام سائل حفر مائي عالي الأداء (HPWBDF) في الطبقات السفلية تسرّب العيّنات الفتاتية الناجمة عن الحفر وسوائل الحفر المائية من الطبقات العليا الخالية من الصواعد وتسرّب العيّنات الفتاتية الناجمة عن سوائل الحفر المائية العالية الأداء من طبقات الآبار السفلية (خيارٌ للآبار الاستكشافية/التقييمية المستقبلية المُحتمَلة في البلوك 4)			X	X		X	X	X		X	X								X	X	X	
نقل العيّنات الفتاتية والسوائل الناجمة عن سوائل الحفر غير المائية (NADF) إلى الشاطئ (ينطبق فقط على الخيار 1 أعلاه)	X	X													X				X	X	X	
تسرّب المواد الإسمنتية خلال أعمال الحفر			X			X																
تسرّب معجون الأنابيب خلال أعمال الحفر				X			X	X											X			
التسرّبات الناجمة عن اختبار مانع الانفجار (BOP) خلال أعمال الحفر				X			X	X											X			
تسرّب الصرف الصحّي من وحدة الحفر المتنقّلة في البحر وبواخر الدعم/ التموين				X			X	X											X			
تسرّب النفايات الغذائية من وحدة الحفر المتنقّلة في البحر وبواخر الدعم/ الإمداد (لا يُسمَح بأيّ تسرّب في حالة البئر B4-1 عند أقلّ من 12 ن.م. من الأرض. يُسمَح بالتسرّب للآبار الاستكشافية/التقييمية المستقبلية المُحتمَلة إذا كانت تتعدّى 12 ن.م. من الأرض.)				X			X	X											X			
التسرّبات الناجمة عن وحدة التحلية في وحدة الحفر المتنقّلة في البحر				X			X	X											X			
تسرّب مياه التصريف (تصريف المياه المتجمّعة على سطح الوحدة، ومياه الإطفاء، ومياه الجوف والمياه المجمّعة من مختلف المصارف) من وحدة الحفر المتنقّلة في البحر وبواخر الدعم/ التموين				X			X	X											X			
رفع وتصريف مياه التبريد من وحدة الحفر المتنقّلة في البحر				X			X	X											X			

	جودة الهواء	التغيّر المناخي	جودة/تكوين الرواسب	جودة المياه		القاعيّات	الأسماك	العوالق	الطيور البحرية	الحيتانيات والسلاحف وزعنفيات	الموائل البحرية الحسّاسة	الموائل الساحلية	الإيكولوجيا البرّية	الموارد الأثرية والحضارية	البنى التحتية	الظروف الاجتماعية	التعليم والتدريب	الاقتصاد العام	مصايد الأسماك	الشحن	السياحة	الصحّة العامة
تسرّب سوائل الإثقال من وحدة الحفر المتنقّلة في البحر وبواخر الدعم/التموين				X			X	X											X			
إنتاج النفايات الصلبة في وحدة الحفر المتنقّلة في البحر وبواخر الدعم/ الإمداد	لا آثار شرط إدارة النفايات بالشكل المناسب																					
تشغيل المحرقة في وحدة الحفر المتنقّلة في البحر (لا ينطبق ذلك في حالة البئر B4-1 بسبب عدم وجود محرقة على وحدة الحفر، لكنّه قد ينطبق على الآبار الاستكشافية/التقييمية المستقبلية المُحتمَلة، بحسب وحدة الحفر التي سيتمّ اختيارها)	X	X																				
انبعاثات جوّية بفعل إنتاج الطاقة في وحدة الحفر المتنقّلة في البحر وبواخر الدعم/ التموين	X	X																				
اختبار بئر التقييم المستقبلي المُحتمَل حفره (لا ينطبق في حالة البئر B4-1)	X	X																				
الضجيج تحت الماء نتيجة أنشطة المسح الزلزالي العمودي (VSP)							X			X									X			
الضجيج تحت الماء نتيجة عمليات وحدة الحفر المتنقّلة في البحر وبواخر الدعم/ التموين							X			X									X			
أنشطة الدعم (حركة بواخر الدعم)															X				X	X	X	
تسرّب الأضواء من وحدة الحفر المتنقّلة في البحر							X		X	X											X	
نقل المواد الكيميائية وتخزينها	لا آثار شرط إدارة المواد الكيميائية بالشكل المناسب																					
تسجيل قياسات الآبار باستخدام المصادر المشعّة المختومة radioactive sealed sources (ينطبق أيضًا على تخزين المصادر المشعّة المختومة ونقلها على اليابسة)	لا آثار في ظلّ العمليات الطبيعية																					
تشغيل القاعدة اللوجستية															X	X	X	X			X	X
تشغيل القاعدة اللوجستية – الانبعاثات الجوّية	X	X																				X
تشغيل القاعدة اللوجستية – تسرّب مياه الصرف				X																		
تشغيل القاعدة اللوجستية – إنتاج الضجيج													X								X	X
تشغيل القاعدة اللوجستية – إدارة النفايات	لا آثار شرط إدارة النفايات بالشكل المناسب														X	X						X
تشغيل القاعدة اللوجستية – إدارة المواد الكيميائية	لا آثار شرط إدارة المواد الكيميائية بالشكل المناسب																					
النقل بطائرات الهليكوبتر إلى مطار رفيق الحريري الدولي									X			X	X		X						X	X
سيناريوهات الحوادث العَرَضية المُحتمَلة																						
سقوط جسم من وحدة الحفر المتنقّلة في البحر (الرفع)			X			X																
حصول خلل في احتواء المواد الكيميائية على متن وحدة الحفر المتنقّلة في البحر			X	X		X	X	X											X			

	جودة الهواء	التغيّر المناخي	جودة/تكوين الرواسب	جودة المياه		القاعيّات	الأسماك	العوالق	الطيور البحرية	الحيتانيات والسلاحف وزعنفيات	الموائل البحرية الحسّاسة	الموائل الساحلية	الإيكولوجيا البرّية	الموارد الأثرية والحضارية	البنى التحتية	الظروف الاجتماعية	التعليم والتدريب	الاقتصاد العام	مصايد الأسماك	الشحن	السياحة	الصحّة العامة
فقدان المصدر المشعّ في البئر			X																			
حدوث ثقب في الأنبوب الصاعد وتسرّب سوائل الحفر في البحر			X	X		X	X	X											X			
انفجار غازي على عمق منخفض – تسرّب الغاز في العمود المائي	X		X	X		X	X	X											X	X		
انفجار – تسرّب الانبعاثات الكثيفة والغاز	X			X			X	X	X	X		X		X	X	X		X	X	X	X	X
اصطدام سفينة تابعة لطرف ثالث بوحدة الحفر المتنقّلة في البحر – تسرّب مخزونات وقود السفينة التابعة للطرف الثالث، واحتمال وقوع أضرار في وحدة الحفر المتنقّلة في البحر والأنبوب الصاعد				X			X	X	X	X	X								X	X		
تحطّم طائرة هليكوبتر على سطح وحدة الحفر المتنقّلة في البحر – تسرّب وقود الطيران في البحر				X				X														
حصول خلل في إجراءات الاحتواء أثناء نقل المواد بحرًا إلى وحدة الحفر المتنقّلة في البحر – تسرّب سوائل الحفر أو الديزل البحري في البحر			X	X		X	X	X											X			
فقدان توازن المنصّة (انقلاب المنصّة) بسبب الظروف المناخية البحرية، مع تسرّب مخزونات الوقود				X			X	X	X	X	X	X		X	X	X		X	X	X	X	X
وقوع زلزال، ما يؤدّي إلى تضرُّر سلامة البئر وتسرّب الهيدروكربونات في البحر				X			X	X	X	X	X	X		X	X	X		X	X	X	X	X
حصول خلل في إجراءات الاحتواء أثناء نقل المواد إلى بواخر الدعم/ الإمداد على الرصيف – تسرّب سوائل الحفر/ الديزل في البحر				X																	X	

يمكن تجميع الآثار المُقدَّمة في دراسة تقييم الأثر البيئي على النحو التالي.

التجهيز والتركيب والتفكيك

ترتبط الآثار الناجمة عن تجهيز وتركيب وتفكيك وحدة الحفر المتنقّلة في البحر بأنشطة تشغيل جهاز الحفر والانبعاثات المتّصلة به (عوادم المحرّكات)، والضجيج (من المحرّكات والتحديد الموقعي الديناميكي)، وتصريفات المياه العادمة (مياه

الصرف الصحّي، والنفايات الغذائية المتآكلة، وتصريفات وحدة التحلية، والتصريف، ومياه التبريد، ومياه الصابورة). وهناك أيضًا آثار مُحتمَلة على الشحن ومصايد الأسماك من جرّاء وجود وحدة الحفر المتنقّلة في البحر ومنطقة الأمان التابعة لها[3].

تمّ اختيار سفينة حفر لبرنامج حفر البئر B4-1. في حال استخدام جهاز حفر نصف مغمور للآبار الاستكشافية/التقييمية التي قد تُقام لاحقًا، فهناك آثار إضافية مُحتمَلة ناتجة عن عملية الرسو على رواسب قاع البحر والبيئات القاعية، وأيّ معالم أثرية غير معروفة في قاع البحر.

عمليات الحفر

تؤدّي عمليات الحفر إلى تصريفات في البيئة البحرية، مثل العيّنات الفتاتية وسوائل الحفر، وكمّيات صغيرة من الإسمنت وطلاء الأنابيب وسوائل اختبار مانع الانفجار.

سيتمّ حفر آبار البلوك 4 على خمس طبقات، ويُصبِح القُطر (diameter) أضيق تدريجيًا كلّما ازدادَ عمق عملية الحفر.

يتمّ حفر الطبقتَيْن الأولى والثانية من الثقب "من دون أنبوب صاعد" (لا توجد إمكانية لاستعادة العيّنات الفتاتية الناتجة خلال حفر هذه الطبقات) وتترسّب العيّنات الفتاتية وسوائل الحفر في قاع البحر مباشرةً حول موقع البئر. تُحفَر هذه الطبقات باستخدام مياه البحر وسوائل الحفر المائية.

وبالنسبة إلى الطبقات الثلاث الباقية، يتمّ وضع أنبوب بحري، وتُعاد العيّنات الفتاتية وسوائل الحفر إلى وحدة الحفر المتنقّلة. هناك خياران في ما يتعلّق باستخدام سوائل الحفر في هذه الطبقات السفلية:

- الخيار 1: استخدام سائل حفر غير مائي (NADF) لضمان ملاءمته مع التكوينات الجيولوجية الموجودة. في هذه الحالة، لن يتمّ تصريف العيّنات الفتاتية وسوائل الحفر، بل يتمّ شحنها إلى الشاطئ للمعالجة والتخلّص منها.
- الخيار 2: استخدام سائل حفر مائي عالي الأداء (HPWBDF). في هذه الحالة، يتمّ تصريف العيّنات الفتاتية في البحر من جهاز الحفر، ويخضع ذلك لموافقة السلطات المعنيّة. ويتمّ فصل سوائل الحفر عن العيّنات الفتاتية على منصّة جهاز الحفر ويُعاد استخدامها في طبقات الآبار اللاحقة.

تمّ اختيار الخيار الأوّل للبئر الاستكشافي الأوّل B4-1 بما أنّ التكوينات الجيولوجية لأسفل البئر غير معروفة جيّدًا في الوقت الحالي، وخيار سائل الحفر غير المائي NADF يوفّر ثباتًا أفضل للبئر. وبالنسبة إلى الآبار اللاحقة في البلوك 4، يتمّ تطبيق الخيار 1 أو الخيار 2 اعتمادًا على نتائج البئر الأوّل.

أمّا التخلّص من العيّنات الفتاتية وسوائل الحفر المائية في البحر فقد يؤثّر على جودة مياه البحر والرواسب، والكائنات القاعية، والكائنات التي تعيش في العمود المائي (الأسماك والعوالق)، والموائل البحرية الحسّاسة، ومصايد الأسماك والبنى التحتية (الكابلات البحرية). وستؤدّي عملية التخلّص من العيّنات الفتاتية برًّا إلى آثار مرتبطة بالانبعاثات الجوّية من جرّاء

[3] سيتمّ إنشاء منطقة أمان (500 م) حول وحدة الحفر المتنقّلة في البحر (MODU).

النقل بالبواخر، بالإضافة إلى الآثار المُحتمَلة على المُستقبِلات البرّية. تجدر الإشارة إلى أنّه في حالة البئر الأوّل في برنامج حفر البلوك 4، سيتمّ تصدير العيّنات الفتاتية الناتجة عن سوائل الحفر غير المائية إلى قبرص لمعالجتها والتخلّص منها في منشآة المعالجة التابعة لـ"مركز الحلول البيئية المبتكرة" (IESC). تخضع هذه المنشأة لترخيصٍ منفصل من قِبَل السلطات في قبرص، ويُعتبَر هذا المسار خارج نطاق هذه الدراسة لتقييم الأثر البيئي.

في حال أُجريَ مسح زلزالي عمودي[4] للآبار في البلوك 4، سوف يؤدّي ذلك إلى إنتاج ضجيج نبضيّ تحت الماء في المنطقة لفترة زمنية قصيرة جدًا، ما قد يؤثّر على الحيوانات البحرية، وخصوصًا الحيتان والدلافين والسلاحف. وستؤدّي أيضًا أنشطة الحفر على وحدة الحفر المتنقّلة إلى مستويات أدنى ومستمرّة من الضجيج تحت الماء.

لن يتمّ إجراء اختبار لبئر الاستكشاف الأوّل في البلوك رقم 4. وفي حال إجراء عملية اختبار لبئرٍ في المستقبل، فسيترافق ذلك مع انبعاثات جرّاء إحراق سوائل الاختبار، مع تأثيرات مُحتمَلة على جودة الهواء.

وقد تؤثّر عمليات وحدة الحفر المتنقّلة في البحر على الموارد الأثرية والحضارية (خلال بدء حفر البئر ومن جرّاء مراسي جهاز الحفر شبه المغمور)، كما أنّ وجود وحدة الحفر المتنقّلة ومنطقة الأمان التابعة قد يؤثّر على الشحن ومصايد الأسماك ويُحتمَل أن يؤثّر أيضًا على السياحة (من تغييرات المنظر المُطِلّ على البحر من الشاطئ).

أعمال الدعم

من المُحتمَل أن تؤدّي القاعدة اللوجستية على البرّ إلى آثار متعلّقة بالهواء والضجيج من جرّاء تشغيل محطّة خلط سوائل الحفر/منشأة التجميع وأيّ مولّد(مولّدات) مرتبط(ة) بها ومن جرّاء عمليات التحميل/التفريغ، بالإضافة إلى الآثار المُحتمَلة على البنية التحتية لمرفأ بيروت. وفي ما يتعلّق بالآثار الإيجابية، فإنّ تشغيل القاعدة اللوجستية قد يؤدّي إلى فُرَص عمل وتدريب محلّية (علمًا أنّها تقتصر على مرحلة الاستكشاف هذه).

من جهة أخرى، من المُحتمَل أن تؤدّي حركة بواخر التموين بين وحدة الحفر المتنقّلة في البحر والقاعدة اللوجستية إلى آثار على الحيوانات البحرية (آثار ناجمة عن الضجيج تحت الماء)، وجودة المياه (من عمليات تصريف المياه العادمة التشغيلية من البواخر)، والبنى التحتية الساحلية (مرفأ بيروت)، والشحن، ومصايد الأسماك، والسياحة (الأنشطة الترفيهية).

أمّا عمليات نقل طواقم العمل بواسطة طائرات الهليكوبتر فقد يكون لها آثار مُحتمَلة مرتبطة بالضجيج على الموائل الساحلية الحسّاسة، والمجتمعات المحلّية، والسياحة.

الحوادث العَرَضية والآثار العابرة للحدود

يتمّ تحليل الحوادث المفاجئة أو غير المخطّط لها بشكل منفصل عن العمليات الروتينية المخطّط لها، إذ عادةً ما تطرأ نتيجة وقوع خلل فنّي أو خطأ بشري أو ظاهرة طبيعية، كالزلازل.

[4] المسح الزلزالي العمودي يشمل إجراء عمليات قياس بسمّاعات أرضية داخل حفرة البئر ومصادر (مجموعة مدافع هوائية) على السطح قرب البئر. وتُنتِج هذه الطريقة عادةً معلومات جيولوجية أكثر دقّة من تقنية المسح الزلزالي بالمصفوفات السطحية المقطورة.

يُظهِر الجدول ES-1 احتمالات تمثيلية عن حوادث قد تقع خلال حملة أعمال الحفر الاستكشافي في البلوك 4، كما ترد هذه الاحتمالات بشكل أكثر تفصيلًا في الفصل 6 من دراسة تقييم الأثر البيئي. تمّ إجراء عملية نمذجة لنوعَيْن من حوادث تسرّب الهيدروكربونات على نطاقٍ واسع (انفجار البئر مع تسرّب الانبعاثات الكثيفة وتسرّب فوري لكمية كبيرة من وقود الديزل البحري في البلوك 4) كجزء من دراسة تقييم الأثر البيئي. وتُشير النتائج إلى إمكانية وصول بعض بقايا النفط إلى الساحل الشمالي للبنان وسوريا.

تُعتبَر الضوابط والتدابير الرامية إلى الحدّ من احتمال وقوع حادث انسكاب/تسرُّب جزءًا أساسيًا من عملية الإجراءات التخفيفية، وهي موضَّحة في الفصل 6. وقامت شركة TEP Liban بوضع خطّة للطوارئ الخاصّة بحوادث الانسكابات النفطية، مع التركيز على تحسين الاستجابة في البحر للحدّ قدر الإمكان من الآثار المنتقلة إلى الساحل وعبر الحدود.

الآثار التراكمية

الآثار التراكمية تأخذ في الاعتبار الأثر الإضافي للنشاط الأوّلي (أي المشروع الحالي) مع أيّ أنشطة محلّية ناتجة عن طرف ثالث.

سيكون برنامج الحفر الخاصّ بشركة TEP Liban في البلوك 4 أوّل نشاط حفر استكشافي بحري في لبنان. والبلوك الآخر الوحيد في المياه البحرية اللبنانية الذي تمّ اعتماده حاليًا هو البلوك 9، وتتعهّده شركة TEP Liban أيضًا. تبلُغ المسافة التقريبية التي تفصل بين البلوك 4 والبلوك 9 حوالى 45 كلم. بالتالي، لا يُتوقَّع حدوث آثار تراكمية من أيّ أنشطة متزامنة في المستقبل في هاتين الرقعتَيْن.

ولا توجد مشاريع مستقبلية أخرى معروفة في منطقة البلوك 4.

إدارة وتنفيذ الإجراءات التخفيفية

يجب وضع إجراءات لضمان تنفيذ شركة TEP Liban والمقاولين الالتزامات الواردة في دراسة تقييم الأثر البيئي خلال حملة أعمال الحفر الاستكشافي.

وقد تمّ إعداد سجلّ التزامات يضمّ جميع الإجراءات التخفيفية التي تمّ تحديدها في دراسة تقييم الأثر البيئي. يتمّ رصد هذه الالتزامات من خلال خطط للإدارة البيئية والاجتماعية، أُعِدَّت لحملة أعمال الحفر. تشكّل خطط الإدارة البيئية والاجتماعية جزءًا من نظام إدارة الصحّة والسلامة والبيئة الخاصّ بشركة TEP Liban. وتشكّل خطط الإدارة البيئية والاجتماعية أساسًا لإعداد وتنفيذ خطط لاحقة تفصيلية من قبل المقاولين المعنيّين بوحدة الحفر المتنقّلة في البحر، وسوائل الحفر والإسمنت؛ والمقاول المعني بالقاعدة اللوجستية؛ والمقاول المعني ببواخر الدعم/الإمداد، الذين سيُطلَب منهم الالتزام بالمتطلّبات البيئية والاجتماعية ذات الصلة، الواردة في خطط الإدارة البيئية والاجتماعية الخاصّة بشركة TEP Liban.

كذلك، على المقاولين وضع أنظمة خاصّة بهم لإدارة الصحّة والسلامة والبيئة.

الخلاصة

قدّمَ هذا التقرير تقييمًا للآثار البيئية والاجتماعية المرتبطة بأعمال الحفر الاستكشافي في البحر التي تعتزم شركة TEP Liban القيام بها في البلوك 4.

تمّ النظر في البدائل الممكنة لأعمال المشروع المُقترَحة؛ وتمّ اختيار الموقع المُقترَح للبئر الاستكشافي B4-1 استنادًا إلى مسار الحفر المباشر نحو مخزون الهيدروكربونات المرتقب؛ كما أنّ جهاز الحفر سيكون مُصمَّمًا خصّيصًا للعمل في بيئة المياه العميقة في البلوك 4 في لبنان، وسيتضمّن ميزات تشغيلية عالية الكفاءة؛ وسيتمّ التعامُل مع التصريفات الناتجة عن أعمال الحفر وفقًا لما تنصّ عليه اتّفاقية "ماربول" (MARPOL) 78/73.

تمّ اختيار موقع القاعدة اللوجستية البرّية الخاصّة بالمشروع استنادًا إلى مبدأ الحدّ قدر الإمكان من الإخلال بالبنية التحتية الحالية، وكان مرفأ بيروت هو الخيار الأقرب والأنسب حيث تتوفّر فيه الإمكانات المطلوبة دون الحاجة إلى التوسيع.

خلال تقييم الأثر البيئي، تمّ تحديد جميع المُستقبِلات (receptors) البيئية والاجتماعية–الاقتصادية التي ترتبط بالمشروع، وتمّ تقييم مدى حساسيتها تجاه أعمال المشروع المُقترَحة، كما تمّ النظر في الإجراءات التخفيفية إذا لم يكن من الممكن تجنّب الآثار. باختصار، من المتوقّع أن تكون جميع الآثار المحدّدة في هذا التقييم قابلة للمعالجة مع وجود بعض الآثار المقبولة التي قد تبقى بعد تطبيق الإجراءات التخفيفية.

تجدر الإشارة إلى أنّ مشروع الحفر الاستكشافي المُقترَح من قبل TEP Liban هو أوّل مشروع من هذا النوع يتمّ تقديمه للموافقة عليه في لبنان. بالتالي، إذا نجحت عملية الاستكشاف، فقد تكون لها آثار مفيدة مُحتمَلة على الاقتصاد الوطني للبنان.

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APPENDICES

GLOSSARY

Acronym or term	Definition
A	
AeDW	Aegean deep water
AdDW	Adriatic deep water
ACCOBAMS	Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area
AEWA	Agreement on the Conservation of African-Eurasian Migratory Water Birds
AIDS	Acquired Immunodeficiency Syndrome
AIS	Alien invasive species
AOI	Area of Influence
AOX	Halogenated organic compounds
AQMN	Air Quality Monitoring Network
B	
BAOAC	Bonn Agreement Oil Appearance Code
BAT	Best Available Technique
bbls/day	Barrels per day
BC	Before Christ
Beaufort scale	Scale of wind speed
BHA	Bottom Hole Assembly
BID	Background Information Document
BOCP	Blowout Contingency Plan
BOD	Biological oxygen demand
BOP	Blowout preventer
BTEX	Benzene, toluene, ethylbenzene, xylene
C	
CANA	CNRS' research vessel
CAS	Central Administration of Statistics
CDR	Council for Development and Reconstruction
CEDAW	UN Convention on the Elimination of all Forms of Discrimination against Women
CFC	Chlorofluorocarbon
CH_4	Methane
CHARM	Chemical Hazard and Risk Management
CIEEM	Chartered Institute of Ecology and Environmental Management
CLO	Community Liaison Officer

Acronym or term	Definition
CMP	Chemical management plan
CNRS	National Council of Scientific Research
Conseil d'Etat	State Council
CO	Carbon monoxide
CO_2	Carbon dioxide
COD	Chemical oxygen demand
COP21	Paris Climate Conference
CSO	Civil Society Organisation
CYCOFOS	Cyprus coastal ocean forecasting system
D	
dB	Decibel
DGA	Directorate General for Antiquities
DGEF	Division for Global Environment Facility
DGU	Directorate General for Urban Planning
DO	Dissolved oxygen
DOSMP	Drilling operations social management plan
DP equipment	Dynamic positioning equipment
DREAM	Dose Related Risk and Effect Assessment Model
DSTF	Dead Sea Transform Fault
DV	Domestic violence
dw	Dry weight
E	
E	East
EAFS	East Anatolian Fault System
EBS	Environmental Baseline Survey
EBSA	Ecologically and biologically significant area
ECC	Environmental Compliance Certificate
EdL	Electricité du Liban
EIA	Environmental and Social Impact Assessment
EEZ	Exclusive Economic Zone
EITI	Extractive Industries Transparency Initiative
EMDW	Eastern Mediterranean deep water
ELCA	East Levantine Canyons Area
EPA	Exploration and Production Agreement
ERP	Emergency Response Plan
ESMP	Environmental and social management plan
EU	European Union

Acronym or term	Definition
EQS	Environmental Quality Standards
F	
Facies	Character of rock in regard to formation, composition etc.
FAO	Food and Agricultural Organisation
FAQ	Frequently Asked Questions
FGD	Focus group discussions
G	
GBL	Geochemical Background Levels
GBV	Gender-based violence
GDP	Gross Domestic Product
g/h	Grams per hour
GHGs	Greenhouse gases
GoL	Government of Lebanon
GPS	Global positioning system
H	
HAT	Highest Astronomical Tide
HCFC	Hydrochlorofluorocarbon
HDI	Human Development Index
HIV	Human Immunodeficiency Virus
HMCS	Harmonised Mandatory Control Scheme
HOCNF	Harmonised Offshore Chemical Notification Format
HPWBDF	High-performance water-based drilling fluid
HRC	Human Rights Council
HSE	Health, Safety and Environment.
HQ	Hazard Quotient
Hz	Hertz
I	
IBA	Important Bird and Biodiversity Area
ICERD	UN International Convention on the Elimination of All Forms of Racial Discrimination
IDAL	Investment Development Authority of Lebanon
IEE	Initial Environmental Examination
IEMA	Institute of Environmental Management and Assessment
IFC	International Finance Corporation
IHME	Institute for Health Metrics and Evaluation
ILO	International Labour Organisation
IMDG code	International Maritime Dangerous Goods Code
IMEWE	India-Middle East-Western Europe
IMF	International Monetary Fund
IMO	International Maritime Organization
IMR	Infant Mortality Rate

Acronym or term	Definition
Infaunal	Fauna living within the benthic substrate/seafloor
IRC	International Rescue Committee
ISWM	Integrated solid waste management
ITEQ	International Toxic Equivalents
K	
KBA	Key Biodiversity Area
kHz	Kilohertz
KII	Key informant interviews
km	Kilometre
km^2	Square kilometre
knot	One nautical mile per hour
kV	Kilovolt
L	
L	Litre
LAEC	Lebanese Atomic Energy Commission
LAF	Lebanese Armed Forces
LAT	Lowest Astronomical Tide
LC_{50}	Median lethal dose
LCPS	Lebanese Centre for Policy Studies
LPA	Lebanese Petroleum Administration
M	
m	Metre
m^2	Square metre
m^3	Cubic metre
MARPOL	International Convention for the Prevention of Pollution from Ships
mg	Milligram
mg/L	Milligrams per litre
MHSZ	methane hydrate stability zone
ml	Millilitre
MLT	Mount Lebanon thrust
mm/yr	Millimetre per year
MMO	Marine mammal observer
MoA	Ministry of Agriculture
MoC	Ministry of Culture
MODU	Mobile offshore drilling unit
MoE	Ministry of Environment
MoEW	Ministry of Energy and Water

Acronym or term	Definition
MoL	Ministry of Labour
MoPH	Ministry of Public Health
MoPWT	Ministry of Public Works and Transport
MPA	Marine Protection Area
MPN	Most probable number (bacteria)
MPN/g	Most probable number per gram (bacteria)
mS/cm	Microsiemens per cm – electrical conductivity unit
M.Sm3/d	Mega standard cubic metres per day
MSW	Municipal solid waste
MT	Metric ton
N	
N	North
NAAQS	National Ambient Air Quality Standards
NADF	Non-aqueous drilling fluid
NBSAP	National Biodiversity Strategy and Action Plan
nb./m^3	Number per cubic metre
NCDs	Non-communicable diseases
NCMS	National Centre for Marine Sciences
NE	No effect
NEBA	Net Environmental Benefit Analysis
NGO	Non-governmental Organisation
NIP	National Implementation Plan
NIS	Non-Indigenous Species
NM	Nautical mile
NO	Nitric oxide
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
NOAA	U.S. National Oceanic and Atmospheric Administration
NOEC	No observed effect concentration
NOSCP	National Oil Spill Contingency Plan
NPMPLT	National Physical Master Plan of the Lebanese Territory
NSSF	National Social Security Fund
NTS	Non-technical summary
NTU	Nephelometric Turbidity Unit
N_2O	Nitrous oxide
O	
O_3	Ozone

Acronym or term	Definition
OCNS	Offshore Chemical Notification Scheme
OMSAR	Office of the Minister of State for Administrative Reform
OPRC	International Convention on Oil Pollution Preparedness, Response and Co-operation
OPRL	Offshore Petroleum Resources Law
OSCP	Oil Spill Contingency Plan
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
P	
P	Phosphorous
PAH	Poly-aromatic hydrocarbon
PAM	Passive acoustic monitoring
PAR	Petroleum Activities Regulations
PCB	Poly-chlorinated biphenyls
PEC	Predicted environmental concentration
PGA	Peak ground acceleration
PLONOR	Pose Little or No Risk to the Environment
PM	Particulate matter
PM_{10}	Particulate matter, 10 micrometres or less in diameter
PNEC	Predicted no-effect concentration
POB	Persons on-board
POPs	Persistent Organic Pollutants
Pow	Partition Coefficient n-Octanol/Water
ppb	Parts per billion
ppm	Parts per million
PPP	Purchasing Power parity
PSU	Practical Salinity Unit
PSV	Platform supply Vessel
PWDs	People with disabilities
R	
REDOX	Oxidation and reduction chemical reactions
RMS	Root mean squared
ROV	Remotely operated underwater vehicle
RTA	Road traffic accidents
S	
s	Second
S	South
SBS	Social Baseline Study
SCI	Site of Community Importance
SDGs	Sustainable Development Goals
SEA	Strategic Environmental Assessment

Acronym or term	Definition
SEL	Sound exposure level
SEP	Stakeholder engagement plan
SMEs	Small- and medium-sized enterprises
SMP	Social management plan
SO_2	Sulphur dioxide
SO_x	Sulphur oxides
SOPEP	Shipboard oil pollution emergency plan
sp.	Species
SPA	Special Protection Area
SPL	Sound pressure level
SSD	Species sensitivity distributions
T	
t/day	Tons per day
TDS	Total dissolved solids
TDW	Tyrrhenian deep water
TEDO	Tripoli Environment and Development Observatory
TEUs	Twenty-foot equivalent units
Thermocline	Sharp temperature gradient in a water body
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TOM	Total Organic Matter
TPH	Total petroleum hydrocarbon
TRV	Toxicity Reference Value
TSS	Total Suspended Solids
U	
UDHR	Universal Declaration of Human Rights
UN	United Nations
UNCAC	United Nations Convention Against Corruption
UNCLOS	United Nations Convention for the Law on the Sea
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United National Framework Convention for Climate Change
UNHCR	United Nations High Commissioner for Refugees
UNSF	United Nations Strategic Framework
UPR	Universal Periodic Review
USD	US Dollar
UTC	Coordinated Universal Time

Acronym or term	Definition
V	
VOCs	Volatile organic compounds
VSP	Vertical seismic profile
W	
W	West
WBDF	Water based drilling fluid
WHO	World Health Organisation
WHS	World Heritage Site
WMDW	western Mediterranean deep water
WMP	Waste management plan
Symbols	
µg	Microgram
µm	Micron (micrometre)
µPa	Micropascals
%	Percentage
°C	Degrees Celsius

1 INTRODUCTION

1.1 Introduction

Total Exploration & Production Liban Sal (TEP Liban) intends to carry out exploration drilling activity in Block 4 of the Levant sedimentary basin in offshore Lebanese waters, hereafter called the project. The proposed activity for Block 4 comprises drilling of one exploration well, a possible second exploration well and potentially one appraisal well, depending on the results of the previous exploration wells. Therefore, a maximum of three wells may be drilled in Block 4 as part of the project.

This document presents the results of the environmental impact assessment (EIA)[1] of the project, covering the three possible wells. It has been prepared in accordance with applicable national legislation[2], applicable international conventions/agreements and TOTAL's corporate standards. The draft 'Sector-specific EIA Guidelines for Oil and Gas Reconnaissance and Exploration Drilling Activities in Lebanon' (MoE and LPA, 2019) and recommendations from the draft 'Update of the Strategic Environmental Assessment (SEA) for Exploration and Production Activities Offshore Lebanon' (MoEW, 2019) have also been considered.

An EIA report document (Rev 0 of this document) was first produced in line with the MoE's scoping report comments, as far as available information allowed. At this stage, the EIA was published via a website for consultation purposes (from 4 September to 4 October 2019) and the results of the EIA process were presented at two public meetings in September 2019. The EIA was then updated, where necessary, in response to comments received during that process. Revision 1 of the EIA was submitted to the MoE on the 31 October 2019. After submission, a number of comments on the EIA were received from the MoE. Responses and clarifications were provided to these comments, and when necessary, modifications were made to the EIA. Consequently, the EIA report was approved by the MoE on 18 February 2020 provided that the comments listed in the Technical Committee Report 18/2/2020 are complied with. In addition, it was requested that a compiled and comprehensive version of the EIA report be submitted, reflecting the comments received from the MoE. This document (Revision 2) has been compiled in response to this request, so that it constitutes the final compiled version of the EIA as approved by the MoE.

1.2 Background

On 29 January 2018, the Government of the Republic of Lebanon signed an exploration and production agreement (EPA) with TEP Liban, Eni Lebanon BV and NOVATEK Lebanon SAL for offshore Block 4. The Minister of Energy and Water (MoEW) approved the exploration plan for the block in May 2018, triggering the start of an initial three-year exploration period.

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[1] Reference to the term 'EIA' includes environmental and social impact assessment (ESIA).

[2] In particular, the Environmental Impact Assessment Decree No. 8633/2012.

Block 4 is in the Levant sedimentary basin, offshore northern Lebanon, with its eastern boundary approximately 6 km from the nearest coastline. The block covers 1911 km^2 within water depth ranging from 320 m to 1780 m (see Figure 1.1).

TEP Liban analysed seismic data generated by PGS during 2006–2012 (MoEW 2019) and identified a priority area within which they will drill the first exploration well (B4-1). The possible second exploration well and appraisal well would also be within this same priority area. The location of Block 4, the priority area and the proposed first exploration well location are presented in Figure 1.1.

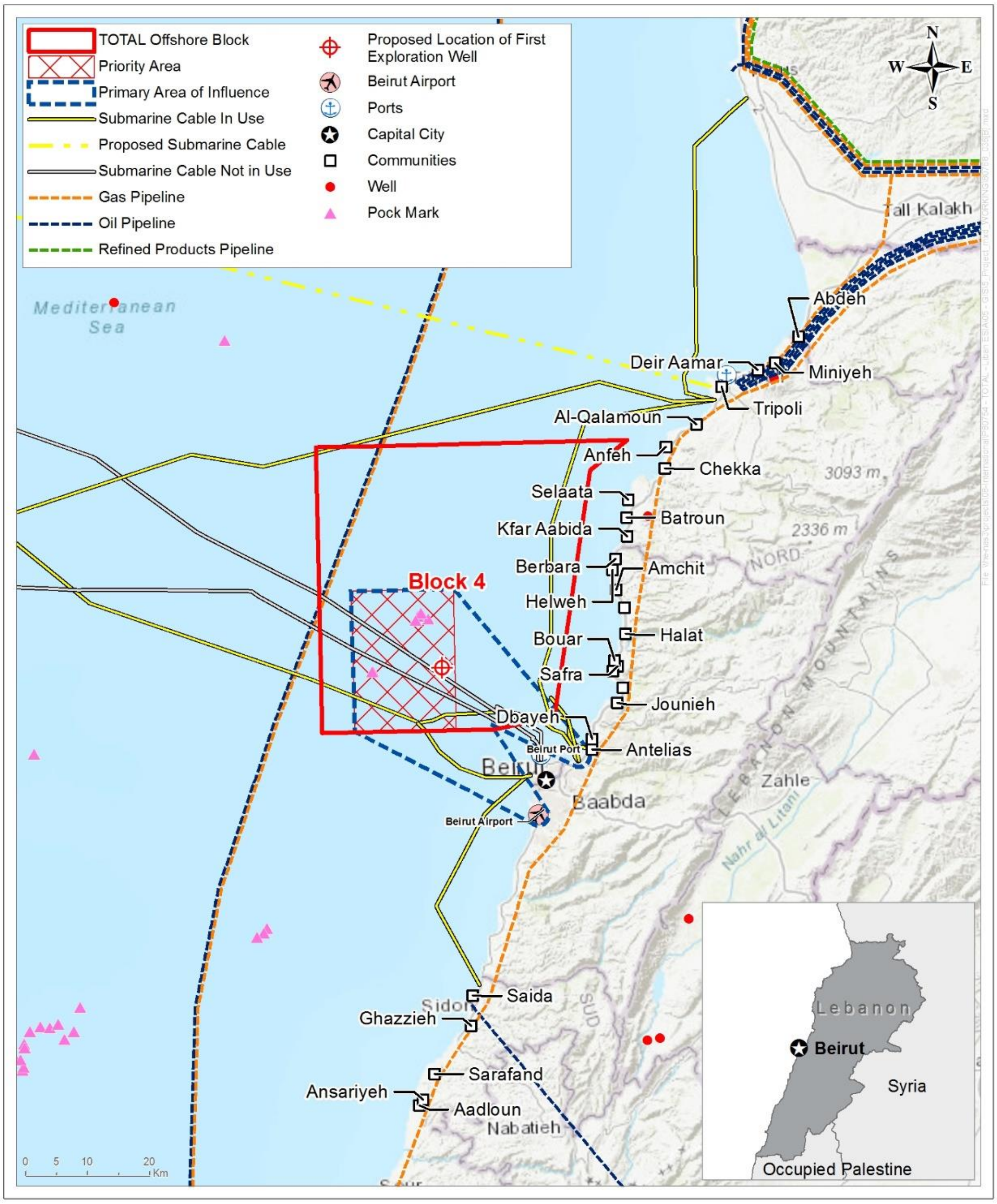

Figure 1.1: Location of Block 4 offshore Lebanon, including the priority area and first exploration well site for drilling operations

Source of cable data: C-Map (2018); SHOM Charts (7306, 7255); UKHO Admiralty Charts; Websites: atlantic-cables.com; cytaglobal.com Live cables are CADMOS, BERYTAR and IMEWE.

1.3 Overview of Block 4 exploration drilling campaign

TEP Liban is planning to drill its first exploration well in Block 4 in February 2020. The target is a gas reservoir about 4400 m below mean sea level.

The first exploration well location will be about 20 km from the shore (see Figure 1.1) and will be a pseudo-vertical well in 1520 m of water. The well will be drilled using a mobile offshore drilling unit (MODU) and the drilling programme will have a duration of about 60 days as shown in (Figure 1.2), more details of the programme are provided in Chapter 4: Project Description.

The drilling duration, shown as 2-3 months is intended to cover the duration for any of the wells, however it is anticipated that the first well will involve only around 60 days of drilling.

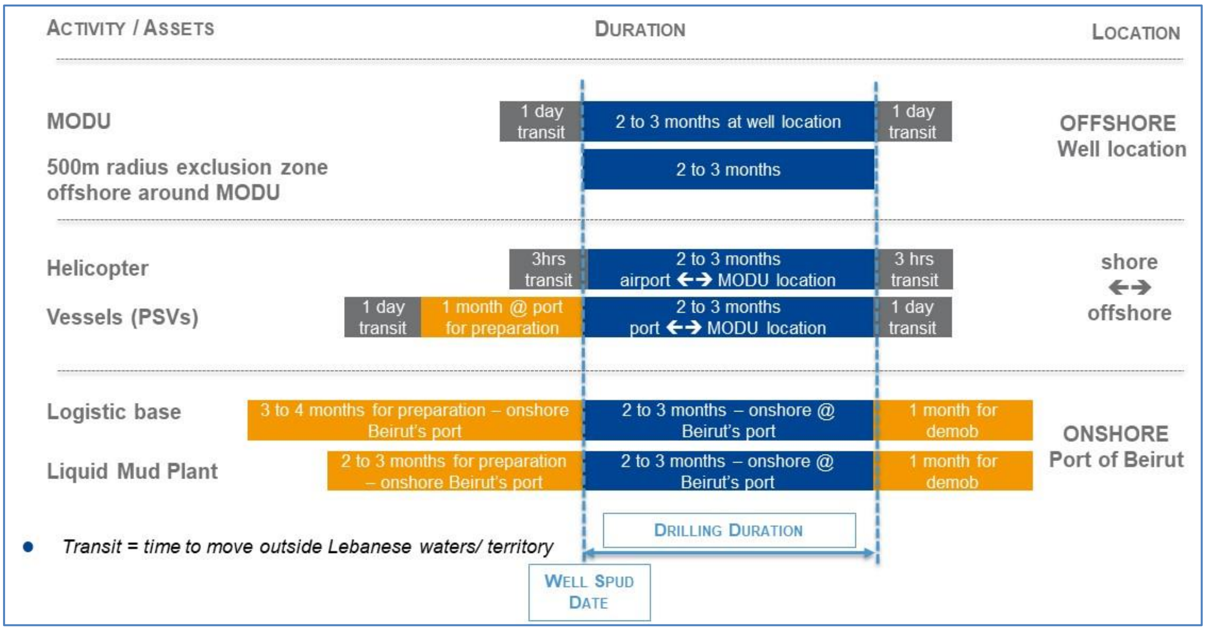

Figure 1.2: Outline of the duration and location of each activity

Drilling operations will be supported from a logistics base within the existing port of Beirut. Facilities at the base will include

- a pipe yard (outdoor storage up to 7000 m^2)
- warehousing (indoor storage up to 300 m^2 100 m^2 for chemical storage / dangerous goods, and 6 m^2 for cold room)
- a 100-m linear jetty with 1000 m^2 for laydown area and mobile cranes for vessels operations
- a drilling-fluids mixing plant and bulk facilities (1250 m^2)
- areas for offices, canteen, vehicles, marshalling areas, cargo containers, waste transfer and transit areas (no waste treatment).

The duration of the logistics base will be dependent on the success of the B4-1 well and any subsequent wells.

Three vessels will support the drilling operations from the logistics base. One support vessel will be based permanently at the drill site, providing security surveillance. The other two vessels will transfer supplies, materials, equipment and waste between the

MODU and the logistics base. It is estimated that up to ten return trips will be required per week. Helicopter transfers of personnel will be from Beirut International Airport, with an estimated ten return trips per week.

1.4 Project justification

Decree number 42/2017 (under the auspices of the Offshore Petroleum Resources Law (OPRL) 132 from 24 August 2010) delineates the division of the Lebanese maritime waters into ten blocks (Figure 1.3).

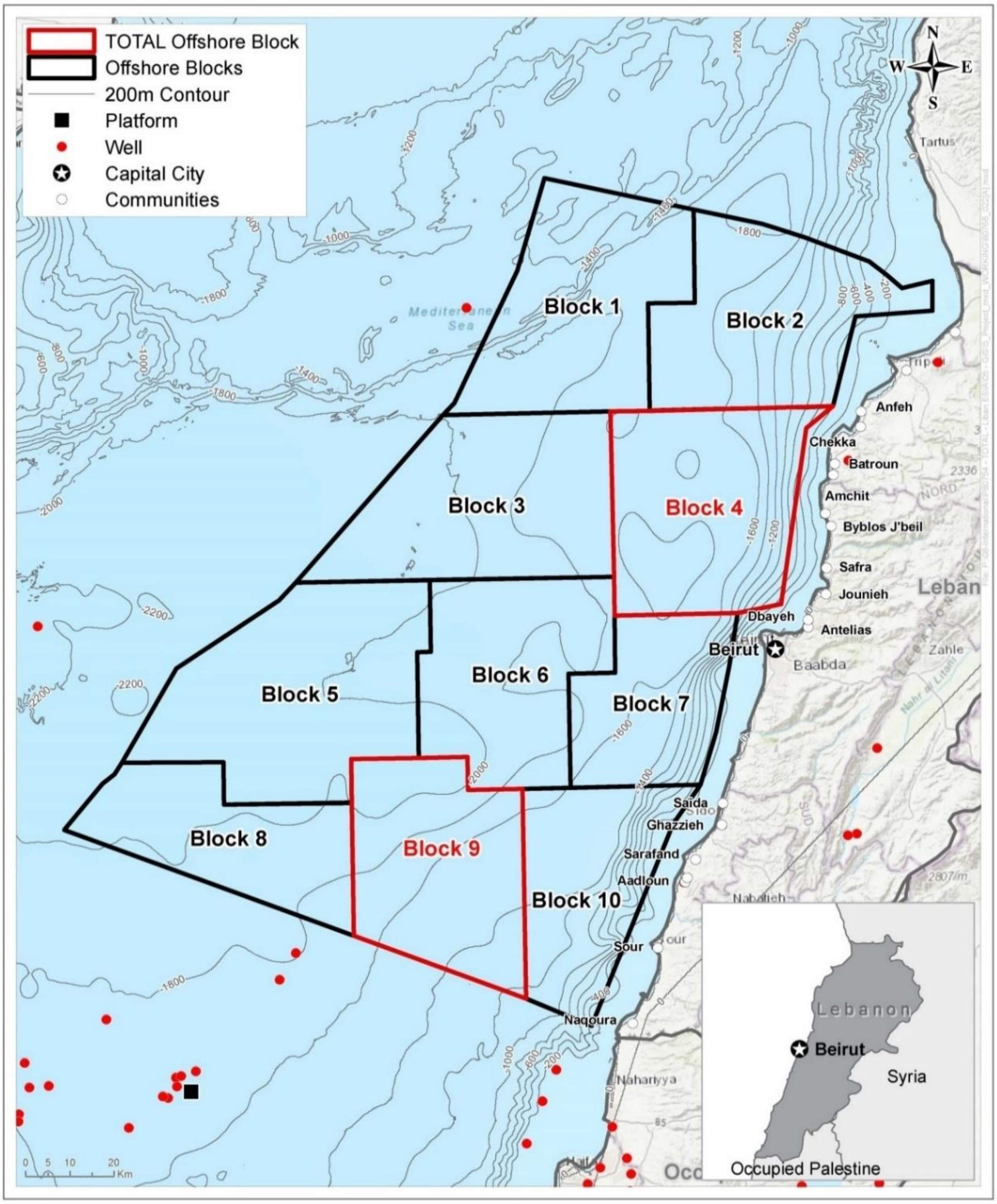

Figure 1.3: Exploration blocks in Lebanese maritime waters

Note: Red dots indicate existing wells onshore in Lebanon and in surrounding waters.

The first offshore licensing round in Lebanon opened five blocks for bidding applications and completed the process in December 2017 with the signature of the first two exploration and production agreements (EPA) for Blocks 4 and 9. The EPAs were granted to a consortium consisting of TEP Liban, Eni Lebanon BV and NOVATEK Lebanon SAL. A second licensing round is currently open with applications due before 31 January 2020. Well B4-1 will be the first deep-water well drilled in Lebanese waters.

The exploration and evaluation of hydrocarbon reserves in Block 4 will provide input to the future development of hydrocarbon resources in Lebanon and, in the case of a commercial discovery, will have a positive effect on national economy and energy security.

1.5 EIA objectives

The objectives of the EIA process are to

- identify the legal and regulatory requirements and other standards relevant to the project (national legislation and regulations, international agreements and TOTAL's corporate requirements)
- identify sensitive environmental, socio-economic and cultural heritage receptors in the project's area of influence
- inform stakeholders and obtain their views and opinions (potentially affected communities/people and other interested parties)
- determine project aspects and activities that could result in environmental, socio-economic or cultural heritage impacts, along with scoring of impact significance
- develop mitigation measures to reduce potential negative impacts to acceptable levels and enhance any beneficial environmental, socio-economic and cultural heritage impacts arising from the project
- determine residual project impacts, along with scoring of residual impact significance
- ensure that mitigation measures are incorporated into management plans that will be implemented by the project sponsor and its contractors and subcontractors during the exploration drilling programme.

1.6 EIA team

The EIA work for the Block 4 exploration drilling campaign has been carried out by a team consisting of personnel from in-country accredited consultancy Dar Al-Handasah (Dar) and international consultancy RSK Environment Ltd (RSK).

Dar has been responsible for compiling and undertaking the social baseline studies and assisting in the compilation of other sections of this EIA, as well as undertaking scoping and EIA public consultation sessions. Dar contracted another local consulting firm, InfoPro, to assist with social baseline data collection and stakeholder engagement.

RSK has been responsible for delivering an EIA document that is consistent with national legislation, accepted standards of international best practice and TOTAL's corporate requirements.

Creocean, Keran Liban and ELARD, contractors to TEP Liban, have carried out the environmental baseline studies.

Oil spill and cuttings modelling studies were performed by Total and provided to RSK team for inclusion, while Xodus provided underwater noise modelling results.

More information on the contributors to this EIA is presented in Appendix 1.1.

1.7 EIA report structure

The EIA structure is based on that presented in the draft 'Sector-specific EIA Guidelines for Oil and Gas Reconnaissance and Exploration Drilling Activities in Lebanon' (MoE & LPA, 2019) and is summarised in Table 1.1.

Table 1.1: EIA report content

Chapter	Description
Executive Summary	Summary of the EIA report using non-technical language
Chapter 1: Introduction	General introduction, background and justification for the project. Description of the EIA objectives, the EIA team, and EIA report structure. An outline of the EIA process including screening, scoping, base case design, existing conditions, impact significance assessment, stakeholder consultation, and management and implementation
Chapter 2: Policy, Legal and Administrative Framework	Summary of the administrative structure and applicable national and international environmental, socio-economic and cultural heritage legislative requirements. TOTAL's corporate requirements and good practice also outlined
Chapter 3: Public Participation	Description of the consultation process carried out to inform stakeholders of the proposed exploratory drilling activity and obtain their feedback
Chapter 4: Description of Proposed Project	Description of the technical aspects of the project, including the MODU, the exploratory drilling programme, shore-based operations and transfers, emissions, discharge and waste inventory, work force and detailed schedule
Chapter 5: Description of the Surrounding Environment	Description of the physical and biological environmental parameters and the socio-economic conditions and cultural heritage features in the study area that are of relevance to project implementation and potential impacts. Identification of sensitive environmental and social receptors and disadvantaged or vulnerable individuals/groups
Chapter 6: Potential Impacts of the Project	Assessment of the potential environmental (physical and biological) and socio-economic and cultural heritage impacts associated with the project's routine/planned activities and potential unplanned/accidental events Impacts on ecosystem services, cumulative effects and potential transboundary impacts also considered
Chapter 7: Analysis of Project Alternatives	Description and analysis of project alternatives considered and the 'no project option'. Rationale provided for the preferred option(s) against other alternatives, considering positive as well as adverse impacts

Chapter	Description
Chapter 8: Environmental and Social Management Plan	Overview of the environmental and social management plans and commitments register developed for the project
Chapter 9: Conclusion	Overall conclusion of the assessment of impact
References	List of the literature sources referred to in the EIA
Appendices	Relevant proponent documents, independent studies that contribute to understanding impacts, evidence of public notices and public participation, technical specification of materials and procedures, CVs of the consultants, and other relevant documents

1.8 EIA process and methodology

This section describes the EIA process adopted for the Block 4 exploration drilling programme and the methodology implemented to determine impact significance.

1.8.1 EIA process

The EIA process constitutes a systematic approach to the evaluation of a project and its associated activities. The process includes

- screening and scoping
- defining the base case design and project alternatives
- describing the existing environmental and social conditions
- stakeholder consultation
- conducting an impact significance assessment, proposing mitigation and assessing residual impacts
- management and implementation.

These are described briefly in the following sections.

1.8.2 Screening

Screening, the first step in the EIA process, determines whether an environmental impact assessment (EIA) is required for a project. In Lebanon, an application for EIA classification must be made pursuant to Articles 4 and 5 of the Environmental Impact Assessment Decree No. 8633/2012. TEP Liban submitted a screening application for Block 4 to the LPA on 16 July 2018. The MoE responded through the LPA on 29 August 2018 to confirm that an EIA would be required for the proposed exploration drilling activities.

1.8.3 Scoping

Scoping is a high-level assessment of anticipated interactions between project activities and environmental, socio-economic and cultural heritage receptors. Its purpose is to focus the EIA on key issues and eliminate activities from the full impact assessment process based on their limited potential to result in discernible impacts.

Scoping is a requirement in Lebanon under the Environmental Impact Assessment Decree No. 8633/2012. The Scoping Report was structured in accordance with Annex 7 of the Decree and TOTAL's General Specifications.

Revision 0 of the scoping report was developed to capture the environmental screening and scoping process carried out for the Block 4 exploration drilling activity. Information gathered during the project's scoping phase provided clarity on the EIA scope of work (see Section 1.8.3.2). Revision 1 of the scoping report included updates from the stakeholder engagement, public meetings and a scope of work for the ESIA and was submitted to the LPA and Ministry of Environment (MoE) for approval on 27 June 2019 before progressing to the next stage of the project. Revision 1 of the scoping report also included an appendix which listed the comments made during the stakeholder engagement and public meetings, together with responses and locations in the revised scoping report where more information was located.

The MoE provided approval of the scoping report, following their review, but listed conditions to be included in the EIA and specific actions required from TEP Liban. The approval is provided as Appendix 1.2. Also included in this appendix are the comments provided by the LPA on the scoping report. This EIA addresses the comments made on the scoping report by the MoE and LPA.

1.8.3.1 Area of influence

The Sector-specific EIA guidelines for oil and gas reconnaissance and exploration drilling activities in Lebanon' (MoE and LPA, 2019) refer to the IFC Performance Standard (PS) 1, paragraph 8 (IFC 2012), definition of the area of influence (AOI), which states that the AOI should encompass the following components as appropriate:

- "The area likely to be affected by
    i. the project and the client's activities and facilities that are directly owned, operated or managed (including by contractors) and that are a component of the project;
    ii. impacts from unplanned but predictable developments caused by the project that may occur later or at a different location, or
    iii. indirect project impacts on biodiversity or on ecosystem services upon which affected communities' livelihoods are dependent.
- Associated facilities, which are facilities that are not funded as part of the project, would not have been constructed or expanded if the project did not exist and without which the project would not be viable
- Cumulative impacts that result from the incremental impact, on areas or resources used or directly affected by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted."

The following points are also considered when developing the AOI:

- any permanent or temporary footprint related to the project including supply bases, potential access roads or transit routes and waste management facilities
- the area outside the footprint potentially affected by direct impacts such as noise
- the area potentially affected by indirect impacts such as coastal villages and towns affected by e.g. in-migration of contractor workers or job seekers
- the area potentially affected by unplanned events, such as diesel spills from vessels during mobilisation and project implementation

- the area used for assessing cumulative impacts (CIA).

The AOI is different for each phase of a project, i.e., mobilisation, project implementation and demobilisation. The AOI is also different for each receptor.

The draft guidance also indicates that the definition of the spatial extent of the AOI for each receptor should be based on several considerations, including

- the project aspect generating the impact, e.g., vessel traffic, anchoring, local labour employment
- distance from the source of impact in which the receptor is affected
- the spatial extent of the affected receptor (e.g. range of the affected species)
- the sensitivity of the receptor affected
- international good practice.

The AOI should be defined on a precautionary, realistic worst-case basis, where there is uncertainty with any assumptions clearly stated. In addition, the temporal and spatial boundaries of the AOI should be refined based on the application of mitigation measures, i.e., it should be based on residual impacts.

The study area for each receptor takes account of the AOI but may be larger to understand the context in which the receptor exists, including any trends and pressures on the condition of the receptor.

Figure 1.4 presents the area that could give rise to direct effects and includes:

- the transportation corridor used by supply vessels (and potentially helicopters) between the block and port facilities, logistic base and airport
- the area surrounding the exploration drilling site (and potential additional sites) that could be affected by emissions, discharges, cuttings discharge and dispersion or other drilling-related activity
- the logistic base (managed by a third party) used for supporting services such as boat docking, a mud plant, waste management, moving and storing cargo, and crew change
- Beirut International Airport, which may be used as a base from which crew changes are made via helicopter.

The main focus with respect to the potential impacts from routine or planned activities is the deep-water offshore development area and relates to the areas potentially affected by seabed disturbance, discharges to sea, underwater noise and interference with fishing or shipping activities. The zones of impact are relatively localised in the offshore area and the area of influence is informed by predictive dispersion modelling of routine discharges and underwater noise propagation modelling. Consideration has also been given to the supply route to the field and the use of the onshore logistics base, primarily in terms of potential socio-economic effects.

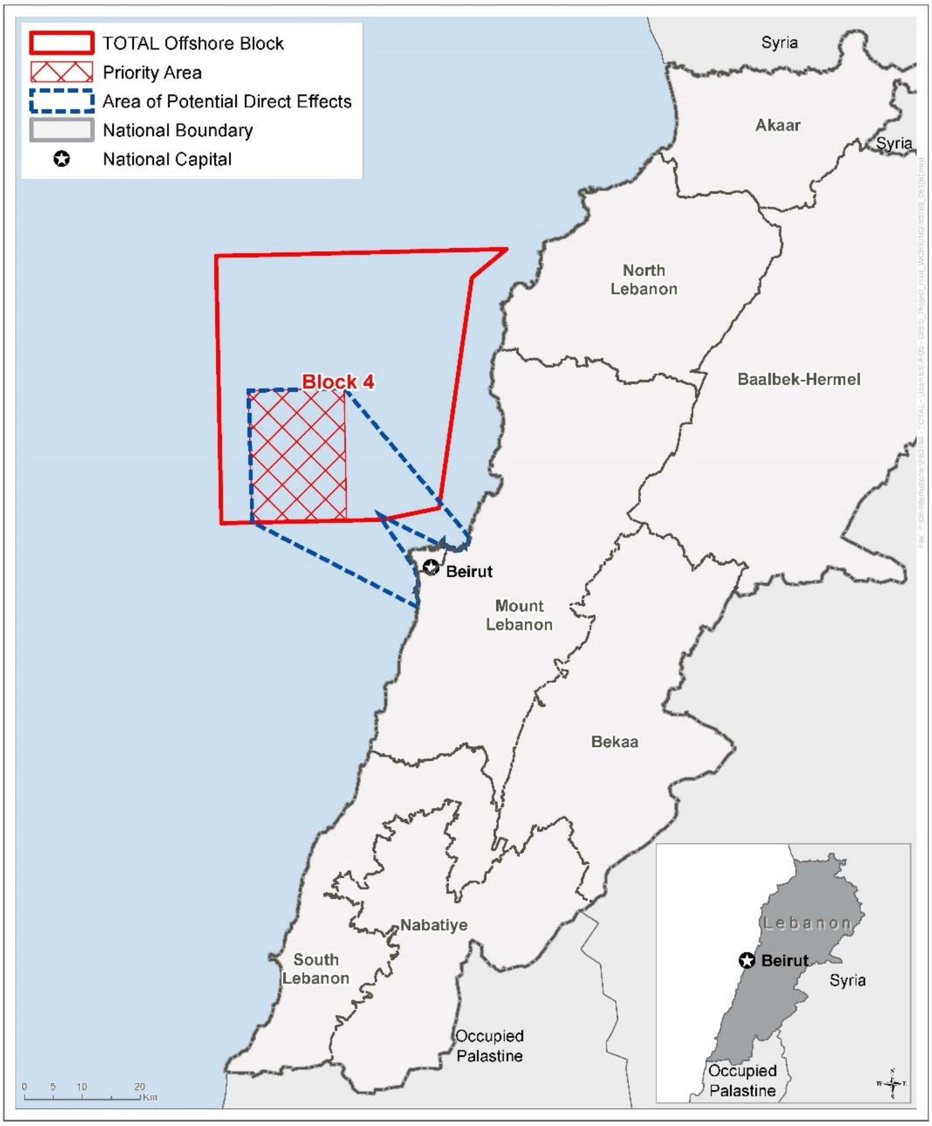

Figure 1.4: Block 4 and area of potential direct effects

Beyond the area identified above, the AOI includes areas where project activities could have indirect, accidental or cumulative impacts. With respect to unplanned events, particularly a major hydrocarbon release, the AOI has been considered also to include the coast of Lebanon.

The environmental and social sensitivities in this area, and potential impacts, are presented separately.

It should be noted that TEP Liban intends to dispose of cuttings generated from some well sections (see Project Description Section 4.6.5.2) at an existing waste treatment facility in the Republic of Cyprus (Innovating Environmental Solutions Center - IESC). This waste treatment facility in Cyprus is not owned directly by TEP Liban, or any of its contractors, and will not be developed or expanded by the project. As the project has the option to use other facilities, the waste site is not considered an associated facility.

The AOI for each group of receptors is described in Chapter 5: Description of the Surrounding Environment with an explanation of the respective study area if this is larger than the AOI.

1.8.3.2 EIA scope

The impact of the project, both routine activities and unplanned/accidental events, on the physical, biological, socio-economic and cultural heritage environment will address the following phases:

- drilling of well, including MODU mobilisation, installation, well testing and demobilisation
- operation of the logistics base.

Treatment and disposal of drill cuttings in Cyprus is considered outside of the scope of this assessment. The treatment facility, Innovating Environmental Solutions Center (IESC), is permitted separately by the authorities in Cyprus.

If an appraisal well is drilled and a discovery is made that can be commercially exploited and the project goes to the next phase of production, a further EIA will be conducted to assess the impacts of the production phase.

1.8.4 Base case design and project alternatives

The EIA team worked with the TEP Liban drilling team to gather and interpret relevant project technical information for this EIA. Opportunities for improvement of project design in terms of reducing possible environmental and social impacts were considered by the teams and incorporated into the base case design where appropriate and practicable.

The following project alternatives were considered within the framework of this exploration drilling campaign:

- final well location
- MODU type and specifications
- MODU crew transfer to the rig by boat or helicopter
- drilling technology, including the drilling fluid type for technical sections (to be confirmed during the detailed engineering phase)
- options for treatment/disposal of drill fluids and cuttings
- scheduling of the drilling programme for the first well
- the ‘no project’ option.

Chapter 7: Analysis of Project Alternatives presents the project design that served as the basis for the impact assessment and a discussion of alternatives.

1.8.5 Existing conditions

To identify potential impacts of the project on receptors, an understanding of the existing (baseline) pre-project conditions is required.

The following studies/surveys have been carried out for the Block 4 exploration drilling campaign and used to inform this EIA:

- Social Baseline Study– bibliographic review and primary data collection

- Offshore Environmental Baseline Study – Literature Review Report Blocks 4 & 9 (Keran Liban/Creocean, 2019a) – bibliographic review
- Offshore Environmental Baseline Survey (Keran Liban/Creocean, 2019b) – water and sediment sampling and analysis, marine mammal observation, and archaeological observation.

The Offshore Environmental Baseline Survey of Blocks 4 and 9 was carried out between 19 March and 12 April 2019. Water and sediment samples, with seabed video surveillance, were collected from stations throughout the priority area and from three outside the priority area. All water and sediment samples were analysed for a range of chemical, physical and biological analyses (plankton and benthos). During the survey, a watch for marine mammals (marine mammal observation, MMO, and passive acoustic monitoring, PAM), seabirds, reptiles and other local sea users was conducted. An archaeologist was also present onboard for the survey's duration to examine seabed video footage and sediment samples for archaeological potential (Keran Liban/Creocean, 2019b).

Other key documents to provide baseline data include

- 'Mission: Update on the Strategic Environmental Assessment (SEA) for Exploration and Production Activities Offshore Lebanon (ToR11) Revised Draft SEA Report Volume 2- Baseline Conditions' (Draft SEA Update by MoEW) (Revised Draft SEA Report, March 2019)
- Marine Resources and Coastal Zone Management Program, Institute of the Environment – University of Balamand (2012), Component A: Improved Understanding, Management and Monitoring in the Coastal Zone, Environmental Resources Monitoring in Lebanon (ERML)
- MoE/IUCN (2012), 'Lebanon's Marine Protected Area Strategy: Supporting the management of important marine habitats and species in Lebanon'. Beirut, Lebanon, Gland, Switzerland and Malaga, Spain: The Lebanese Ministry of Environment/IUCN.

Chapter 5: Description of the Surrounding Environment summarises the existing conditions in the study area.

1.8.6 Public consultation

The EIA process includes stakeholder consultation, the main goal of which is to identify the views and opinions of potentially affected people and other interested parties. Stakeholder feedback is used to focus the impact assessment and, where appropriate, influence project design and execution.

Stakeholder consultation has been carried out in accordance with the stakeholder engagement plan developed for the Block 4 exploration drilling campaign EIA. Five stakeholder engagement meetings took place on Tuesday 14 May and Wednesday 15 May 2019.

A draft scoping report was published online and open for public review from 3 May to 2 June 2019. Comments from the public and public authorities were solicited, collated and submitted to the LPA. A public consultation meeting was held on 24 May 2019 to answer questions and concerns raised by the public.

More information on public consultation and disclosure is provided in Chapter 3: Public Participation.

1.8.7 Impact assessment

An impact, as defined by ISO 14001:2015, is "any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's environmental aspects (activities, products or services)". The types of impacts considered in this assessment include

- **negative**: an impact that is considered to represent an adverse change from the baseline or that introduces a new undesirable factor
- **positive or beneficial**: an impact that is considered to represent an improvement to the baseline or that introduces a new desirable factor
- **direct (or primary)**: impacts that result from a direct interaction between a planned project activity and the receiving environment
- **secondary**: impacts that can occur subsequent to the primary interactions between the project and its environment, e.g., loss of part of a habitat affects the viability of a species population over a wider area
- **indirect**: impacts that result from other activities that develop as a consequence of the project, e.g., new business set up to cater for increased traffic on roads.

The methodology for determining impact significance is based primarily on that recommended by TOTAL's General Specification documents 'Environmental Impact Assessment of Exploration & Production Activities' (GS EP ENV 120) and 'Social Impact Assessment' (GS EP SDV 102), which are based on a systematic approach developed by the World Bank and the ISO 14001 standard. This involves

- identifying project aspects
- identifying related environmental and social receptors
- evaluating project effects on those receptors.

Based on the **sensitivity** of the environmental/social receptors and the **intensity** of the effect, the **significance** of the impacts can be assessed.

Mitigation measures are then applied to determine whether the significance of the impacts can be reduced. The significance of the 'residual' impacts, subsequent to application of mitigation measures, is determined using the same criteria. The process of impact assessment is intended to be iterative, with the final assessment of residual impacts taking place after all mitigation measures are taken into consideration.

Definitions for scoring intensity, sensitivity and significance are provided below.

1.8.7.1 Impact intensity (or magnitude)

For each source of impact, the intensity of the effect is defined according to the following criteria:

- the nature of the change (what is affected and how)
- its size and scale
- its geographical extent and distribution
- its duration, frequency and reversibility
- possible cumulative effects from other activities
- outputs from modelling exercises.

The intensity is then scored from 1 (very low) to 4 (high) based on definitions of negative effects. A rating of 0 is also provided for beneficial (positive) effects (see Table 1.2).

Impact intensity is defined using a combination of factors, as relevant, identified and defined in Table 1.2: geographic extent (column 2), duration of impact (column 3) and professional knowledge, using indicators in column 4 and 5, to account for receptor and impact variation where appropriate[3].

An example of a low intensity impact to species biodiversity would be disturbance of a local population or individuals of a species resulting in a decline in abundance or distribution over one or more generations, but that does not change the overall longevity or viability of the population of the species or populations of other dependent species. Alternatively, a high intensity impact would disturb a sufficient portion of the biogeographic population of a species and may cause a decline in abundance, distribution or size of genetic pool such that natural recruitment could not return the population of the species, and other species dependent on it, to former levels.

1.8.7.2 Receptor sensitivity

The sensitivity of environmental, socio-economic and cultural heritage receptors (or valuable ecosystem components, VECs) will be defined taking into account such factors as the presence of protected areas or species of conservation concern, ecosystem function, number of inhabitants, the importance of socio-economic resources and the importance of archaeological or cultural heritage features. The assessment of the sensitivity of human receptors will take into account their likely response to the change and their ability to adapt to and manage the effects of the impact. Sensitivity is then scored from 1 (very low) to 4 (high) (see Table 1.3).

Examples of environmental receptors/VECs that would be determined to have very low sensitivity would include commonly occurring habitats and species that are not subject to significant decline or habitats that are already significantly disturbed and/or modified with little biodiversity value. High-sensitivity examples would include species listed as critically endangered or endangered on the IUCN Red List and habitats that are difficult to restore to natural conditions, such as coral reefs.

[3] The criteria used for impact intensity has been developed by RSK drawing upon experiences and lessons learned from numerous offshore EIAs and on guidance issued by the Institute of Environmental Management and Assessment (IEMA) and the Chartered Institute of Ecology and Environmental Management (CIEEM).

Table 1.2: Definitions to assist with scoring the intensity of the impact

Score	Geographical extent	Duration of impact	Nature of the change, size, scale and any potential cumulative effects	
			Environmental (physical and biological)	Social (socio-economic, health, cultural heritage)
0 Positive (Benefical)	-	-	Beneficial impacts on habitats and species	Beneficial impacts on local communities, health, resources, or cultural heritage sites
1 Very low	Immediate: within the project footprint	Very short term: impact likely to be mitigated through natural processes (or project mitigation measures) immediately (within one month of impact occurring)	Disturbance to the environment limited to the immediate area, with rapid recovery without intervention Planned activity or accident causes disturbance to individuals of a species that is similar in effect to the random changes in population due to normal environmental variation No discernible effect due to disruption of behaviour or species interactions of nationally/internationally important species of conservation concern No protected areas affected Emissions and effluent discharges do not breach licence limits, or national/international standards and have negligible impact due to rapid dilution and dispersion Noise from project site is audible at receptor locations but would not contribute to an exceedance of project criteria Spill or accidental event (onshore or marine) that causes immediate area damage only and can be restored to an equivalent capability in a period of days up to one month	Changes to demographics, employment, social service provision or lifestyle are neutral Very limited / intermittent interference, may be noticed by users of resources Incidence of chronic and acute illness and reduction of wellbeing stays within normal variation in baseline levels. Accident causing treatable and non-disabling injury but with no time off work No degradation of cultural heritage sites

Score	Geographical extent	Duration of impact	Nature of the change, size, scale and any potential cumulative effects	
			Environmental (physical and biological)	Social (socio-economic, health, cultural heritage)
2 Low	Local: within the project footprint and up to 3 km from site	Short term: impact likely to be mitigated through natural processes (or mitigation measures) within a year of cessation of activities	Disturbance of habitat on a local scale, restoration within a year requiring minimal or no intervention Localised short-term disturbance of individuals of a species that does not affect other trophic levels or the integrity of the population Potential disruption of behaviour or species interactions of nationally/internationally important species of conservation concern Activities may temporarily disturb protected areas but not lead to any long-term effects on the ecological integrity of the protected area Emissions and effluent discharges do not breach licence limits, or national/international standards Noise levels from the proposed project site at receptors may contribute to an exceedance of project criteria dependent on cumulative noise levels, but does not exceed project criteria alone Spill or accidental event (onshore or marine) leading to immediate area or localised damage to water resources or soil that may take up to six months to restore to pre-existing capability/function Environmental incident typically resolved with on-site response equipment	Activity that causes minor interference with other users of resources. Direct or indirect impacts will be discernible but use and value of resource not impacted. Rapid return to baseline conditions on completion of project activities Planned activity resulting in a short term increase in incidence of acute or chronic illnesses in the local community. Accident causing treatable and non-disabling injury but with some time off work (lost time injury) Activity that causes minor disturbance and / or superficial damage to cultural heritage site that is easily rectified

Score	Geographical extent	Duration of impact	Nature of the change, size, scale and any potential cumulative effects	
			Environmental (physical and biological)	Social (socio-economic, health, cultural heritage)
3 Medium	Regional: effects of impact experienced up to 50 km from site	Medium term: impact likely to be mitigated through natural processes (or mitigation measures) within a few (up to 5) years of cessation of activities	Impacts on a unique habitat, or regional scale, resulting in medium term damage and a restoration time of several years that may require intervention Disturbance of a population of species resulting in a change of abundance over one or more generations, but that does not change the integrity of the population of the species, or populations of dependent species Potential for small-scale pathological damage of nationally/internationally important species of conservation concern Occasional non-compliances with emission and effluent discharge licence limits or national/ international standards. Predicted noise levels from site plant at receptor locations exceed project criteria by up to 5 dB Spill or accidental event (onshore or marine) leading to damage to water resources, soil or habitat over a larger geographical area (not localised), or that cannot be restored to pre-existing capability/function within one year Environmental incident typically requiring mobilisation of in-country response resources	Planned activity that causes changes to demographics, employment, social service provision or lifestyle that may affect groups of local stakeholders Activity or accident that causes moderate interference with other users of resources Planned activity resulting in short-term increase in incidence of acute or chronic illnesses in local community or long-term increase in vulnerable groups, e.g. children, elderly. Accident causing permanent disability Activity or accident that damages a site of cultural heritage importance that requires immediate repair by existing project resources

Score	Geographical extent	Duration of impact	Nature of the change, size, scale and any potential cumulative effects	
			Environmental (physical and biological)	Social (socio-economic, health, cultural heritage)
4 High	Widespread: impact experienced >50 km from site	Long term: impact and its effects will continue for up to five years or more following cessation of activities, potentially irreversible	Impacts on a unique habitat, or national scale, resulting in long-term damage and a restoration time of more than five years and requiring substantial intervention Activity or event disturbing a sufficient portion of the biogeographic population of a species to cause a change in abundance, distribution or size of genetic pool such that natural recruitment would not return the population of the species, and several species dependent on it, to former levels within several generations Potential for large-scale pathological damage of nationally/internationally important species of conservation concern Numerous non-compliances with emission and effluent discharge licence limits, or national/ international standards Environmental incident with potential for extensive ecological damage typically requiring mobilisation of in-country or international response resources	Activity or event causing substantial interference to other users of resources, change to demographics, employment, social services provision or lifestyle that is out of line with international guidelines or national policy affecting a large number of people and lasting considerably beyond project lifetime Planned activity resulting in increased long-term mortality, long-term chronic illness, permanent disability or significant reduction in wellbeing in a large number of people Incident with massive impact to other users or the value of the resource, fatalities, or international damage to the developer's corporate reputation Activity or accident that seriously damages a site of cultural heritage importance, notifiable to the relevant authority and requiring specialist skills to repair

Table 1.3: Definitions to assist with scoring of receptor sensitivity

Score	Physical	Biological	Social (socio-economic, health, cultural heritage)
1 Very low	Surface waters (including marine) with no community use or only used for low grade industrial use	Commonly occurring habitats and species, not subject to significant decline Habitats that are already disturbed or are periodically subject to natural disturbance Fauna and flora not susceptible to emissions or discharges, fauna not susceptible to noise emissions	Study area and potential zone impacted includes no inhabitants and/or resources that are not used or protected No human receptors for air emissions and noise apart from work force Highly skilled and experienced labour pool No cultural heritage assets, or those with very little surviving archaeological interest
2 Low	Surface waters (including marine) with some pre-existing pollution that limit their use or value for wildlife or communities	Low sensitivity or local ecosystem value Sites of local biodiversity value but not intact, fragile or unique Habitats that recover quickly following disturbance (e.g., habitats comprising species that rapidly recolonise disturbed areas) Widespread common species with low biodiversity value Fauna and flora with low susceptibly to air emissions and discharges, fauna with low susceptibly to noise emissions	Study area and potential zone impacted include a low number of inhabitants and/or resources that are used but not protected Individuals or households in local communities have access to alternative nearby resources, the use of which may cause limited adverse indirect impacts Human receptors for air quality and noise limited to individuals from local community that may pass through the area, but exposure for extended periods unlikely Skilled labour pool, but lack relevant experience Designated and undesignated cultural heritage assets of local importance

Score	Physical	Biological	Social (socio-economic, health, cultural heritage)
3 Medium	Surface waters (including marine) of moderately high quality, e.g., in its natural state, or supports an area or species valued or designated for its importance at national level. Waters that support commercial or subsistence fishery	Medium sensitivity or regional/national ecosystem value Sites of regional importance, or designated for protection at national level Habitats of high species or habitat diversity or 'naturalness', or recognised as intact or unique, or areas recognised by non-governmental organisations as having high environmental value Regionally or nationally important population of a species, either because of population size or distributional context Species listed as near threatened on the IUCN Red List or species in significant decline at national or regional level Habitats that are unlikely to return to natural conditions without some intervention, but which are capable of assisted recovery Flora and fauna with moderate susceptibility to air emissions and discharges, fauna with moderate susceptibly to noise emissions	Study area and potential zone impacted include a moderate number of inhabitants and/or resources of regional importance. Some individuals/households depend on the affected resource with no nearby alternatives Human receptors for air quality and noise include residential buildings where longer periods of exposure may occur Some households and business owners/operators perceive that the change will affect their ability to maintain their livelihood (artisanal fishing) or quality of life for a significant time period (<1 year) Limited skills and experience in labour pool Cultural heritage sites or artefacts of regional or national importance

Score	Physical	Biological	Social (socio-economic, health, cultural heritage)
4 High	Surface waters (including marine) that are very high quality, e.g. in natural state or supports an area or species valued or designated for importance at international level. Waters that support very productive fisheries	High sensitivity or international ecosystem value Sites of international importance/designated for protection at international level High densities of species that are vulnerable, endangered or critically endangered or at an international level (i.e. listed on IUCN Red List, CITES) Critical habitats as defined by IFC P-S6 'Biodiversity Conservation & Sustainable Natural Resource Management'[4] Habitats that are very difficult to restore to natural conditions Flora and fauna with high susceptibility/very low tolerance of air emissions or discharges, fauna with very low tolerance to noise emissions	Study area and potential zone impacted include a significant number of inhabitants and/or resources of national or global importance. Communities depend of the affected resource(s) with no nearby alternatives Human receptors for air quality and noise include residential buildings, schools, hospitals where near-constant presence of people is possible and long-term exposure likely Many households and business owners/ operators perceive that the change will affect their ability to maintain their livelihood or quality of life to an unacceptable extent and may have to leave the area/community Lack of skilled and experienced labour pool Cultural heritage sites or artefacts of international importance such as UNESCO World Heritage Sites

[4] Critical habitats are areas with high biodiversity value, including (i) habitat of significant importance to critically endangered and/or endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes.

1.8.7.3 *Impact significance*

The significance of the impact will then be calculated as follows:

Significance = Intensity × Sensitivity

The significance of impacts will be determined using the matrix presented in Figure 1.5. It is qualified according to a scale that ranges from negligible to major, with an additional category for positive impacts (see Table 1.4).

Significance			Sensitivity rating			
			Very low	Low	Medium	High
		0 Positive	1	2	3	4
Intensity rating	Very low	1	1 Negligible	2 Negligible	3 Minor	4 Minor
	Low	2	2 Negligible	4 Minor	6 Moderate	8 Moderate
	Medium	3	3 Minor	6 Moderate	9 Moderate	12 Major
	High	4	4 Minor	8 Moderate	12 Major	16 Major

Figure 1.5: Impact significance matrix

Residual impacts are then evaluated, taking into account application of mitigation measures. Any significant (moderate or major) residual impacts may trigger additional mitigation or compensation. In addition, measures for enhancing any positive impacts should be highlighted.

The assessment of impacts resulting from the Block 4 exploration drilling campaign is provided in Chapter 6: Potential Impacts of the Project.

Table 1.4: Impact significance scale

Score	Category	Definition
0	Positive	The positive impact should be welcomed by key stakeholders and measures should be taken to maximise the benefit.
1–2	Negligible	Negligible impacts that are unlikely to warrant additional mitigation measures or monitoring.
3–4	Minor	The potential negative impact is likely to be acceptable to key stakeholders without additional mitigation measures. Monitoring should check that the baseline conditions are not affected beyond predicted levels.
5–9	Moderate	Additional mitigation measures should be developed to control the potential negative impact so that changes to baseline conditions are kept ‘as low as reasonably practicable’.

Score	Category	Definition
> 9	Major	The possible negative impact is too significant to be acceptable. Controls must be implemented to reduce either the likelihood or the impact severity or provide compensation/offset if this cannot be achieved.

1.8.7.4 Accidental impacts

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

Scoring of accidental impact significance/risk is undertaken using the same methodology as described for routine events. However, the likelihood of the event is then a key consideration in the final grading.

The significance/risk of the impact has been calculated as follows:

Significance/Risk = Sensitivity × Intensity × Likelihood (see Table 1.5).

Table 1.5: Likelihood categories for unplanned/accidental events

Category	Score	Definition
Likely 10^{-1}–10^{-2}	5	Could occur several times during over plant* lifetime
Unlikely 10^{-2}–10^{-3}	4	Could occur once for every 10 to 20 similar plants over 20 to 30 years of plant lifetime
Very unlikely 10^{-3}–10^{-4}	3	One time per year for at least 1000 units. One time for every 100 to 200 similar plants in the world over 20 to 30 years of plant lifetime. Has already occurred in the company but corrective action has been taken
Extremely unlikely 10^{-4}–10^{-5}	2	Has already occurred in the industry but corrective action has been taken
Remote $<10^{-5}$	1	Event physically possible but has never or seldom occurred over a period of 20 to 30 years for a large number of sites.

Source: Likelihood categories extracted from the TEP Liban Risk Register that has been submitted as a standalone document to the authorities.

*Plant is the term used in the TEP Liban Risk Register and has been used in this case instead of 'project'

The significance/risk is then qualified according to a scale that ranges from low to high (see Table 1.6). Low risks are defined as those where at least two of the scores from sensitivity, intensity or likelihood are defined as low or very low (sensitivity and intensity of 2 or less, likelihood of 3 or less), moderate risks arise where at least two of the scores are medium, and high risks exist where at least two of the component scores are high and the third is at least medium.

Table 1.6: Accidental impact significance/risk scale

Score	Category	Definition
1–12	Low	Broadly acceptable risk level
13–36	Moderate	Tolerable risk level if demonstrated to be 'as low as reasonably practical'
>36	High	Not acceptable, risk level to be obligatorily reduced to moderate or low

The results from the oil spill modelling process, described in Section 1.8.7.6, were a key input into the accidental impact assessment.

1.8.7.5 Transboundary and cumulative impacts

Transboundary impacts are those that extend or occur across a national boundary: impacts that affect countries other than the country in which the project will be constructed or operated.

The proposed location of the first exploration well is just over 67 km from Cyprus Exclusive Economic Zone (EEZ) border, 77 km from Syria EEZ border and 107 km from Occupied Palestine EEZ border (the closest point of this border is on the coastline). The proximity of these borders has been taken into consideration when assessing transboundary impacts for both routine activities and accidental events.

Cumulative impacts are those that act together with other impacts, from the same or other projects, to affect the same environmental or social resource or receptor. There can be either

- additive impacts, which result from the combined or incremental effects of the project when considered in combination with those associated with other known future projects. While a single activity, in itself, may result in an insignificant impact, it may, when combined with other impacts in the same geographical area and occurring at a similar time, result in a cumulative impact that could have a detrimental effect on important resources.
- in-combination impacts, where different types of impact from the project being considered are likely to affect the same environmental or social features. For example, a sensitive receptor being affected by both noise and turbidity during construction could potentially experience a combined effect greater than the individual impacts in isolation.

The potential for cumulative impacts with other activities at the Beirut Port, and with other oil and gas exploration and exploitation activities in the eastern Mediterranean, has been taken into consideration in this assessment.

1.8.7.6 Modelling studies

The following studies have been carried out for the Block 4 exploration drilling campaign to provide a more accurate assessment of project impacts:

- modelling of drilling discharges (cuttings and associated drilling fluids) from the well (see Chapter 6)
- underwater noise modelling for the drilling campaign and assessment of the effects on marine mammals (see Chapter 6)

- oil spill modelling study for worst-case possible accidental release scenarios in Block 4 (see Chapter 6).

1.8.8 Management and implementation

Processes are required to ensure that both the operator and relevant contractors implement commitments derived from the EIA during the exploration drilling campaign.

A commitments register has been compiled that lists all the specific mitigation measures identified in this EIA (see Chapter 8). These commitments will be tracked through to the environmental and social management plans (ESMPs) developed for the drilling campaign. More information is provided in Chapter 8: Environmental and Social Management Plan.

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2 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

2.1 Introduction

The Block 4 exploration drilling programme will be carried out in accordance with the environmental and social requirements of

- national policy, legislation and regulations
- applicable international treaties and agreements to which Lebanon is a party
- TOTAL's corporate requirements
- international good practice.

This chapter sets out the legal and policy context for the project and describes the Lebanese administrative structure within which the project will be implemented.

2.2 National institutional framework

The Ministry of Environment (MoE) is the main body responsible for environmental protection and management in Lebanon. The role of the MoE in the oil and gas sector is explicitly defined in the Offshore Petroleum Resources Law (OPRL) No. 132/2010 and the Petroleum Activities Regulations (PAR) Decree No. 10289/2013, as amended by Decree No. 177/2017. The ministry is tasked with supervising the conduct of petroleum activities and ensuring its overall compliance with environmental standards and regulations.

Another main stakeholder in the environmental management of petroleum activities is the Lebanese Petroleum Administration (LPA). The LPA was established in 2012, to be the regulatory body in charge of managing the petroleum sector in Lebanon. The LPA is an independent public entity and operates under the tutelage of the Minister of Energy and Water (OPRL, article 10). It plays a critical role during licensing, exploration, development, production and decommissioning stages and actively undertakes planning, regulatory and supervisory roles across the Lebanese petroleum sector.

The MoE works in coordination with the LPA supervising and controlling environmental matters related to petroleum activities and will coordinate with other concerned authorities, take initiatives or measures deemed necessary to minimise negative impact that petroleum activities may have on local communities and the environment (OPRL No. 132/2010, article 60). Other stakeholders involved in the environmental management of the petroleum sector are listed in Table 2.1, along with their roles.

Table 2.1: Roles and responsibilities of the prime stakeholders

Institution	Role and responsibilities	Relevance to the project
Ministry of Environment (MoE)	The MoE is responsible for the protection of the environment within Lebanese territory including territorial waters and the exclusive economic zone (EEZ). As per Law No. 132/2010 (OPRL) and Decree 10289/2013 (PAR), MoE is involved in setting the principles and procedures for the management of offshore petroleum operations, environmental impact assessment (EIA) studies for any plan for development, production, transportation, storage, utilisation, cessation of petroleum activities and decommissioning, and setting out inspection, monitoring and verification requirements. PAR includes regulations on provisions for strategic environmental assessments (SEA) and EIAs for the sector, reconnaissance licensing and activities, exploration and production rights, petroleum production and transportation, cessation of petroleum activities and decommissioning of facilities, production entitlements and fees, drilling and wells, managing facilities, health, safety and environment, as well as general and final provisions (LCPS, 2015). The MoE is also responsible for drafting guidelines relating to activities with an environmental aspect. The main areas regulated by the MoE are • environmental matters including emissions, discharges, hazardous materials, waste and state of the ambient environment • development of environmental strategies, plans and programmes • development of legislation, specifications and standards necessary for protecting the environment and sustainability of its natural resources and addressing emergency and chronic hazards affecting it • environmental permitting • monitoring the condition of the environment • supervision and inspection of facilities, activities and operations relating to environmental impact • environmental accident investigations	MoE is responsible for • reviewing and approving EIAs, IEES, SEAs and EAs • environmental permitting (environmental licensing for hazardous waste) • the national database for hazardous waste • environmental monitoring, auditing an inspection • supervision of incident clean-up (should one occur) • water quality monitoring should an incident occur (MoE & LPA, 2019).

Institution	Role and responsibilities	Relevance to the project
	• enforcement in cases of emergency leading to environmental impacts • enforcement in cases of non-conformity or violation of environmental regulations • reviewing and approving EIAs, initial environmental examinations (IEEs), SEAs and EAs. The MoE is also the focal point for environmental conventions, including the Basel convention for the export of waste and the Stockholm convention for the import of persistent organic pollutants (POPs) chemicals. The MoE is responsible for ensuring there is no violation of the Lebanese commitments to any international conventions signed.	
Lebanese Petroleum Administration (LPA)	The LPA is an independent public entity responsible for managing the Lebanese petroleum sector during licensing, exploration, development, production, and decommissioning stages, by creating the greatest possible value for the economy and the society from the oil and gas activities while protecting the environment (LCPS, 2015). In addition, LPA is responsible for • preparing technical studies to support and inform the decision-making processes • undertaking planning, regulatory and supervisory roles across the petroleum industry value chain. It plays critical roles during the licensing phase, the exploration phase, the development and production phase and the decommissioning phase. The QHSE Department of the LPA is responsible for all matters related to the quality of operators' systems and the extent of their adherence to the conditions of health, safety and environment, and particularly responsible for studying applications for licences, studying plans on quality of performance, monitoring preparedness for addressing accidents and emergencies, monitoring the compliance of operators with various regulations, assessing the impact of operations on occupational and environmental health, and monitoring facilities to ensure compliance with environmental, health and safety standards (LCPS, 2015).	LPA is responsible for undertaking planning, regulatory and supervisory roles across the petroleum industry value chain. LPA also plays a critical role during the licensing, exploration, development and decommissioning phases.

Institution	Role and responsibilities	Relevance to the project
	Additional mandates are assigned to LPA when it comes to management and follow up of environmental aspects of the petroleum activities, as mandated by PAR (LCPS, 2015).	
Council of Ministers (CoM)	CoM is the executive body of the Republic of Lebanon and is generally tasked with overseeing daily affairs. In addition, CoM sets forth the state's petroleum policy.	The CoM is involved in the management of petroleum resources and settling any differences between concerned stakeholders.
Ministry of Energy and Water (MoEW)	Role of the ministry in offshore oil and gas activities is stipulated in the OPRL and PAR. In cases of emergency, the MoEW ensures the implementation of the petroleum policy. The MoEW endeavours to enhance the state petroleum capabilities and is responsible for monitoring and supervising petroleum activities, and taking the necessary measures to protect water, health, property, and the environment from pollution. Before the drilling of any individual well deeper than 50 m, a drilling permit must be granted by the Minister of Energy and Water based on the opinion of the LPA. The Ministry is responsible for works related to biodiversity and protected species which will be a component of the environmental and social impact assessments carried out during the development of oil and gas activities (Kanbar, 2015).	Minister is responsible for monitoring and supervising petroleum activities in addition to granting exploratory drilling permits before drilling.
Ministry of Public Health (MoPH)	The MoPH (2018) is responsible for supervising and monitoring healthcare facilities and providing universal health coverage. The MoPH is also in charge of • promotion of hygiene • rehabilitation of sanitation facilities at public health centres • promotion of sound healthcare waste management practices • provision of disease surveillance information. MoPH also has a role in permitting import and management of radioactive sources. As per Decree 8377/1961, MoPH is mandated with the drafting of laws and regulations related to the management of the health sector. The MoPH supervises and monitors healthcare facilities (MOE/UNDP/ECODIT, 2011).	MoPH is the authority responsible for ensuring the proper health and safety of workers during exploratory drilling activities. MoPH provides customs clearance for certain chemicals.

Institution	Role and responsibilities	Relevance to the project
Ministry of Public Works and Transport (MoPWT)	The MoPWT is the marine competent authority responsible for all matters related to national maritime transportation activities in line with local and international maritime requirements. It is the competent authority for several international conventions (MARPOL, ILO, etc.). The MoPWT is responsible for • maintaining and improving the marine navigational aids in ports and along the coast • protecting the marine environment from pollution in coordination with MoE. The Directorate-General of Land and Maritime Transport has the responsibility to monitor all Lebanese and non-Lebanese ships. Monitoring procedures aim to ensure that ships comply with all of the requirements under international conventions pertaining to safety, environmental protection and pollution prevention, particularly the International Convention for the Safety of Life at Sea, 1974 (SOLAS), as amended, the International Convention for the Prevention of Pollution from Ships (MARPOL), the STCW Convention, as amended in 1995, and the ILO Conventions, as amended. As per Decision No. 96/2018, MoPWT is involved in the rules of control and supervision of the bodies approved by the Directorate-General of Land and Maritime Transport (MoPWT, 2019). The Directorate-General of Civil Aviation has responsibility for regulating and operating Beirut International Airport and has technical experts in the fields of aviation safety, air transport, facility and equipment maintenance, meteorology and telecommunications. The Air Navigation Department is responsible for the provision of air traffic services for the entire territory of Lebanon, including its territorial waters as well as airspace over the high seas within the Beirut Flight Information Region. As per Regulatory Decree No. 1610, dated 26th July 1971, the Directorate-General of Civil Aviation is associated to the MoPWT.	MoPWT is responsible for maintaining marine navigation, including back and forth trips from port of Beirut to the drilling location. The Ministry also issues notices to mariners providing information on any constraints to marine navigation. The Ministry is responsible for ensuring MARPOL control measures are implemented and complied with. Role of Directorate-General of Civil Aviation applicable to project helicopters accessing Beirut International Airport. The Directorate-General of Civil Aviation is responsible for issuing permits for the use of helicopters and the monitoring compliance for helicopter operations.

Institution	Role and responsibilities	Relevance to the project
Ministry of Agriculture (MoA)	The MoA is responsible for formulating the agricultural sector strategic framework and developing related policies and programmes. The MoA is also responsible for developing legislative and regulatory frameworks governing the agricultural sector and for securing infrastructure to facilitate investment, production and marketing operations. The directorate of rural development and national resources under the MOA is responsible for aquaculture development (FAO, 2019). In addition, the MoA has a primary role in the management of natural resources (agricultural land, irrigation water, forests and forestry, fisheries, rangelands) and in the preparation and implementation of rural development programmes (MoA, 2014).	The MoA's legal mandate covers the coastal zone and the management of fisheries, fishing and hunting activities.
Ministry of Labour (MoL)	The MoL is responsible for labour and employment issues. Labour inspection is the responsibility of the Department of Labour, Inspection, Prevention and Safety (DLIPS). The National Social Security Fund carries out inspection services to verify social security contributions (MOL, 2019). Based on the role of OPRL and PAR, the role of MoL with relation to the offshore sector is limited (MOL, 2019).	The MoL is involved in matters related to work and workers (MOL, 2019),
Ministry of Finance (MoF)	The Ministry of Finance aims to foster sustainable economic growth in alignment with national priorities. Some of the ministry's objectives include • ensuring that the legal responsibilities of the Ministry are executed impartially • developing and maintaining a stable economic environment • optimally structuring and managing the nation's assets and abilities • fostering stable financial institutions and markets • facilitating the development of the national economy and international trade • developing and maintaining leading-edge organisational and management practices. The Customs directorate is responsible for the collection of customs duties and other duties and taxes that may be imposed on goods imported to Lebanon (MoF, 2017).	The directorate of customs under the MoF will be involved in facilitating customs procedures; specifically with regard to importing equipment and materials for project activities and the export of waste and import of controlled chemicals.

Institution	Role and responsibilities	Relevance to the project
Ministry of Foreign Affairs (MoFA)	Several directorates are under the Ministry of Foreign Affairs, including the Directorate for Economic, Cultural and Social Affairs. This directorate coordinates with the competent administrations in the matters related to Lebanon's economic and financial relations with foreign countries. It works on finding new markets for Lebanon's products, promoting Lebanese tourism, handling employment and housing affairs and attending social and economic conferences. The Directorate contributes to the preparation of economic, cultural, social, touristic and environmental agreements and follows-up their implementation.	The MoFA will coordinate with other countries in the event of transboundary adverse impacts in light of the applicable international conventions.
Port of Beirut	The Port of Beirut Authorities are responsible for the Port inside the quay line. Outside of the Port limits, the MoPWT is the competent maritime authority.	The Port of Beirut will serve as a logistics base and will be the port used by supply vessels for the MODU
Lebanese Army	The Lebanese Armed Forces is the military of the Lebanese Republic. It consists of three branches: the army, the air force, and the navy.	The Lebanese Navy monitors vessel movements in coastal waters. Involved in issue of information and instructions to mariners pertaining to shipping hazards and safety zones (in conjunction with MoPWT). Army Intelligence Directorate involved in port security. The Lebanese Air Force provides security clearance for helicopter use.
Ministry of Social Affairs (MoSA)	The Ministry of Social Affairs is responsible for providing assistance; for example, the ministry's strategy is based on the principle of sustainable human development where it responds to the basic needs of the groups most in need and creates partnerships with public and private sectors at various levels (MOSA, 2019).	The Ministry of Social Affairs is responsible for providing assistance to people in need and vulnerable groups (MOSA, 2019). This is mainly related to the relevant social impacts of the exploratory drilling activities.
National Council for Scientific Research (CNRS) (under CoM)	The CNRS is a national institution, established in 1962, responsible for encouraging scientific research and supporting human resources development along the general scientific policies adopted by the government (CNRS, 2006; 2019).	Data collection for the EIA from the relevant centres including the following: • Geo-hazards, Remote Sensing and GIS • Centre for Geophysical Research • National Centre for Marine Studies.

Institution	Role and responsibilities	Relevance to the project
	The CNRS has been entrusted with two missions: the first is advisory, the second executive. The consultative mission of the CNRS involves the formulation of guidelines for national scientific policies aimed at enhancing the development of the country (CNRS, 2006) (CNRS, 2019). As part of its executive mission, the CNRS secures the promotion, organisation and realisation of these policies in action programmes implemented in its own research centres or in collaboration with other academic, research and development institutions (CNRS, 2006; 2019). The CNRS is responsible for · • drafting the general outline of a national science and research policy · • advising the government on any issue concerning science and national science policy · • carrying out surveys and inventories of ongoing research · • formulating work programmes in cooperation with the relevant ministries and the private sector · • initiating and encouraging scientific research in the theoretical and applied aspects of basic, social and behavioural sciences. The Lebanese Atomic Energy Commission (LAEC), one of the centres under CNRS, is the national agency mandated to establish the radioprotection infrastructure of all radioactivity sources emitting ionising radiation in Lebanon and to carry out surveys on possible radioactive pollution. LAEC's mandate covers monitoring the radioactivity of imported and exported commodities and related equipment and maintaining a national record of all radioactive materials and equipment in Lebanon, under Decree 15512/2005 (LAEC, 2010). Its aim is to protect all personnel working in this field and the general public from radioactive risk and pollution. It is also mandated to establish a plan for the treatment of all radioactive waste from industries and hospitals. The LAEC is mandated to issue utilisation permits to all institutions using ionising radiation. LAEC has a department for environmental radiation control and a department for	CNRS may also monitor the water quality and marine life on behalf of the government. The LAEC is responsible for issuing permits for radioactive materials, such as for use in wireline logging.

Institution	Role and responsibilities	Relevance to the project
	authorisation, inspection and regulations. It is responsible for regulating the use and protection of ionising radiation (Decree No. 105 of 1983).	
Ministry of Culture (MoC) (Directorate General for Antiquities (DGA))	The DGA is part of the Ministry of Culture and responsible for executing, monitoring and enforcing the Antiquities law, and for archaeological remains, antiques, traditional and historical monuments (Archeolmed Sites, 2019). The DGA's responsibilities include · • organisation and execution of archaeological excavations, upkeep of the historic monuments and discovery of new archaeological sites · • delivery of excavation permits and control of scientific archaeological missions performing excavations · • establishment and management of museums, organisation of archaeological and historic exhibitions · • control of commerce and export of antique objects· • enforcement of current laws and regulations · • management of the World Heritage Sites in Lebanon.	The Ministry of Culture's relevance to the project is ensuring that the drilling activities are not affecting any archaeological or historical sites and areas.
Concerned municipalities	Organised into federations where projects are too large for a single municipality. Responsibilities include local roads and buildings, community facilities, wastewater and drainage. Concerning solid-waste management, municipalities are part of the local administration who are in charge of the daily management of all public works within their jurisdiction. Municipalities are given the right to establish waste disposal facilities in their territories (Elard and Tedobin, 2014)	The concerned municipalities related to the project are mainly those which face Block 4.
Other institutions agencies, academia, NGOs and citizens	As appropriate to the relevant body	Data collection from academia. NGOs and citizens, engagement in the phases of the project to share their concerns, objections, and recommendations concerning the proposed project

Source: CNRS (2006); LAEC (2010); MOE/UNDP/ECODIT (2011); Elard & Tedobin (2014); MoA (2014); UNDP (2014); Kanbar (2015); LCPS (2015); MoF (2017); MoPH (2018); Ramboll (2018); Archeolmed Sites (2019); CNRS (2019); FAO (2019); ILO (2019); MoL (2019); MOSA (2019); UNEP-ROWA (2019); MoE & LPA (2019); MoEW (2019); MoPWT (2019)

2.3 National policy

According to Article 1, the main objective of Law No. 444/2002 on environmental protection, is to define the general legal framework to apply a national environmental protection policy (MoE, 2017). Law 444/2002 goes on to identify the following 11 environmental principles that are applicable to any activity within the Lebanese territory:

- Precaution Principle (cleaner techniques): focuses on the use of best affordable clean techniques to protect the environment from irreversible ramifications
- Prevention Principle: using best affordable technologies to prevent damages that may occur in the environment
- Polluter-Pays Principle: requiring polluters to endure the costs of pollution prevention and control
- Biodiversity conservation Principle: aimed at protecting the biodiversity of Lebanon from any economic activity
- Prevention of Natural Resources Degradation Principle: requiring all activities to avoid causing irreversible damages to the natural resources like water, air, soil, forests, sea, rivers and others
- Public Participation Principle: ensuring that all citizens have the right to free access of national environmental information, and have the duty of notifying any environmental risk occurring
- Cooperation Principle: requiring the cooperation between public and local authorities and citizens to ensure the protection and conservation of the environment on all levels
- Principle of Recognition of Local Mores and Customs in rural areas aimed at enforcing local customs in the absence of law provision
- Pollution Control Principle: aimed at preventing and controlling pollution in all environmental aspects to prevent pollution spreading or influencing other areas
- Economic Incentives Principle: encourages the use of economic incentives to control and abate pollution
- EIA Process Principle: aimed at evaluating environmental impacts of any activity to control and mitigate any potential impacts on the environment.

Table 2.2 presents other key plans, programmes and strategies relevant to the proposed project.

Table 2.2: Key plans, programmes and strategies

Policy	Year	Brief scope	Relevance to project
Lebanon's marine protected area strategy	2012	Document proposes new MPAs in addition to the two existing sites and sets the MPAs management strategy which aims to fulfil the following objectives: • establish a more systematic approach to marine protected areas planning and establishment • enhance collaboration for management and monitoring of marine protected areas • increase awareness, understanding and participation of the local community in the marine protected areas network • link Lebanon's network of marine protected areas to Mediterranean networks.	Project needs to adhere to the requirements of the strategy and set measures to protect MPAs and proposed sites
Fifth national report of Lebanon to the Convention on Biological Diversity	2015	It provides an update on biodiversity status, trends and threats and implications for human well-being and provides the national biodiversity strategy and action plan.	National targets and national action plans relevant to the project will be adhered to, especially targets related to preserving threatened species, control of invasive alien species and sustainable management of ecosystems.
Lebanon's National Biodiversity Strategy and Action Plan (NBSAP) 2016–2030	2016	The NBSAP aims to mainstream biodiversity into sectoral and cross-sectoral strategies, plans and programmes while its vision is to preserve and conserve the Lebanese ecosystems, habitats and species. The NBSAP is aligned with the new Convention on Biological Diversity goals and integrated the 2020 Aichi Biodiversity Targets.	National targets and national actions relevant to the project will be adhered to, especially targets related to preserving threatened species, control of invasive alien species and sustainable management of ecosystems.
Strategic Environmental Assessment (SEA) for Exploration and Production Activities Offshore Lebanon	2014 (2019 update at draft stage)	In 2011, the Lebanese Government commissioned a SEA which was finalised in 2012 and published in 2014. The SEA report evaluated the likely environmental and social effects of introducing and developing oil and gas activities in Lebanon.	Mitigation measures approved in the SEA for Exploration and Production Activities Offshore Lebanon are mandatory to petroleum sector activities.

Policy	Year	Brief scope	Relevance to project
		This document was updated and disclosed for public consultation in 2019.	
National Oil Spill Contingency Plan (NOSCP) in Lebanese Waters	2017	The NOSCP objectives are aligned with the IMO objectives for a NOSCP. As such, it • establishes a viable operational organisation with representation from all concerned agencies • identifies the national high-risk areas • identifies priority coastal areas for protection and clean-up • provides a minimum level and appropriate types of pollution response in accordance with the OPRC Convention • prevents the spread of further pollution from identified oil spills • controls the spill source and clean-up of existing pollution • employs net environmental benefit analysis to ensure that the chosen recovery strategy does not further damage the environment.	Procedures and requirements of the national plan to be incorporated into project spill response plan
Lebanon's Intended Nationally Determined Contribution under the UNFCCC / MoE	2015	Lebanon's mitigation included unconditional targets of • GHG emission reduction of 15% compared to 2011 scenario by 2030 • 15% of power and heat demand in 2030 generated by renewables • 3% reduction in power demand through energy-efficiency measures by 2030 and conditional targets of • GHG emission reduction of 30% compared to 2011 scenario by 2030	GHGs from the petroleum sector will be controlled to achieve the targeted GHG emission reduction from the energy sector.

Policy	Year	Brief scope	Relevance to project
		• 20% of power and heat demand in 2030 generated by renewables • 10% reduction in power demand through energy-efficiency measures by 2030.	
Lebanon Rural Tourism Strategy	2015	The goal of the five-year strategy is to enhance economic opportunities in Lebanese rural areas through improving the competitiveness of specific value chains including rural tourism and another set of agricultural sectors and food products.	Project supply base will not be located close to areas important for tourism and will not affect the visual amenity in such areas
Lebanon's commitment to the UN sustainable development goals, 2030 (SDGs)	2017	The Lebanese government has taken major steps towards the implementation of the SDGs and has sought to send a positive message about Lebanon's commitment and determination to implement the 2030 Agenda for Sustainable Development. The government established a National Committee in June 2017 consisting of all ministries and public institutions, as well as representatives from civil society and the private sector. UN Sustainable Development Goals: Goal 1: No poverty Goal 2: Zero hunger Goal 3: Good health and well-being Goal 4: Quality education Goal 5: Gender equality Goal 6: Clean water and sanitation Goal 7: Affordable and clean energy Goal 8: Decent work and economic growth Goal 9: Industry, innovation and infrastructure Goal 10: Reduced inequalities Goal 11: Sustainable cities and communities	The project will consider the SDGs and contribute to the extent possible to the related goals.

Policy	Year	Brief scope	Relevance to project
		Goal 12: Responsible consumption and production Goal 13: Climate action Goal 14: Life below water Goal 15: Life on land Goal 16: Peace, justice and strong institutions Goal 17: Partnerships for the Goals.	
National Implementation plans (NIP) for the Management of Persistent Organic Pollutants	2006	Lebanon signed the Stockholm Convention on 22 May 2001 and ratified it in law 432 on 29 July 2002; the convention came into force on 17 May 2004. Following this, Lebanon was selected to take part in the "UNEP/DGEF 12 Countries Pilot Project for the Development of National Implementation Plans for the Management of POPs". This project aims to strengthen national capacity to manage persistent organic pollutants (POPs) and to assist Lebanon in meeting its obligations under the Stockholm POPs Convention. It also aims to assist Lebanon in developing a National Implementation Plan (NIP) for POPs management in order to reduce and eventually eliminate POPs emissions.	Requirements of the NIP relevant to the project will be taken into account.
Integrated Solid Waste Management Framework	2018	Sets the overall guiding principles and requirements for solid waste management in Lebanon. Regarding hazardous waste, MoE shall prepare a feasibility study and shall take the necessary steps to build interim hazardous waste storage sites and build needed treatment facilities. Enacted by the ISWM National Strategy 2019.	To be taken into account with respect to project waste management
Policy Summary on Integrated Solid Waste Management	2018	The policy takes into consideration the following procedural aspects: • household solid waste	Requirements relevant to the project will be taken into account.

Policy	Year	Brief scope	Relevance to project
		• gradual closure and rehabilitation of uncontrolled dumpsites • hazardous and other wastes.	
Road Map 2019-2030 for the ISWM sector	2019	Decisions of the Council of Ministers regarding the Road Map 2019-2030 for the Integrated Solid Waste Management (ISWM) sector.	Requirements relevant to the project will be taken into account.
A National Energy Strategy for Lebanon	2017	It presents Lebanon's national aspirations for the energy sector specifically electricity and oil & gas	Information relevant to the project will be taken into account.

Source: FAO (2019); MoEW (2016, 2019); Khoury and Alhaj (2019); MoE (2006)

2.4 National legislation

Figure 2.1 presents the hierarchy of legislation in Lebanon.

The Lebanese Constitution represents the strongest legislative text in Lebanon, and proposed legislation cannot be issued if in contradiction with the Constitution.

International treaties/agreements ratified by Lebanon have second priority in the Lebanese legislative framework. These are discussed in more detail in Section 2.7.

The need for environmental protection has long been recognised by the Lebanese authorities and many parliamentary Laws, Council of Ministers' Decrees and Ministerial Decisions and Orders are available for enforcement. These are summarised in Table 2.3 along with their relevance to the Block 4 exploration drilling programme.

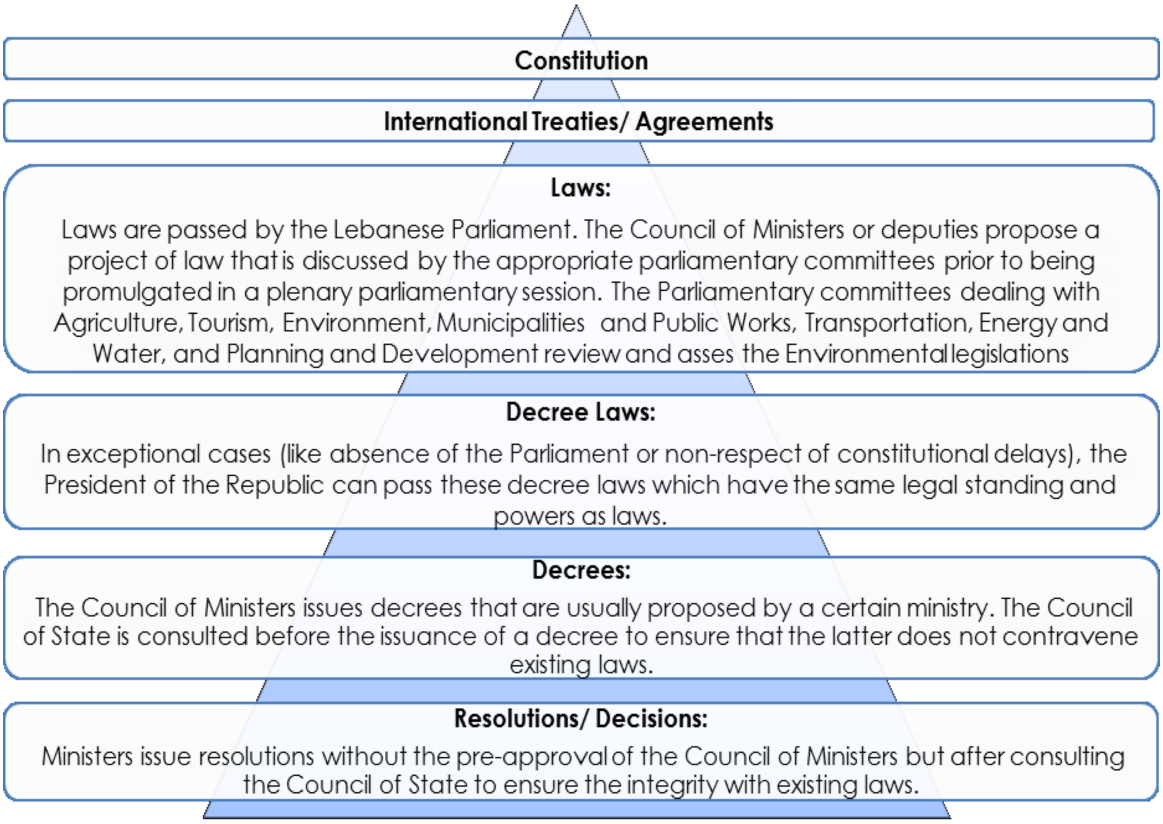

Figure 2.1: Hierarchy of legislation in Lebanon

Table 2.3: Key national legislation of relevance to the Block 4 exploration drilling programme

Legislation	Title	Key requirements	Relevance to project
Petroleum legislation			
Law No. 132/2010	Offshore Petroleum Resources Law (OPRL)	Law sets the principles and procedures for the management of offshore petroleum operations. It requires the State to conduct a strategic environmental assessment study (SEA) prior to awarding any petroleum rights. It requires EIA studies for any plan for development, production, transportation, storage, utilisation, cessation of petroleum activities and decommissioning. It requires a permit for venting and flaring. It sets out inspection, monitoring and verification requirements.	Includes EIA requirements for development of petroleum activities relevant to project Specifies that a permit is required for venting and flaring Competent authority has the right to inspect any facility used for petroleum activities in order to monitor and verify the consistency of information and reports relating to activities
Decree 43 Annex 2 2017	The Exploration and Production Agreement (EPA)	Article 17 is related to health, safety and environmental requirements. It requires the right holders and operators to comply with: (i) best international petroleum industry standards relating to health, safety and the environment; (ii) applicable Lebanese laws relating to health, safety and the environment; and (iii) reasonable requirements of the Lebanese Petroleum Administrator or any other competent authority relating to the protection pf health, safety and the environment. EIA studies required for development and production; construction, placement and operation of a transportation facility, and plan for cessation of petroleum activities and decommissioning of facilities Block-specific environmental requirements included in EPA	Requirements of the EPA need to be taken into consideration in the impact assessment, including any block-specific requirements

Legislation	Title	Key requirements	Relevance to project
Decree 10289/2013	Petroleum Activities Regulations (PAR)	Includes regulations on provisions for SEAs and EIAs for the sector, reconnaissance licensing and activities, exploration and production rights, petroleum production and transportation, cessation of petroleum activities and decommissioning of facilities, production entitlements and fees, drilling and wells, managing facilities, health, safety and environment, as well as general and final provisions. Requires all parties in the upcoming oil and gas sector to comply with the requirements in the industry. Requires a flaring or venting permit to be awarded by the MoEW. Article 141 requires use of modern technologies and practices that guarantee protection from environmental damage and control of wastes and avoidance of unnecessary losses and damages to natural resources. Article 128 requires preferential use of materials and chemicals which are least hazardous or damaging offering improved safety elements and thus minimising the risks to the health and safety of personnel, to the environment and to property. The Right Holder has to provide protection from: accidents and physical damage due to his activities, damage or risk of damage to workers, damage to fauna, flora, marine biodiversity and archaeology, marine pollution, air pollution and damage to hydrocarbon bearing formations. The Right Holder has to assure the implementation and monitoring of mitigation measures. Article 141 stipulates that the Petroleum Administration must be informed of the amount of operational and accidental discharges, leakages and waste, and such information will be made public. For other requirements/articles reference is made to the decree.	Main decree governing offshore petroleum activities. It details different phases licensing conditions and requirements in addition to HSE requirements. Test production subject to a permit stipulating procedure, volumes, and including when required in case of necessity, flaring or venting. Specifies that operational and accidental discharges are to be reported to authorities. Requirement to have an EIA including criteria for choices made, description of development stages, co-ordination, permitting and legal compliance, list of quality standards, number of wells, equipment used, injection of any component, management – planning, organisation & implementation, mitigation measures, emergency measures for safety, costs of the development. For a full list see article 44.
Decree 1177/2017	Amendment of some articles of Decree 10289/2013	Deletes Article 79: ”General Provisions Regarding the Valuation of Petroleum” and amends Article 80: ”Valuation of Crude Oil” and Article 81: ”Valuation of Petroleum Other than Crude Oil” of the PAR	Amendments to the main decree governing offshore petroleum activities.

Legislation	Title	Key requirements	Relevance to project
Decree 7968/2012	Lebanese Petroleum Administration	The establishment of the LPA and the roles of each department.	Role of LPA detailed in Table 2.1.
Law No 84/2018	Strengthening Transparency in the Petroleum Sector	This law defines the following: • transparency support in the petroleum sector • the duties of the Petroleum Sector Management Authority • National Authority for Combating Corruption.	LPA commitment to complying with transparency procedures and enhancing public access to information.
Environmental legislation			
Law No. 444/2002	Environmental Protection Law	Includes general provisions for protection of the environment (see Section 2.3). Article 30: It is strictly forbidden for all discharges, immersions or burning in the Lebanese territorial waters of every material that may directly or indirectly • affect the health of human beings or natural marine resources • harm the activities and marine creatures, including shipping, fishing, flora and seaweed • corrupt the quality of marine water • reduce the entertainment value and tourism possibilities of the sea and the Lebanese coast. Article 31: requires a permit for discharge to sea (application decree not issued). Article 44: requires a permit for the import, handling or disposal of dangerous/hazardous chemicals (application decree not issued).	Permit required for discharge into territorial waters. Permit required for import, handling and disposal of hazardous chemicals.
Decree 8633/2012	Environmental Impact Assessment	Decree aims at setting forth the rules that shall be considered in the EIA of public and private projects to avoid potential environmental impacts during construction, operation and decommissioning of these projects. More information provided in Section 2.5.	The Lebanese government has specified that an EIA is required for the Block 4 exploration drilling programme. The EIA report will be prepared in accordance with the requirements of the Decree.

Legislation	Title	Key requirements	Relevance to project
Decree 8213/2012	SEA	Decree aims at determining mandatory procedures to be followed for the assessment of potential environmental impacts of any policy, plan, programme, study, investment or organisation proposal that tackles an entire Lebanese region, or an activity sector, in order to ensure that these activities are compliant with conditions related to health, public safety, the protection of the environment and the sustainability of natural resources.	Mitigation measures approved in the SEA for Exploration and Production Activities Offshore Lebanon are mandatory to petroleum sector activities.
Law No. 690/2005	Organisation of the MoE	The MoE is responsible for all matters related to the environmental sector.	MoE responsible for imposing the preparation of EIA/IEE studies and for subsequent review and approval or rejection.
Law 130/2019	Law of Protected Areas	Defines the categories of protected areas and sets the procedures for the creation of protected areas.	Applicable in case of the presence of potential protected areas.
Decree 2275/2009	Organisation and mandates of the MoE	Application Decree on the organisation and mandates of the MoE, its divisions and departments	Departments of the MoE practice their mandated functions related to the offshore petroleum activities.
Decision 262/1 of 2015	Defining the procedures for filing and review of an objection on MoE Decisions related to EIAs	Defines the procedures for filing and review of an objection on MoE Decisions related to EIAs	Shall be adhered to during EIA studies conducted for petroleum activities.
Decision 261/1 of 2015	Defining the procedures for the review of Scoping	Includes the mechanism and procedures to review the EIA scoping reports and EIAs	Shall be adhered to during EIA studies conducted for petroleum activities.
Decision No. 1294/1 of 2017	Environmental conditions for transport of healthcare wastes	Regulates the transport of hazardous and infectious waste within Lebanese territory and determines the environmental conditions for transport from production sites to treatment sites	Applicable for the transport of healthcare wastes generated from petroleum activities to treatment facilities.

Legislation	Title	Key requirements	Relevance to project
Discharges, emissions, waste and hazardous materials legislation			
Ministerial Decision No. 52/1 of 1996 (amended by MoE Decision 8/1 of 2001)	Specification and Standards for Environmental Quality and Emission Limit Values into the Air Water and Soil	Standards and specifications are provided in 14 Annexes to Decree 52/1 of 1996. Decision 8/1 of 2001 overwrites Decision 52/1 in the form of 6 Annexes (with the exception of Annex 10 - noise levels and exposure limits)	Standards and limits applicable to the project from these decisions are included in Section 2.10.1.
Law No. 78/2018	Law for Protection of Air Quality	The law aims to protect ambient air quality by identifying, monitoring and assessing, preventing and controlling air pollution resulting from anthropogenic activities.	Law has specific requirements to adopt BAT for emissions reduction.
Decree No. 3277/2016 amending Decree No. 2604/2009	Control of Materials that Deplete the Ozone Layer	Decree aims to control substances that deplete the ozone layer which are listed in the annexes of the Montreal Protocol.	Import of ozone-depleting substances listed in the Decree is prohibited.
Law No. 77/2018	Water Resources Law	Law aims to organise, develop and protect water resources. It also aims to promote sustainability by strengthening water establishments.	Sets out penalties on unauthorised discharges or disposal of any kind of waste in water resources, including seawater.
Law No. 80/2018	Integrated Solid Waste Management	The law sets integrated solid waste management principles. It provides guidelines for the management of non-hazardous and hazardous waste.	Applicable to management of waste from exploration drilling programme.
Decree No. 5606/2019	Determination of the Fundamentals of Hazardous Waste Management	Defines the fundamentals of hazardous waste management including the characterisation and classification of these wastes, as well as the establishment of an appropriate monitoring and controlling system to control the operations of generation, sorting, collection, transport, storage, recovery, treatment and final disposal of hazardous waste, aiming at minimising the negative impacts on the environment. Specifies requirements for waste carriers, waste storage facilities, and recovery/treatment/disposal facilities. An environmental licence is required from the MoE for the transportation, storage, and recovery/treatment/disposal of	Applicable to management of hazardous waste generated by exploration drilling programme.

Legislation	Title	Key requirements	Relevance to project
		hazardous waste in accordance with templates in Annex VI and Annex VII of Decree. Requires a report to be submitted to the MoE every three months stating the types and quantities of hazardous wastes transported outside the lot or lots where they were generated, the date of transfer, the name of the carrier, the storage facility and/or recovery, and/or treatment and/or final disposal. The reports should include all completed hazardous waste movement forms.	
Decree No. 5605/2019	Sorting of Solid Waste from Source	The decree refers to sorting of solid waste at source depending on the type and avoiding the following: • pollution of surface water, air, groundwater, soil, fauna and flora • harm to public health • nuisance to surrounding environment from odour • impacting protected areas (if any) and harming nature • threatening nature and biodiversity.	Applicable to municipal-like solid waste generated by exploration drilling programme.
Law No. 64/1988	Preservation of the environment against pollution from dangerous waste and hazardous substances	The law defines dangerous waste and hazardous substances, and includes general provisions for handling hazardous waste, and sets sanctions in case of non-compliance with the provisions of the law.	Applicable to management of waste from exploration drilling programme.
Legislative Decree No. 105 of 1983 Decree No. 15512/2005	Regulating the use of and protection from ionising radiation	Stipulates licensing, regulation and authorisation process for all practices that include ionising radiation.	Applicable to well logging activities. Import, storage, use and export of radioactive material, or devices generating ionising radiation, subject to a permit from the Minister of Public Health.
Decree No. 5243/2001	Classification of industrial facilities	This Decree identifies and classifies the different types of industrial facilities in categories numbered from one to five taking into consideration its potential environmental impacts.	Applicable if hazardous waste warehouse will be available, for storage and/or treatment.

Legislation	Title	Key requirements	Relevance to project
Decree No. 8018/2002	The conditions, criteria and rules for the permitting of the industrial establishments	Process for obtaining an industrial permit	Applicable if hazardous waste warehouse will be available, for storage and/or treatment.
Marine protection legislation			
Decision 1044/1 of 2014	General Conditions to Protect Cetaceans	Aims at protecting cetaceans by prohibiting capture, transfer or sale of whale and dolphin species	Will be taken into consideration in impact assessment mitigation.
Decision 125/1 of 1999	Prohibiting fishing of whales, seals and marine turtles	Decision sets the categorical prohibition to fish whales, seals and turtles in Lebanese waters	Will be taken into consideration in impact assessment mitigation.
Decision 396/1 of 2014	Ban on Catching Seabirds	Aims at protecting animal species by prohibiting capture, transfer or sale of seabirds	Will be taken into consideration in impact assessment mitigation.
Decision No. 129/1 of 1992	Creating a protected marine area within the territory of the Institute of Marine Sciences and Fishing in the region of Al Batroun	Creation of a protected maritime area within the territory of the Institute of Maritime Sciences in the jurisdictional waters of Al Batroun area and providing for the construction of 15 research laboratories, an aquarium, a fishing school, an area for pisciculture, and a harbour	Al Batroun inshore from Block 4.
Law 121/1992	Establishment of Palm Islands Nature Reserve	Declares the Palm Islands a protected area	Palm Islands north-east of Block 4.
Decision No. 200/1 of 1997 (cancelled by Decision No. 14/1999)	Declaring rocks of marine zone and coast in front of Wati Salam (Tabarja) a protected zone	Declares the rocks of the zone extending long the coast in front of Wati Salam a protected zone	Wati Salam inshore from Block 4.
Decision No. 188/1/1998	Classification of Nahr Aarqa watercourse as a protected area	Declares Nahr Aarqa water course as a protected area	Located inshore north-east of Block 4.

Legislation	Title	Key requirements	Relevance to project
Decree No. 3362/1972	Terraces and beach of southern Tripoli towards Qalamoun	Includes beachfront regulations	Located inshore north-east of Block 4.
Decision no. 22/1998	El Jawz River estuary	Declares El Jawz River located in Batroun area as a protected area	Located inshore east of Block 4.
Decision no. 129/1991	Batroun National Marine Hima at the National Centre for Marine Sciences	Declares a National Marine Hima at the Marine Sciences Center in Batroun	Located inshore east of Block 4.
Decision no. 34/1997	Ibrahim River estuary	Declares Ibrahim River estuary as a protected area	Located inshore east of Block 4.
Decision No.97/1998	El Kelb River estuary and historical site	Classifies Wadi Nahr el-Kalb watercourse as a protected area	Located inshore east of Block 4.
Decision No.130/1998	Beirut River estuary	Classifies Nahr el-Beirut watercourse as a protected area. Beirut River estuary is considered a natural site protected bythe MoE. The MoE, in coordination with the Directorate General of Urban Planning, will determine the conditions for licensing any construction or projects in Beirut River estuary within a framework consisting of protection measures deemed necessary by the MoE. The MoE shall determine if the construction and project activities ensure that environmental conditions are met, and therefore request the competent authorities to refuse to grant licences or close existing constructions and projects when these conditions are not met. The licence conditions shall apply to all industrial, residential and tourism projects.	Located inshore south-east of Block 4.
Decision No.131/1998	Awali River estuary	This Decision classifies Nahr el-Awali watercourse as a protected area. The MoE, in coordination with the Directorate General of Urban Planning, shall determine the conditions for licensing any construction or projects in Awali River estuary within a framework consisting of protection measures deemed necessary by MoE. The MoE shall determine if the construction and project activities ensure that environmental conditions are met, and therefore request the competent authorities to refuse to grant licences or close existing constructions and projects when these conditions	Located inshore south-east of Block 4.

Legislation	Title	Key requirements	Relevance to project
		are not met. The licence conditions shall apply to all industrial, residential and tourism projects.	
Cultural heritage legislation			
Decision 166/1933	Antiquities System	Sets the procedures for protecting and preserving antiquities and reporting of new archaeological findings	Archaeological sites shall be protected, and new archaeological findings shall be reported to antiquities directorates within 24 hours from discovery.
Law 37/2008	Cultural Properties	Defines cultural properties, identifies them into categories and sets protection measures	Cultural heritage protection measures will be taken into consideration in impact assessment mitigation measures.
Access to information legislation			
Law No. 28/2017	The Right of Access to Information	Allows any person the right to request access to information from all public entities and some private entities as well. The law provides a limited list of exceptions to this right including secrets of national defence and information that falls within the right of privacy of individuals. The law also requires all public entities to release annual reports and documents to strengthen understanding of regulations and associated decisions.	MoE and LPA are committed to complying with transparency procedures and enhancing public access to information. The EIA document will be disclosed to public.
Labour legislation			
1946 Labour Code and its amendments	Labour Code	Regulates labour sector and includes provisions related to employment contracts, employment of children and women, work hours and holidays, dismissal, inspection, health and safety and sanctions	Provisions of the law applicable to offshore petroleum activities (those not overruled by the OPRL and PAR) shall be adhered to.
Compliance and enforcement legislation			
Decree No. 8471/2012	Environmental Compliance for Industrial Establishments	Requires all industries to apply for an Environmental Compliance Certificate (ECC) every three years to comply with permitting requirements of establishment and operations. It stipulates the preparation of environmental audits that include an Environmental Management Plan and relevant mitigations. The renewal of the	Mostly relevant to any production phase

Legislation	Title	Key requirements	Relevance to project
		ECC, according to Article 6 of the Decree, requires industries to submit a Self- Environmental Audit as per Annex 3 of the Decree.	
Law No. 251/2014	Lawyers and Investigative Judges for Environmental Related Cases	Law assigns fulltime lawyers and investigation judges for environmental related cases and defines environmental crimes.	Applicable in the event of breaching of environmental laws and regulations
Decree 3989/2016	Environmental Police	Designation of an Environmental Police Department within the MoE to regulate environmental crimes and enforce penalties.	Applicable in the event of breaching of environmental laws and regulations
Other relevant legislation			
COM Decision 41/2013	National Coordination Committee	To adopt the necessary measures and procedures to coordinate disaster response operations and national crises resulting from events, acts of war, natural disasters, or crises that threaten the security and safety of the community and environment, and require interference at a national level	The committee practice its duties in case of large scale accidental events from the offshore petroleum sector.
Decree 167/2017	Application decree to Article 20 of law 444/2002 (tax reduction)	Tax reduction on environmental industry activities and on spending aimed at protecting and preserving the environment in a sustainable manner This decree provides tax exemptions on income and customs for individuals or legal entities that are engaged in environmental activities or importing goods to be used to avoid, reduce or eliminate pollution or to treat recycle and or reuses waste.	Can be considered as possible incentives wherever applicable to the project

Legislation	Title	Key requirements	Relevance to project
Decision No. 96/2018	MOPWT Organisational Decree	As per this Decision, MoPWT is involved in the rules of control and supervision of the bodies approved by the Directorate General of Land and Maritime Transport.	The MoPWT is the marine competent authority responsible for all matters related to national maritime transportation activities in line with local and international maritime requirements. The MoPWT is responsible for protecting the marine environment from pollution in coordination with MoE.
Decree No. 4461/2000	Customs Law	It presents the general provisions and principles governing customs, the import and export restrictions, duty deferral statuses and other similar statuses, on exemptions and privileges, different charges imposed on services rendered by customs, coastal navigation and domestic trade, customs jurisdiction, and procedures, proceedings and final provisions.	Applicable in the event of import and export

Source: Kanbar (2015); LOGI (2017); MoE (2017); LPA (2018); Ramboll (2018); FAO (2019), Khoury and Alhaj (2019)

2.5 National EIA process and approvals

The Environmental Impact Assessment Decree No. 8633/2012 deals with all the requirements for screening and preparation of the environmental assessment and the supervision of the environmental assessment process including consultation and disclosure. Full authority for the implementation of the Decree and associated decision-making is assigned to the MoE.

According to Article 5 (related to project classification), upon receiving the proposed project classification request as per the standard format and supporting documents, the MoE shall verify whether the project falls in the domain of Annex 1 or Annex 2, or is located in an area listed in Annex 3 in addition to the likelihood of a significant impact on that area.

If the proposed project falls in the domain of Annex 1, it will be subject to an EIA study[1]. If it falls in the domain of Annex 2, it will be subject to an IEE. If the proposed project is classified in the domain of Annex 2 and located in a sensitive area (these are listed in Annex 3), or it may have a significant environmental impact on that area, the project will be subject to an EIA study. If the project does not fall in the domain of Annex 1 or Annex 2 but is located in an area listed in Annex 3 where it may have a significant environmental impact, it will be subject to an IEE or EIA. The MoE based on an informed review may request an IEE or an EIA report for the project regardless of its classification.

Figure 2.2 presents the Lebanese EIA process and approval system.

Based on the submission of the screening report for Block 4, the Lebanese government confirmed that a full EIA is required for the Block 4 exploration drilling programme, prepared in line with Decree No. 8633/2012.

Guidance on the content and methodology for preparing an environmental impact assessment in Lebanon is also provided in the draft 'Sector-specific EIA guidelines for oil and gas reconnaissance and exploration drilling activities in Lebanon' prepared by the MoE and LPA (MoE and LPA, 2019). Although not legally binding, the requirements of the EIA Guidelines have been taken into consideration in the preparation of this EIA document.

[1] Annex 1: Projects that duly require an EIA study: # 9 Oil and gas:
Installation of pipelines on / off the beaches; excavation and extraction of oil and gas; refineries; platforms; tanks.

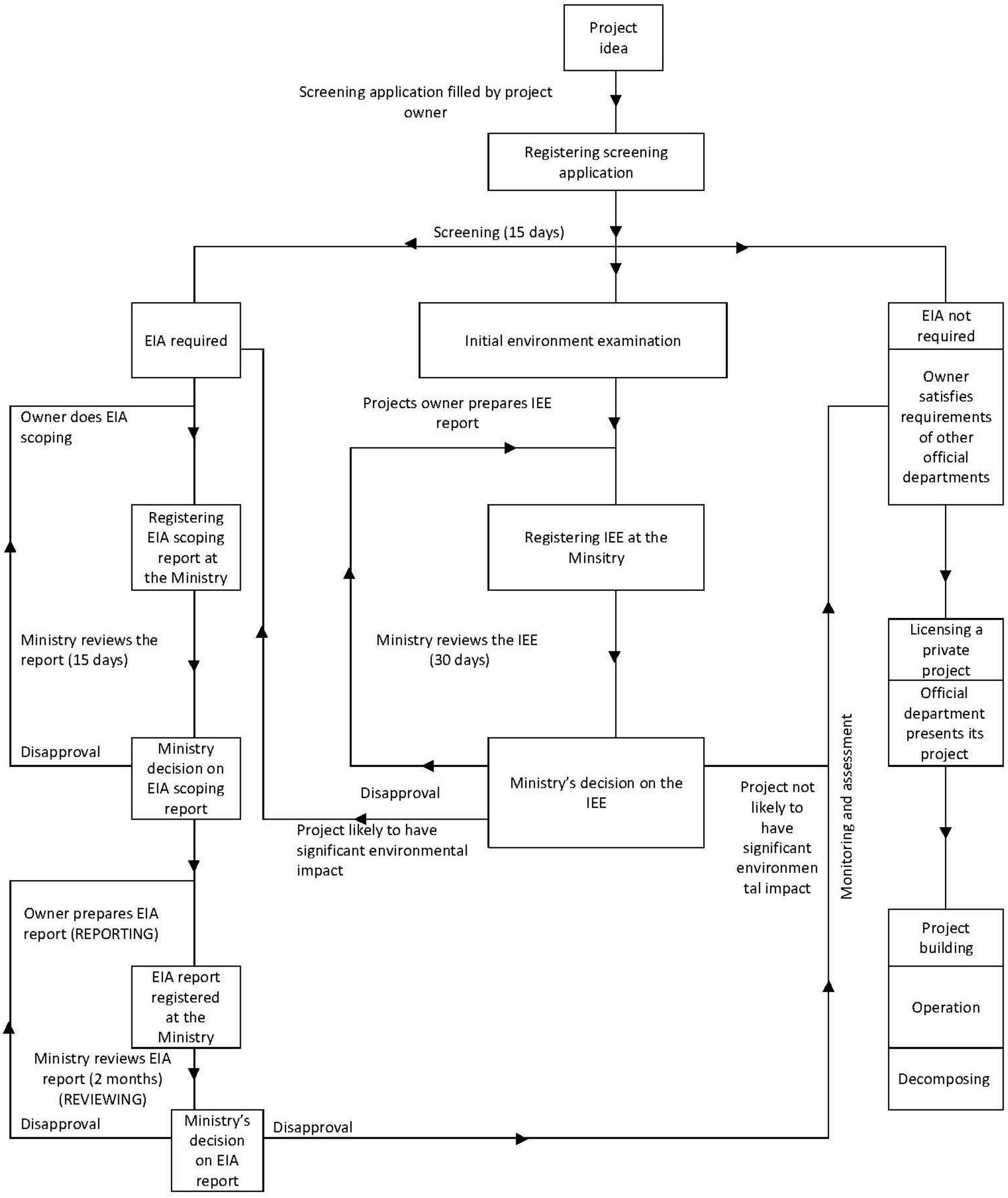

Figure 2.2: Diagram of the EIA system

Source: Reproduced after Annex 9 of Decree 8633/2012

2.6 Exploration and production agreement for petroleum activities in Block 4

The Lebanese Constitution and the OPRL vest full ownership of petroleum resources and their management in the state. Petroleum activities cannot be performed without official authorisation, which gives oil and gas companies the exclusive right to explore for, develop and produce oil and gas in Lebanon's territorial waters and EEZ.

Exploration and production rights are awarded through an Exploration and Production Agreement (EPA) approved by the Council of Ministers and signed by the oil and gas company and the Minister of Energy and Water.

On 29 January 2018, the Government of the Republic of Lebanon signed an EPA with TEP Liban, Eni Lebanon BV and NOVATEK Lebanon SAL for offshore Block 4. The Minister of Energy and Water approved the exploration plan for the block in May 2018, triggering the start of an initial three-year exploration period.

An EPA allows rights holders to carry out petroleum activities in the contract area. It defines the rights and obligations of the rights holders between themselves and towards the state, and includes requirements related to health, safety and the environment (HSE).

Article 17 of the Block 4 EPA includes the following requirements:

Petroleum activities should at all times comply with (i) best international petroleum industry standards relating to the protection of HSE; (ii) applicable Lebanese laws relating to HSE; and (iii) the reasonable requirements of the Petroleum Administration or any other competent authority relating to the protection of HSE. The right holders shall also cause anyone carrying out work on their behalf including any contractors and subcontractors to comply with the foregoing.

In particular, the right holders will

- make all efforts to prevent accidents, damage to assets, injuries, loss of life and environmental damage and, should any adverse impact on the environment or risks to the workforce or the public occur, to minimise such damage and the consequences thereof
- prevent harm to the degradation of livelihood or quality of life of surrounding communities and should some adverse impact and ensure proper compensation for injury to persons or damage to property or ecosystems caused by the effect of petroleum activities
- instil a culture of proactive commitments to HSE values among all personnel involved in the petroleum activities
- develop detailed guidelines that meet best international petroleum industry standards for HSE protection, monitoring and community interaction
- conduct internal HSE audits and inspections and implement self-monitoring processes
- report on a regular basis on the HSE performance to the relevant competent authorities
- facilitate the work and access of the SHE inspectors and auditors from relevant competent authorities.

Without prejudice to any other applicable Lebanese law (including the Environmental Protection Law No. 444 (2002), Decree 8633/2012, Organisation of the MoE Law No.

690 (2005), Integrated Solid Waste Management Law No. 80 (2018) and Law for the Protection of Air Quality No.78 (2018)), the Right Holders shall at all times comply with

- the general obligation to conduct petroleum activities in a responsible and prudent matter in accordance with Article 61 of the OPRL
- the provisions concerning HSE contained in Chapter 9 of the OPRL and Chapter 9 of the PAR
- the obligation to prepare an EIA study in connection with (i) a development and production plan in accordance with Article 43 of the PAR; (ii) the construction, placement and operation of a transportation or storage facility in accordance with Article 55 of the PAR; and (iii) a plan for cessation of petroleum activities and decommissioning of facilities in accordance with Article 61 of the PAR
- the obligation to prepare and regularly update and develop an HSE plan that contains, as a minimum, the information detailed in Article 129 of the PAR.

Where an EIA is required, the right holders will engage third-party specialised HSE professionals to conduct such a study.

In the event of any accident, damage, injury or other significant occurrence arising from petroleum activities and affecting the environment, the operator will immediately notify the petroleum administration in accordance with Article 133 of the PAR and promptly implement an emergency response plan prepared in accordance with Article 138 of the PAR. The operator should also take such action as is prudent and perform such site restoration as may be necessary in accordance with best international petroleum industry standards.

Article 20 of the Block 4 EPA includes requirements for recruitment and training and specifies that the right holders shall develop and carry out an effective recruitment and training programme for Lebanese personnel in accordance with the OPRL and the EPA. It states that a proposal for a detailed recruitment and training programme shall be submitted to the petroleum administration for approval no later than six months after the effective date of the EPA. It also requires that an updated programme for recruitment and training be submitted annually to the petroleum administration. This article also specifies the percentage of employees that shall be Lebanese nationals.

2.7 International conventions and agreements

The Lebanese government has ratified several environmental, socio-economic and cultural heritage conventions, protocols and agreements. Table 2.4 presents those of particular relevance to the Block 4 exploration drilling programme.

Table 2.4: Relevant international conventions and protocols

Convention/ Treaty/Protocol	Status	Brief scope	Relevance to the project
General			
United Nations Law on the Sea (UNCLOS), 1982	Ratified via Law No. 295/1994	Governs the delimitation of the EEZs of maritime nations and provides a universal legal framework for the management of marine natural resources, including efforts to prevent, reduce and control marine pollution	Ratification of UNCLOS by the Government of Lebanon established the nation's EEZ extending the state's sovereign rights to 200 nm offshore. Block 4 is within Lebanon's EEZ.
Protection of habitats and species			
Convention on Biological Diversity, 1992	Ratified via Law No. 360/1994	In support of conserving biological diversity, governments commit to the integration, conservation and sustainable use of biological resources into national decision-making, establishing a system of protected areas and requiring environmental impact assessment of proposed projects that may adversely affect biological diversity	Applicable to biodiversity studies and assessment of potential impact on protected areas in the study area. Lebanon's National Biodiversity Strategy Action Plan described in Table 2.2
The Convention on Wetlands of International Importance (Ramsar)	Ratified via Law No. 23/1999	Aims at conserving and sustaining the utilisation of wetlands in addition to recognising their fundamental ecological functions along with their economic, cultural, scientific and recreational values.	Applicable to any Ramsar sites in the study area. Four Ramsar sites in Lebanon – the project relevant marine and coastal sites are the Palm Islands Nature Reserve, the Tyre Coast Nature Reserve, and Ras El Chekaa Cliffs
Agreement on the Conservation of African-Eurasian Migratory Water Birds (AEWA)	Grant to join via Law No. 412/2002	Aims to conserve the migratory waterbirds and their habitats across Africa, Europe, the Middle East, Central Asia, Greenland and the Canadian Archipelago	Applicable to biodiversity studies and assessment of potential impact on protected areas in the study area Project activities shall not affect waterbird species or habitats.
Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous	Grant to join via Law No. 571/2004	A cooperative tool for the conservation of marine biodiversity in the Mediterranean Sea and Black Sea. Its purpose is to reduce threats to cetaceans in	Applicable to biodiversity studies and assessment if potential impact on cetaceans. ACCOBAMS guidance

Convention/ Treaty/Protocol	Status	Brief scope	Relevance to the project
Atlantic Sea (ACCOBAMS, 1996)		these waters and improve knowledge of these animals	applicable to underwater noise impact assessment
Protection of atmosphere and climate			
Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC)	Ratified via Law No. 738/2006	Has as its objective the reduction of negative changes to the Earth's climate, with a particular focus on GHGs. Commits industrialised countries (Annex 1) to limit and reduce GHG emissions in accordance with agreed individual targets Being a non-Annex 1 party Lebanon is only required to periodically prepare GHG inventories as part of its reporting to the UNFCCC.	Project to minimise GHG emissions and an inventory of emitted gases to be prepared
Paris Agreement- Paris Climate Conference (COP21) 2015	Signed in 2016	Agreement within the UNFCCC to respond to global climate change threat by keeping the global temperature rise below 2°C above pre-industrial levels and to pursue efforts to limit temperature increase to 1.5°C	Project to minimise GHG emissions
Vienna Convention for the Protection of the Ozone Layer, 1993 Montreal Protocol on Substances that Deplete the Ozone Layer, 1987 Copenhagen Amendment to the Montreal Protocol Beijing Amendment to Montreal Protocol London Amendment to the Montreal Protocol	Ratified by Law No. 253/1993 Ratified by Law No. 122/1999 Ratified 21/11/2008 Accession 31/3/1993	Vienna Convention commits governments to take measures to protect human health and environment against adverse effects resulting from depletion of the ozone layer. Montreal protocol designed to regulate the production and consumption of ozone depleting substances. Phase-out schedules specified for controlled substances as substitutes are developed. Copenhagen amendment aims at amending the list of substances that deplete the ozone layer. The main modifications include 1) adjustments strengthening existing measures for the control of substances covered by the original Protocol; 2) control measures for ozone-depleting substances not originally regulated; 3) establishment of a multilateral fund to assist	No import or use of prohibited ozone depleting substances, e.g., chlorofluorocarbons (CFC) and hydro chlorofluorocarbons (HCFCs) in the Block 4 exploration drilling programme.

Convention/ Treaty/Protocol	Status	Brief scope	Relevance to the project
Montreal Amendment to the Montreal Protocol Kigali Amendment to the Montreal Protocol	Accession 31/7/2000 Committed to ratification but not yet ratified	developing countries in meeting Montreal Protocol commitments; and 4) provisions for further investigation of specific scientific, technical, and legal matters. It includes the phase-out of HCFCs in developing countries, as well as the phase-out of methyl bromide in developed and developing countries in 2005 and 2015, respectively.	
Marine pollution			
International Convention for the Prevention of Pollution from Ships (MARPOL 73/78)	Ratified via Law No. 13/1983 Lebanon has ratified MARPOL Annexes I-V. Lebanon has not ratified MARPOL Annex VI.	Main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. MARPOL 73/78 currently comprises six annexes: • Annex I Regulations for the Prevention of Pollution by Oil • Annex II Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk • Annex III Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form • Annex IV Prevention of Pollution by Sewage from Ships • Annex V Prevention of Pollution by Garbage from Ships • Annex VI Prevention of Air Pollution from Ships. It should be noted that the Mediterranean Sea is designated under MARPOL 73/78 Annexes I and V as a 'special area' that is provided with a higher level of protection.	Applicable to project support / supply vessels and rig. Section 2.10.2.1 summarises the main MARPOL 73/78 provisions relevant to the Block 4 exploration drilling programme.

Convention/ Treaty/Protocol	Status	Brief scope	Relevance to the project
Barcelona Convention (Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean) 1976, amended 1995 Amendments to Barcelona Convention	Ratified via Decree No. 126/1977 Ratified 22/04/2009	The Barcelona Convention generally commits its contracting parties to take appropriate measures to prevent, abate, combat and eliminate pollution of the Mediterranean Sea and to protect and enhance the marine environment so as to contribute towards its sustainable development. It further commits the parties to • apply the precautionary principle, i.e., where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation • apply the “polluter pays” principle, i.e., the costs of pollution prevention, control and reduction measures are to be borne by the polluter, with due regard to the public interest • undertake EIAs for proposed activities that are likely to cause a significant adverse impact on the marine environment and are subject to authorisation by competent national authorities.	Applicable to project discharges and impact assessment.
Barcelona Convention: 1976 Dumping Protocol and 1976 Emergency Protocol	Ratified via Decree No. 126/1977	Dumping Protocol: Aims to prevent and abate pollution of the Mediterranean Sea area caused by dumping from ships and aircraft, and combat pollution resulting from exploration and exploitation of the continental shelf and the seabed and its subsoil. Amended in 1995. Emergency Protocol: Objective is to protect the coastal and the marine ecosystem of the Mediterranean Sea area against pollution by oil and other harmful substances resulting from	It should be noted that dumping does not include the disposal at sea of wastes or other matter incidental to, or derived from, the normal operations of vessels or aircraft and their equipment. Applicable to project oil spill response

Convention/ Treaty/Protocol	Status	Brief scope	Relevance to the project
		accidental causes or an accumulation of small discharges. Amended in 2002.	
Barcelona Convention: 1980 Land Based Sources Protocol and 1982 Specially Protected Areas Protocol	Ratified via Law No. 292/1994	Land Based Sources Protocol: Objective is to prevent, abate, combat and eliminate the pollution of the Mediterranean Sea caused by discharges from rivers, coastal establishments or outfalls, or emanating from any other land-based sources and activities within their territories, giving priority to the phasing out of inputs of substances that are toxic, persistent and liable to bioaccumulate. Specially Protected Areas Protocol: Objective is to protect the coastal and the marine ecosystem of the Mediterranean Sea area against pollution by oil and other harmful substances resulting from accidental causes or an accumulation of small discharges.	Applicable to any discharges from project supply-base. Applicable to any project activities in proximity to marine protected areas
Barcelona Convention: 1995 Protocol on Integrated Coastal Zone Management in the Mediterranean	Accessed via Law No. 639/2014	The Contracting Parties establish a common framework for the integrated management of the Mediterranean coastal zone. Incorporates transboundary cooperation requirements.	Applicable to project activities taking place in the coastal zone of Lebanon Applicable to potential transboundary impacts of project
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972	Signature: 15/5/1973	Concerns the international control and prevention of marine pollution. It prohibits the dumping of certain hazardous materials and requires a prior special permit for the dumping of several other identified materials as well as a prior general permit for other wastes or matter.	Convention does not apply to the disposal of wastes incidental to or derived from the normal operation of installations, therefore not applicable to the discharge of drill cuttings Only applicable to dumping of hazardous materials
International Convention for the Prevention of Pollution of the Sea by Oil (OILPOL), 1954 and its 1962 amendments	Ratified via Law No. 68/1966	Attempts to tackle the problem of pollution of the seas by oil through • definition of ships including platforms, oil transport and storage facilities	Applicable to disposal of oil related wastes from the project.

Convention/ Treaty/Protocol	Status	Brief scope	Relevance to the project
		• delimitation of zones with oil cannot be dumped • establishment of dumping far from land rule • sanctions in case of breach • creation of zones in ports to handle waste and dumping.	
IMO Ballast Water Management Convention, 2004	CoM Decision 31/2009.	Objective is to prevent, minimise and ultimately eliminate the transfer of harmful aquatic organisms and pathogens through the control and management of ships' ballast water and sediments. Convention requires all ships to implement a ballast water and sediments management plan. all ships required to carry a ballast water record book and carry out ballast water management in line with given standards.	Applicable to project ballast water exchange activities, see Section 2.10.2.2
International Convention on the Control of Harmful Anti-Fouling Systems on Ships, 2001	Grant to join via Law No. 100/2010	It aims to prohibit and/or restrict the application, re-application, installation, or use of harmful anti-fouling systems on ships.	Applicable to anti-fouling of project vessels and rig
IMO International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC), 1995	Accession: 30/3/2005	Establishes measures for dealing with marine oil pollution incidents nationally and in co-operation with other countries. Ships are required to carry a shipboard oil pollution emergency plan (SOPEP), in accordance with the provisions adopted by the IMO for this purpose	Applicable to project oil spill response
IMO International Convention relating to Intervention on the High Seas in cases of Oil Pollution Casualties, 1960	Ratified via Decree No. 9226/1974	Affirms the right of a coastal State to take such measures on the high seas as may be necessary to prevent, mitigate or eliminate grave and imminent danger to their coastline or related interests from pollution or threat of pollution of the sea by oil, following upon a maritime casualty or acts related to such a casualty	Applicable to project oil spill response
International Convention relating to the Limitation of the Liability of Owners of	Accessed via Law No. 294/1994	Objective is to determine uniform rules relating to the limitation of the liability of owners of sea-going ships	Applicable to project vessels

Convention/ Treaty/Protocol	Status	Brief scope	Relevance to the project
Sea-going Ships and Protocol, 1957			
International Convention on Civil Liability for Bunker Oil Pollution Damage (BUNKER)	Accessed via Decree No. 10285/2013	Aim of Convention is to ensure that adequate, prompt, and effective compensation is available to persons who suffer damage caused by spills of oil, when carried as fuel in ships' bunkers	Applicable to project oil spill response.
The International Convention on Civil Liability for Oil Pollution Damage (CLC), 1969	Ratified via Law No. 28/1973	It attempts to ensure that adequate compensation would be available where oil pollution damage was caused by maritime causalities involving oil tankers. It establishes owner's liability for any pollution damage caused by oil which has escaped or been discharges from the ship as a result of the incident.	Applicable to project civil liability
1992 Protocol which amends the International Convention on Civil Liability for Oil Pollution Damage (CLC) (1969)	Grant to join via Law No. 607/2004	The Protocol of 1992 changed compensation limits and widened the scope of the Convention to cover pollution damage caused in the EEZ or equivalent area of a State Party. It covers pollution damage as before, but environmental damage compensation is limited to costs incurred for reasonable measures to reinstate the contaminated environment. It also allows expenses incurred for preventive measures to be recovered even when no spill of oil occurs, provided there was grave and imminent threat of pollution damage.	Applicable to project civil liability
Control of waste and hazardous materials			
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, 1989	Ratified by Law No. 387/1994	Main objectives of the Convention are to: • reduce the transboundary movement of wastes subject to the convention to a minimum consistent with the environmentally sound and efficient management of such wastes • minimise the amount and toxicity of hazardous wastes generated and ensure their environmentally sound	Applicable to any hazardous wastes generated by the project

Convention/ Treaty/Protocol	Status	Brief scope	Relevance to the project
		management as close as possible to the source of generation • assist developing countries in environmentally sound management of the hazardous and other wastes they generate.	
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade	Ratified via Law No. 728/2006	Convention promotes open exchange of information and calls on exporters of hazardous chemicals to use proper labelling, include directions on safe handling, and inform purchasers of any known restrictions or bans. Signatory nations can decide whether to allow or ban importation of chemicals listed in the treaty, and exporting countries are obliged to make sure that producers within their jurisdiction comply.	Applicable to project drilling and cementing chemicals
Stockholm Convention on Persistent Organic Pollutants (POPs), 2001	Ratified via Law No. 432/2002	Global treaty to protect human health and the environment from POPs by prohibiting; phasing out as soon as possible; or restricting the production, placing on the market and use of these substances.	No use of POPs by Block 4 exploration drilling programme
Minamata Convention on Mercury	Entered into Force on 16 August 2017	Global treaty to protect human health and the environment from the adverse effects of mercury.	Applicable to the project in case of the use of mercury
Cultural heritage			
UNESCO Convention on the Protection of Cultural & Natural Heritage, 1972	Adhesion via Law 19 dated 30/10/1990	Defines the kind of natural or cultural sites that can be considered for inscription on the World Heritage List and sets out the duties of states/parties in identifying potential sites and their role in protecting and preserving them	Applicable to environmental and cultural heritage studies and assessment of potential impact on any UNESCO World Heritage Sites in the study area. Five UNESCO World Heritage Sites in Lebanon – the project relevant marine and coastal sites are Byblos, Tyre and Sidon.

Convention/ Treaty/Protocol	Status	Brief scope	Relevance to the project
UNESCO Convention on the Protection of the Underwater Cultural Heritage, 2001	Acceptance 8 January 2007	The convention sets out basic principles for the protection of underwater cultural heritage, provides a detailed state cooperation system and provides widely recognised practical rules for the treatment and research of underwater cultural heritage. It intends to protect all traces of human existence having a cultural, historical or archaeological character which have been underwater for over 100 years.	Applicable to chance finds, cultural heritage studies and assessment of potential impact
UNESCO Convention for the Safeguarding of Intangible Cultural Heritage, 2003	Ratified January 2007	Aimed at safeguarding the uses, representations, expressions, knowledge and techniques that communities, groups and, in some cases, individuals, recognise as an integral part of their cultural heritage. This intangible heritage is found in forms such as oral traditions, performing arts, social practices, rituals, festive events, knowledge and practices concerning nature and the universe, and traditional craftsmanship knowledge and techniques	Applicable to cultural heritage studies
Labour			
Core Conventions of the International Labour Organisation (ILO)	Detailed in next column	There are eight fundamental Conventions protecting the rights of the workforce. Those ratified by Lebanon are: • Right to Organise and Collective Bargaining Convention, 1949 (No. 98) – ratified June 1977 • Forced Labour Convention, 1930 (No. 29) – ratified June 1977 • Abolition of Forced Labour Convention, 1957 (No. 105) – ratified June 1977 • Minimum Age Convention, 1973 (No. 138) – ratified June 2003 • Worst Forms of Child Labour Convention, 1999 (No. 182) – ratified September 2001	Applicable to human resource issues.

Convention/ Treaty/Protocol	Status	Brief scope	Relevance to the project
		• Equal Remuneration Convention, 1951 (No. 100) – ratified June 1977 • Discrimination (Employment and Occupation) Convention, 1958 (No. 111) – ratified June 1977. Lebanon has not ratified the remaining ILO core convention: • Freedom of Association and Protection of the Right to Organise Convention, 1948 (No. 87).	
UN Convention on the Elimination of all Forms of Discrimination against Women (CEDAW)	Ratified 1996	Concerns discrimination against women	Applicable to human resource issues
ILO Weekly Rest (Industry) Convention, 1921, No. 14	Ratified July 1962	Concerns the application of weekly rest in industrial undertakings	Applicable to human resource issues
ILO Vocalisation Rehabilitation and Employment (Disabled Persons) Convention, 1983, No. 159	Ratified February 2000	Concerns the vocalisation rehabilitation and employment of disabled persons	Applicable to human resource issues
ILO Working Environment (Air Pollution, Noise and Vibration) Convention, 1977 No. 148	Ratified April 2005	Concerns protection of workers against occupational hazards in the working environment	Applicable to rig and vessel crew
IMO Convention on the Standards of Training, Certification and Watchkeeping for Seafarers, 1978 amended 1995	Ratified April 2003	Establishes basic requirements on training, certification and watch keeping for seafarers on an international level	Applicable to rig and vessel crew
ILO Seafarer's Pensions Convention, 1946, No. 71	Ratified December 1993	Concerns seafarer's pensions	Applicable to rig and vessel crew
UN International Convention on the Elimination of All Forms of Racial	Ratified November 1971	Concerns elimination of all forms of racial discrimination	Applicable to human resource issues

Convention/ Treaty/Protocol	Status	Brief scope	Relevance to the project
Discrimination (ICERD), 1965			
ILO Protection of Wages, 1949, No. 95	Ratified June 1977	Concerns protection of wages	Applicable to human resource issues.
ILO Occupational Safety and Health (Dock Work) Convention, 1979, No. 152	Ratified September 2004	Concerns occupational safety and health in dock work	Applicable to logistics base and supply vessel crew.
ILO Medical Examination of Young Persons (Industry) Convention, 1946, No. 77	Ratified June 1977	Concerns medical examination for fitness for employment in industry of children and young persons	Applicable to human resource issues
ILO Medical Examination (Seafarers) Convention, 1946, No. 73	Ratified December 1993	Concerns the medical examination of seafarers	Applicable to rig and vessel crew
ILO Labour Inspection Convention, 1947	Ratified July 1962	Concerns the organisation of labour inspection in industry and commerce	Applicable to human resource issues
ILO Labour Administration Convention, 1978, No. 150	Ratified April 2005	Concerns labour administration: role, functions and organisation	Applicable to human resource issues
ILO Hours of Work (Industry) Convention, 1919, No. 1	Ratified June 1977	Limits the hours of work in industrial undertakings to 8 in the day and 48 in the week	Applicable to human resource issues
ILO Occupational Cancer Convention, 1974, No. 139	Ratified February 2000	Concerns prevention and control of occupational hazards caused by carcinogenic substances and agents	Applicable to health and safety of rig and vessel crew and logistics base workers
ILO Equality of Treatment Convention, 1919, No. 1	Ratified June 1977	Concerns equality of treatment for national and foreign workers as regards workmen's compensation for accidents	Applicable to health and safety of rig and vessel crew and logistics base workers

Source: FAO (2019), MoE (2017), Khoury and Alhaj (2015, 2019), Ramboll (2018)

2.8 Corporate commitments

2.8.1 TOTAL's Safety, Health, Environment, Quality (SHEQ) Charter

TOTAL has developed a Safety, Health, Environment, Quality (SHEQ) Charter that sets out the basic principles applicable within the Group regarding protection of people, property and environment (see Figure 2.3). This charter is implemented at several levels within the Group by means of its management systems.

2.8.2 TOTAL's General Specification Documents

This EIA will be carried out taking into consideration the requirements of the following Total General Specification documents:

- Environmental Baseline and Monitoring Studies: Offshore and Nearshore Sites (GS EP ENV 112)
- Social Baseline Study (GS EP SDV 101)
- Environmental Impact Assessment of Exploration and Production Activities (GS EP ENV 120)
- Social Impact Assessment (GS EP SDV 102)
- Environmental Requirements for Projects Design and Exploration and Production Activities (GS EP ENV 001).

2.8.3 OSPAR Convention

It should be noted that TOTAL's General Specification document 'Environmental Requirements for Projects Design and Exploration and Production Activities' (GS EP ENV 001) requires conformance with the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention)[2].

Lebanon is not a contracting party to the OSPAR convention. However, for parties operating in the North-East Atlantic Ocean, the OSPAR Convention aims to protect the marine environment. The convention has implemented a Harmonised, Mandatory Control Scheme (HMCS) for use and reduction of discharges of offshore chemicals. This system promotes the shift towards the use of less hazardous or preferably non-hazardous substances.

The OSPAR Convention requires documentation of ecotoxicological properties of chemicals used in the offshore oil and gas industry. The OSPAR HMCS ranks chemical products using a chemical hazard and risk management model based on ecotoxicology. The properties are documented in the Harmonised Offshore Chemical Notification Format. More information is provided in Section 2.10.2.3.

[2] The OSPAR Convention started in 1972 with the Oslo Convention against dumping at sea and was broadened to cover land-based sources and the offshore industry by the Paris Convention of 1974. These two conventions were unified, updated and extended by the 1992 OSPAR Convention.

TOTAL
COMMITTED TO BETTER ENERGY

SAFETY HEALTH ENVIRONMENT QUALITY CHARTER

In accordance with its Code of Conduct, Total has adopted the following principles concerning safety, security, health, the environment, quality and societal commitment:

1
Total holds safety, security, health, respect for the environment, customer satisfaction, listening to all stakeholders by way of an open dialogue, as paramount priorities.

2
Total complies with all applicable laws and regulations wherever it conducts its business and supplements them with specific requirements and commitments when necessary.

3
Total promotes, among its employees a shared culture which the core components are professionalism, the rigorous compliance and application of regulations, skills management, incident feedback and continuous learning. This approach relies on the vigilance and commitment of all.

4
Each and every team member, at all levels, must be aware of their role and personal responsibility in the practice of their duties. Individuals must demonstrate the strictest discipline in preventing accidents and deliberate damage; in protecting health, the environment and product and service quality whilst addressing stakeholder expectations. Rigor and exemplarity in these fields are important criteria in evaluating the performance of each member of personnel, in particular for those in positions of responsibility.

5
Total favors the selection of industrial and business partners on the basis of their ability to apply policies similar to its own concerning safety, security, health, the environment, quality and societal measures.

6
Total implements, for all of its operations, appropriate management policies regarding safety, security, health, the environment, quality, societal commitment and a periodic risk assessment of relevant policies and measures. Any development of a project or launch of a product is undertaken upon full lifecycle risk assessment.

7
Appropriate safety, health, environmental, quality and societal commitment management systems for each business undergo regular assessment involving measurement of performance setting milestones, formulating relevant action plans and instituting suitable control procedures.

8
Total implements incident response plans and means of intervention designed to face different types of events it may encounter. Such measures are periodically updated and reviewed during exercises.

9
Total is committed to managing its energy consumption, emissions in natural environments (water, air and soils), production of final waste, use of natural resources and impact on biodiversity. It develops new processes, products and customer services in order to enhance energy efficiency and reduce environmental footprint.

10
Total adopts a constructive attitude towards safety, security, health, the environment and quality, based on transparency and an open dialogue with stakeholders and outside parties. Through its societal commitment, Total is particularly keen on contributing to the sustainable development of neighboring communities, with a focus on human, economic and social issues. It conducts its operations in such a way as to responsibly ensure security, in compliance with the Voluntary Principles on Security and Human Rights.

Patrick Pouyanné
Chief Executive Officer

December 2014

Figure 2.3: Total's SHEQ Charter

2.9 Best available industry practice

TOTAL is committed to ensuring that the proposed operations are undertaken in a manner informed by good industry practice. The following represent key guidance documents:

- World Bank EHS Guidelines – Offshore Oil and Gas Development (World Bank, 2015)
- ACCOBAMS Methodological Guide: Guidance on Underwater Noise Mitigation Measures (ACCOBAMS, 2016)
- Technical Memorandum NMFS-OPR-59 – NOAA Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing – Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts (U.S. National Oceanic and Atmospheric Administration, April 2018)
- A Cross-sector Guide for Implementing Mitigation Hierarchy (IOGP, 2015)
- OSPAR Guidelines for Monitoring the Environmental Impact of Offshore Oil and Gas Activities (2017)
- IOGP Report No. 457/2012: Offshore Environmental Monitoring for the Oil and Gas Industry.

2.10 Standards and limits for the project

The standards and limits adopted by the project follow the hierarchical approach of

- applicable Lebanese legislation and regulations
- requirements of relevant international/regional conventions, protocols and agreements
- Total corporate requirements
- international best practice.

These are discussed in more detail below and the project adopted standards/limits for the Block 4 exploration drilling campaign are summarised in Section 2.10.4.

2.10.1 National environmental standards

National emission and discharge standards were established by the MoE in Decision No. 52/1/1996 'Environmental Quality Standards and Criteria for Air, Noise, Water and Soil' and MoE Decision No. 8/1/2001 'National Standards for Environmental Quality (NQES) related to air contaminants and liquid waste emitted from classified establishments into receiving water bodies'. These are presented below.

2.10.1.1 Air quality

Ambient air contaminants

Table 2.5 presents the maximum allowable concentrations of air contaminants.

Table 2.5: Maximum allowable concentrations of ambient air contaminants (MoE Decision No. 52/1/1996)

Pollutant	Limit value (ug/m^3)	Duration of exposure
SO_2	350 120 80	1 hour 24 hours 1 year
NO_2	200 150 100	1 hour 24 hours 1 year
O_3	150 100	1 hour 8 hours
CO	30,000 12,000	1 hour 8 hours
TSP	120	24 hours
SPM10	80	24 hours
Lead	1,000	1 year
Benzene (ppm)	5 ppm	1 year

Air emission limit values

Emission standards are given as mass flows and as concentrations. For mass flows lower than those provided in column 3 of Table 2.6, no concentration emission limit value exists. If the mass flows appearing in column 3 are exceeded, the concentration emission limit values of column 2 apply.

Table 2.6: Maximum emission limits of air contaminants (MoE Decision No. 8/1/2001)

Parameter	Emission limit value		Remark
Dust (mg/m^3)	200 for new establishments 500 for old establishments		Non-containing hazardous compound
Particulate inorganic pollutants (mg/m^3)	Group I Group II Group III	1 10 30	Mass flow > 5 g/h Mass flow > 25 g/h Mass flow > 50 g/h

Parameter	Emission limit value		Remark
Gaseous inorganic pollutants (mg/m³)	Group I	1	Mass flow > 50 g/h
	Group II	5	Mass flow > 300 g/h
	Group III	30	Mass flow > 1 kg/h
	Group IV	500	Mass flow > 10 kg/h
Gaseous organic pollutants (mg/m³)	Group I	20	Mass flow > 500 g/h
	Group II	100	Mass flow > 4 kg/h
	Group III	200	Mass flow > 6 kg/h
Cancer causing pollutants (mg/m³)	Group I	0.2	Mass flow > 5 g/h
	Group II	2	Mass flow > 10 g/h
	Group III	10	Mass flow > 50 g/h

2.10.1.2 Water quality

Standards for wastewater discharge into receiving water bodies (also referred to as emission limit values, ELVs) are set out in MoE Decision No. 8/1/2001 and are shown in Table 2.7.

Table 2.7: Maximum limits (ELVs) for wastewater discharge into receiving waterbodies and public sewers (MoE Decision No. 8/1/2001)

Parameter	Maximum allowable limits for receiving water bodies		
	Public sewers	Surface water (inland)	Sea
Colour	None	None	None
pH	6–9	6–9	6–9
Temperature	35°C	30°C	35°C
BOD (5 day, 20°C)	125 mg/l	25 mg/l	25 mg/l
COD (dichromate method)	500 mg/l	125 mg/l	125 mg/l
Total phosphorous	10 mg/l	10 mg/l	10 mg/l
Total nitrogen	60 mg/l	30 mg/l	30 mg/l
Suspended solids	60 mg/l	60 mg/l	60 mg/l
AOX	5	5	5
Detergents	-	3 mg/l	3 mg/l
Coliform bacteria 37°C in 100 ml		2000	2000
Salmonellae	Absence	Absence	Absence
Hydrocarbons	20 mg/l	20 mg/l	20 mg/l
Phenol index	5 mg/l	0.3 mg/l	0.3 mg/l

Parameter	Maximum allowable limits for receiving water bodies		
	Public sewers	Surface water (inland)	Sea
Oil and grease	50 mg/l	30 mg/l	30 mg/l
Total organic carbon (TOC)	750 mg/l	75 mg/l	75 mg/l
Ammonia (NH_{4+})	-	10 mg/l	10 mg/l
Silver (Ag)	0.1 mg/l	0.1 mg/l	0.1 mg/l
Aluminium (Al)	10 mg/l	10 mg/l	10 mg/l
Arsenic (As)	0.1 mg/l	0.1 mg/l	0.1 mg/l
Barium (Ba)	2 mg/l	2 mg/l	2 mg/l
Cadmium (Cd)	0.2 mg/l	0.2 mg/l	0.2 mg/l
Cobalt (Co)	1 mg/l	0.5 mg/l	0.5 mg/l
Chromium total (Cr)	2 mg/l	2 mg/l	2 mg/l
Hexavalent chromium (Cr^{VI})	0.2 mg/l	0.2 mg/l	0.2 mg/l
Copper total (Cu)	1 mg/l	0.5 mg/l	1.5 mg/l
Iron total (Fe)	5 mg/l	5 mg/l	5 mg/l
Mercury total (Hg)	0.05 mg/l	0.05 mg/l	0.05 mg/l
Manganese (Mn)	1 mg/l	1 mg/l	1 mg/l
Nickel total (Ni)	1 mg/l	0.5 mg/l	0.5 mg/l
Lead total (Pb)	1 mg/l	0.5 mg/l	0.5 mg/l
Antimony (SB)	0.3 mg/l	0.3 mg/l	0.3 mg/l
Tin total (Sn)	2 mg/l	2 mg/l	2 mg/l
Zinc total (Zn)	10 mg/l	5 mg/l	5 mg/l
Active Cl_2	-	1 mg/l	1 mg/l
Cyanides (CN^-)	1 mg/l	0.1 mg/l	0.1 mg/l
Fluorides (F)	15 mg/l	25 mg/l	25 mg/l
Nitrate (NO_3)	-	90 mg/l	90 mg/l
Phosphate ($PO4^{3-}$)	-	5 mg/l	5 mg/l
Sulphate ($SO4^{2-}$)	1,000 mg/l	1,000 mg/l	1,000 mg/l
Sulphide (S^{2-})	1 mg/l	1 mg/l	1 mg/l

2.10.1.3 Airborne noise

Table 2.8 and Table 2.9 present the national maximum allowable noise level and the permissible noise exposure standards as per MoE Decision No. 52/1/1996. As per this Decision, the maximum instantaneous noise level (Lmax) should not exceed 134 dB(A).

Table 2.8: Maximum allowable noise levels

Type	Limit dB (A)		
	Day time (7 am – 6 pm)	Evening (6 pm – 10 pm)	Night time (10 pm – 7 am)
Industrial areas	60–70	55–65	50–60

Table 2.9: Permissible noise exposure standards

Duration per day (hours)	Sound level dB (A)
8	85
4	88
2	91
1	94
½	97
¼	100

2.10.2 Environmental standards – international/regional conventions

2.10.2.1 Prevention of pollution from ships

The key convention with respect to discharge and emissions standards from vessels is MARPOL 73/78. Table 2.10 summarises the requirements of this convention.

Table 2.10: Key provisions in MARPOL 73/78 of relevance to the Block 4 exploration drilling programme

Environmental aspect	Relevant provisions of MARPOL 73/78	Annex
Drainage water	Requirements for the Mediterranean Sea as a 'special area': Oil and all oily mixtures shall either be retained onboard for subsequent discharge to reception facilities or discharged to the sea in accordance with the following provisions: 1. The ship is proceeding **en route**. 2. For ships of >400 gross tonnage, oil filtering equipment shall be provided with alarm arrangements and arrangements that the discharge is automatically stopped when the content of the effluent exceeds 15 ppm. For ships of <400 gross tonnage, the ship has in operation equipment of a designed approved by the administration that ensures that the oil content of the effluent without dilution does not exceed 15ppm.	I

Environmental aspect	Relevant provisions of MARPOL 73/78	Annex
Accidental oil discharge	A shipboard oil pollution emergency plan (SOPEP) is required.	I
Bulked chemicals	Prohibits the discharge of noxious liquid substances, pollution hazard substances and associated tank washings. Vessels are required to undergo periodic inspections to ensure compliance. All vessels must carry a procedures and arrangements manual and a cargo record book.	II
Sewage discharge	Discharge of sewage is permitted only if the ship has approved[3] sewage treatment facilities, the test result of the facilities is documented, and the effluent will not produce visible floating solids nor cause discoloration of the surrounding water.	IV
Garbage	Disposal of garbage from ships and fixed or floating platforms is prohibited. Ships must have a garbage management plan and shall be provided with a garbage record book.	V
Food waste	Requirements for the Mediterranean Sea as a 'special area': Discharge of food waste ground to pass through a 25-mm mesh is permitted more than 12 nm from nearest land.	V
Air pollutant emissions[4]	Sets limits on sulphur oxide and nitrogen oxide emissions from ship exhausts and prohibits deliberate emissions of ozone-depleting substances, including halons and chlorofluorocarbons. Sets limits on emissions of nitrogen oxides from diesel engines. Prohibits the incineration of certain products on board, such as contaminated packaging materials and polychlorinated biphenyls. From 1 January 2020, vessels not fitted with scrubbers will no longer be able to burn fuel with a sulphur content in excess of 0.5% as a result of the implementation of the revisions to this Annex.	VI

2.10.2.2 Ballast water discharge

Under the International Convention for the Control and Management of Ships' Ballast and Sediments (Ballast Water Convention 2004), all ships in international traffic are required to manage their ballast water and sediments to a certain standard, according to a ship-specific ballast water management plan. All ships will also have to carry a ballast water record book and an international ballast water management certificate. The ballast water management standards will be phased in over a period of time. As an intermediate

[3] By definition, an "approved" treatment plant is one that meets Resolution MEPC.2(VI) 1976, if the sewage treatment plant (STP) is installed prior to January 1, 2010: Fecal coliforms < 250 /100ml; TSS < 50 mg/l (shoreside testing); TSS < 100 mg/l (shipboard testing); BOD5 <50mg/l. After 1 Jan 2010, an "approved" STP is one that meets Resolution MEPC.159(55) 2006: Thermotolerant coliforms < 100 / 100ml; TSS <35 mg/l; BOD5 <25 mg/l; COD <125 mg/l; pH 6 < 8.5.

[4] Lebanon has not ratified Annex VI of MARPOL 73/78.

solution, ships should exchange ballast water mid-ocean. However, eventually most ships will need to install an on-board ballast water treatment system.

Ballast water exchange

A ship conducting ballast water exchange to meet the standards specified below will whenever possible, conduct such ballast water exchange at least 200 nm from the nearest land and in water at least 200 m in depth. In cases where the ship is unable to conduct ballast water exchange in accordance with this requirement, such ballast water exchange shall be conducted as far from the nearest land as possible, and in all cases at least 50 nm from the nearest land and in water at least 200 m in depth.

Ballast water exchange standard

Ships performing ballast water exchange shall do so with an efficiency of at least 95% volumetric exchange of ballast water. For ships exchanging ballast water by the pumping-through method, pumping through three times the volume of each ballast water tank shall be considered to meet the standard described. Pumping through less than three times the volume may be accepted provided the ship can demonstrate that at least 95% volumetric exchange is met.

Ballast water performance standard

Ships conducting ballast water management shall discharge

- less than 10 viable organisms per cubic metre $\geq$50 µm in minimum dimension
- less than 10 viable organisms per millilitre <50 µm in minimum dimension and $\geq$to 10 µm in minimum dimension.

Furthermore, discharge of the following indicator microbes shall not exceed the specified concentrations:

- toxicogenic *Vibrio cholerae* – less than 1 colony forming unit (cfu) per 100 mL or less than 1 cfu/g (wet weight) zooplankton samples
- *Escherichia coli* – less than 250 cfu per 100 mL
- intestinal *Enterococci* – less than 100 cfu per 100 mL.

2.10.2.3 Chemical selection

Total's General Specification document 'Environmental Requirements for Projects Design and E&P Activities' (GS EP ENV 001) requires that chemicals are selected according to the following criteria: lowest toxicity, lowest bioaccumulation potential and highest biodegradation. GS EP ENV 001 also states that offshore chemicals will be selected according to a pre-screening scheme based on the OSPAR methodology in force[5] and provided with their material safety data sheet (MSDS). Although OSPAR rules do not apply in Lebanon, as it is not a member of OSPAR, they are a good indication of the environmental properties of a product.

The OSPAR Harmonised Mandatory Control Scheme (HMCS) ranks chemical products using the Chemical Hazard and Risk Management (CHARM) model. Data used in the CHARM assessment includes toxicity, biodegradation and bioaccumulation. The CHARM model calculates the ratio of predicted effect concentration against no effect

[5] OSPAR Recommendation 2017/1 on a Harmonised Pre-screening Scheme for Offshore Chemicals.

concentration (PEC:NEC). This is expressed as a hazard quotient (HQ), which is then used to rank the product. The HQ is converted to a colour banding (see Table 2.11).

Table 2.11: HMCS hazard quotients and colour bands

Minimum HQ value	Maximum HQ value	Colour banding	
>0	<1	Gold	Lowest hazard
≥1	<30	Silver	
≥30	<100	White	
≥100	<300	Blue	
≥300	<1000	Orange	
≥1000		Purple	Highest hazard

Source: CEFAS (2017)

Products not applicable to the CHARM model (i.e., inorganic substances, hydraulic fluids or chemicals used only in pipelines) can be assigned an Offshore Chemical Notification Scheme (OCNS) grouping of A–E[6]. Group A includes products considered to have the greatest potential environmental hazard and Group E the least.

In addition to the above, the OSPAR Commission has prepared a 'List of Substances/ Preparations Used and Discharged Offshore which are considered to Pose Little or No Risk to the Environment (PLONOR)' which contains substances whose use and discharge offshore do not need to be strongly regulated.

2.10.3 Environmental standards – international best practice

2.10.3.1 Underwater noise

Underwater acoustic thresholds for the onset of injury in marine mammals will be assessed in accordance with the limits proposed by the US National Oceanic and Atmospheric Administration (NOAA) Technical Memorandum NMFS-OPR-59, April 2018, see Table 2.12.

Table 2.12: Marine mammal criteria for onset of injury (per 24-hour period)

Marine mammal group	Type of sound	Injury criteria	
		Peak pressure (db re 1 µPa)	Cumulative SEL (dB re 1 µPa^{2}s M-weighted)
Low-frequency cetaceans	Single or multiple pulses - impulsive	219	183
	Non-impulsive continuous noise	-	199

[6] This methodology is used in the UK, where non-CHARMable chemical products are ranked on the basis of toxicity test data.

Marine mammal group	Type of sound	Injury criteria	
		Peak pressure (db re 1 µPa)	Cumulative SEL (dB re 1 µPa^{2}s M-weighted)
Mid-frequency cetaceans	Single or multiple pulses - impulsive	230	185
	Non-impulsive continuous noise	-	198
High-frequency cetaceans	Single or multiple pulses - impulsive	202	155
	Non-impulsive continuous noise	-	173
Phocid pinnipeds (underwater)	Single or multiple pulses - impulsive	218	185
	Non-impulsive continuous noise	-	201
Sirenians	Single or multiple pulses - impulsive	226	190
	Non-impulsive continuous noise	-	206

Source: Xodus (2019)

Guidance from volume 70 of the US Federal Register (Federal Register, 2005) sets the Level B harassment threshold[7] for marine mammals at 160 dB re 1 µPa (rms) for impulsive noise and 120 dB re 1 µPa (rms) for continuous noise. The value for continuous sound sits at the lower end of the range identified in Southall et al. (2007), namely 120–160 dB re 1 µPa (rms) subject to the hearing type of marine mammal. Taking a precautionary approach, a level of 120 dB re 1 µPa (rms) represents the onset of disturbance while a level of 140 dB re 1 µPa (rms) is considered to represent the potential for strong behavioural reaction. These values are summarised in Table 2.13.

Table 2.13: Marine mammal criteria for onset of disturbance

Type of sound		Disturbance criteria (db re 1 µPa)
Continuous	Potential strong behavioural reaction	>140
	Low level (mild) disturbance	120
Multi-pulse	Potential strong behavioural reaction	160
	Low level (mild) disturbance	140

For sea turtles, the most relevant criteria for injury are considered to be those contained in the Sound Exposure Guidelines for Fishes and Sea Turtles (Popper et al., 2014), see Table 2.14. As it is not possible to draw any conclusions on the potential disturbance effects from guidance presented in Popper (2014), thresholds for behavioural reactions to pulsed sounds based on the work by McCauley et al. (2000) (see Table 2.15).

[7] Level B harassment is defined as having the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioural patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild.

Table 2.14: Sea turtle criteria for onset of injury (impulsive noise)

Animal	Parameter	Mortality and injury
Sea turtle	SEL dB re 1 μPa²s	210
	Peak dB re 1 μPa²s	>207

Table 2.15: Sea turtle criteria for onset of disturbance

Type of sound		Disturbance criteria (db re 1 μPa)
Continuous and multi-pulse	Potential strong behavioural reaction	175
	Low level (mild) disturbance	166

2.10.4 Summary of project adopted standards/limits

The project adopted standards/limits for discharges and emissions resulting from the Block 4 exploration drilling campaign are summarised in Table 2.16 and Table 2.17. Standards for chemical selection are provided in Table 2.18.

Table 2.16: Environmental discharge standards for Block 4 exploration drilling campaign

Parameter	Lebanese requirements	Applicable international requirements	Total corporate requirements*	Project adopted standard
Water-based cuttings and drill fluids	No Lebanese requirements specific to the discharge of cuttings from offshore exploration activities. Where national legislation is silent, project will adopt best industry practices and/or findings/recommendations presented in the SEA	Under the Barcelona Convention (Offshore Protocol[8]) water-based drilling fluids and drill cuttings are subject to the following requirements: • The use and disposal of such drilling fluids shall be subject to the chemical use plan and the provisions of this protocol regarding harmful and noxious substances. • Drill cuttings shall either be disposed of on land or into the sea in an appropriate site or area as specified by the competent authority. Under the World Bank EHS Guidelines for Offshore O&G Development discharge to sea of WBDF cuttings is permitted providing • facility is located > 3 miles (4.8 km) from shore • Hg: 1 mg/kg dry weight in stock barite • Cd: 3 mg/kg dry weight in stock barite	Water based drilling fluids should be preferred when appropriate. Offshore, chemicals shall be selected according to a pre-screening scheme based on the OSPAR methodology in force (refer to OSPAR Recommendation 2008/1). See Section 2.10.2.3	Water-based cuttings and drill fluids from riserless well sections will be discharged to sea. If high-performance water-based drilling fluids (HPWBDFs) used in lower-hole well sections, cuttings will be discharged to sea. Drilling fluids will be separated from the cuttings on the MODU, using the onboard solids control equipment, and will be reused in the next hole section. At the end of the drilling campaign, the remaining drilling fluid will be sent to shore for reuse on future projects. Chemicals in water-based drill fluids will be selected in accordance with the OSPAR Harmonised Mandatory Control Scheme and Offshore Chemical Notification Scheme, see Section 2.10.2.3 and Table 2.18.

[8] It should be noted that Lebanon has ratified the Barcelona Convention, but not the Offshore Protocol.

Parameter	Lebanese requirements	Applicable international requirements	Total corporate requirements*	Project adopted standard
		• maximum chloride concentration must be less than four times the ambient concentration of fresh or brackish receiving water • discharge via a caisson to ensure good dispersion of the solids. Under the OSPAR Convention, disposal of water-based cuttings and drill fluids is permitted.		
Non-aqueous cuttings and drill fluids	No Lebanese requirements specific to the discharge of cuttings from offshore exploration activities. Where national legislation is silent, project will adopt best industry practices and/or findings/recommendations presented in the SEA.	Under the Barcelona Convention (Offshore Protocol[8]) oil-based drilling fluids and drill cuttings are subject to the following requirements: • Such fluids shall only be used if they are of a sufficiently low toxicity and only after the operator has been issued a permit by the competent authority when it has verified such low toxicity. • Disposal into the sea of such drilling fluids is prohibited. • Disposal of drill cuttings into the sea is permitted only on the condition that efficient solids control equipment is installed and properly operated, the	Treatment and disposal options shall be systematically studied taking into account the regulatory and environmental context. The use of diesel oil in drilling mud is forbidden. When a non-aqueous drilling fluid is used, the content in aromatics of the base fluid should be less than 0.1% and shall be, in any case, less than 3% by weight. In conventional offshore areas, the drill cuttings treatment system shall ensure that the percentage of NADF discharged to the sea with cuttings and centrifugation residues (fines) shall not exceed 8% by weight for each completed	If non-aqueous drilling fluids (NADFs) used in lower-hole well sections cuttings will not be discharged to the marine environment, they will be contained and shipped to shore for treatment and disposal as per requirements of the SEA and findings of the EIA process. Non-aqueous drilling fluids will be separated from the cuttings on the MODU, using the onboard solids control equipment, and will be reused in the next hole section. At the end of the drilling campaign, the remaining drilling fluid will be sent to shore for reuse on future projects.

Parameter	Lebanese requirements	Applicable international requirements	Total corporate requirements*	Project adopted standard
		discharge point is well below the surface of the water and the oil content is less than 100 g/kg of dry cuttings. • Disposal of such drill cuttings in specially protected areas is prohibited. • In case of production and development drilling, a programme of seabed sampling and analysis relating to the zone of contamination must be undertaken. The use of diesel-based drilling fluids is strictly prohibited unless a special exception is granted.	well and only for the sections drilled with NADF. In addition, daily, the average content of NADF in the dry drill cuttings discharged to the sea shall never exceed 14% by weight. In sensitive marine areas, NADF cuttings discharge shall not exceed an oil concentration of 1% by weight on dry cuttings. When not feasible, other practicable solutions shall be studied, such as cuttings reinjection or transfer/ship to shore for treatment.	
Cement	No Lebanese requirements specific to the discharge of cement from offshore exploration activities. Where national legislation is silent, project will adopt best industry practices and/or findings/recommendations presented in the SEA.	No specific international requirements for cement discharge Under OSPAR, all offshore chemicals (including those used in cementing) are subject to pre-screening using OSPAR Harmonised Mandatory Control Scheme.	Offshore, chemicals shall be selected according to a pre-screening scheme based on the OSPAR methodology in force (refer to OSPAR Recommendation 2008/1). See Section 2.10.2.3.	Careful calculation of cement volumes to keep cement discharges to a minimum Chemicals in cement will be selected in accordance with the OSPAR Harmonised Mandatory Control Scheme and Offshore Chemical Notification Scheme, see Section 2.10.2.3.

Parameter	Lebanese requirements	Applicable international requirements	Total corporate requirements*	Project adopted standard
Sewage / sanitary from rig and vessels	Law 13/1983 ratifies MARPOL requirements.	Requirements in Annex IV MARPOL 73/78, see Section 2.10.2.1	Discharges of effluents from the sewage treatment system into the environment must be compliant with the local regulations and with MARPOL 73/78 for offshore installations	Discharge of sewage to comply with Lebanese Law 13/1983 and therefore MARPOL 73/78
Food waste from rig and vessels	Law 13/1983 ratifies MARPOL requirements.	Requirements in Annex V MARPOL 73/78, see Section 2.10.2.1	-	Discharge of food waste to comply with Lebanese Law 13/1983 and therefore MARPOL 73/78 No discharge of macerated food waste within 12 nm from the nearest land (MARPOL Special Area requirements) No discharge of macerated food waste from B4-1 well site as only 11 nm from nearest land
Desalinisation brine from rig and vessels	No Lebanese requirements specific to salinity of offshore discharges. Where national legislation is silent, project will adopt best industry practices and/or findings/recommendations presented in the SEA.	Requirements in World Bank EHS Guidelines for Offshore O&G Development for desalination brine limited to “mix with other discharge waste streams, if feasible”.	Offshore, chemicals shall be selected according to a pre-screening scheme based on the OSPAR methodology in force (refer to OSPAR Recommendation 2008/1). See Section 2.10.2.3.	It is not anticipated that anti-scaling and antifouling chemicals will be used, however in the circumstance of requirement these will be selected in accordance with lowest toxicity, lowest bioaccumulation potential and highest biodegradation as per best industry practice.

Parameter	Lebanese requirements	Applicable international requirements	Total corporate requirements*	Project adopted standard
Bilge water from rig and vessels	Law 13/1983 ratifies MARPOL requirements.	Requirements in Annex I MARPOL 73/78, see Section 2.10.2.1.	Machinery space effluents drainage (or bilge waters) shall be collected separately and treated in order to be disposed of with a maximum oil content of 15 ppm in compliance with MARPOL 73/78	Discharge of bilge to comply with Lebanese Law 13/1983 and therefore MARPOL 73/78
Slop water (contaminated drilling and completion fluids, cleaning residue from the rig pits, tanks, pipes and decking, and contaminated rain and wash water)	Maximum allowable limits for wastewater discharge into the sea are specified in Decision No. 8/1/2001, see Section 2.10.2.1. Maximum allowable limit of discharge of oil and grease to sea is 30 mg/l	OSPAR has set the discharge limit to 30 ppm oil in water in slop (North Sea).	Previous Total projects have used a corporate standard of 30 ppm oil in water in slop.	Water discharge from MODU slop treatment unit will not exceed 15 ppm oil in water
Cooling water from rig and vessels	Maximum allowable limits for wastewater discharge into the sea are specified in Decision No. 8/1/2001, see Section 2.10.2.1. Maximum temperature of waste water discharge to sea 35°C	Under the World Bank EHS Guidelines for Offshore O&G Development cooling water discharge should result in a temperature increase of no more than 3°C at edge of the zone where initial mixing and dilution take place. Where the zone is not defined, use 100 m from point of discharge. In the UK, no limits on cooling water discharges	For coastal or offshore waters, the generally accepted temperature increase shall not exceed a maximum of 3°C, 100 m away from the outfall discharge point. The temperature of the outlet effluents shall be adapted to the sensitivity of the local environment.	Discharge of cooling water to comply with Lebanese maximum allowable limits with regards to discharge temperature (Decision No. 8/1/2001) and TOTAL/ World Bank temperature requirements 100 m away from discharge point

Parameter	Lebanese requirements	Applicable international requirements	Total corporate requirements*	Project adopted standard
Ballast water from rig and vessels	CoM decision 31/2009 ratifies 'International Convention for the Control and Management of Ships' Ballast Water and Sediments 2004'.	Requirements in 'International Convention for the Control and Management of Ships' Ballast Water and Sediments 2004', see Section 2.10.2.2.	Ballast tanks must be designed in compliance with MARPOL 73/78. Any discharge of contaminated effluents shall be discharged according to MARPOL 73/78.	Discharge of ballast water to comply with Lebanese CoM decision 31/2009 and therefore the 'International Convention for the Control and Management of Ships' Ballast Water and Sediments 2004'.
Garbage from rig and vessels	Law 13/1983 ratifies MARPOL requirements.	Requirements in Annex V MARPOL 73/78, see Section 2.10.2.1.	Offshore, the disposal of garbage must comply with MARPOL 73/78 requirements. An Environmental Management Plan for project shall cover waste management.	Discharge of garbage to comply with Lebanese Law 13/1983 and therefore MARPOL 73/78. Conformance with TOTAL corporate requirements with respect to Waste Management Plan.

*Total General Specification 'Environmental Requirements for Projects Design and E&P Activities' (GS-EP-ENV-001)

Table 2.17: Atmospheric emission standards and noise emission standards for Block 4 exploration drilling campaign

Parameter	Lebanese requirements	Applicable international requirements	Total corporate requirements*	Project adopted standard
Flaring during well testing	Emission limit values are specified in Decision 8/1/2001. Emission standards given as mass flows and as concentrations, see Section 2.10.1.1. Maximum allowable concentrations of ambient air contaminants specified in Decision 52/1/96, see Section 2.10.1.1. A flaring permit is required from the Minister of Energy and Water under the PAR (Decree 10289/2013) and OPRL (Law No. 132/2010)	Requirements of the Paris Agreement (2015) to minimise greenhouse gas emissions.	Well test discharges and emissions shall be minimised. The test equipment shall be correctly designed in order to ensure adequate effluents collection and to avoid any liquid overflow or drop-out (with the test separator correctly sized and the burners designed to fully flare all fluid volumes). Well test burners shall be selected according to the BAT concept with improved combustion. An efficient flare tip (smokeless device) shall be installed in order to maximise the combustion efficiency. Whenever possible, the liquid phase of the separator shall be re-injected into the process lines or stored in appropriate tanks, and only the gaseous phase shall be burned.	Well testing of Block 4 exploration wells is not currently planned, however, it is an option if an appraisal well is drilled. If a well test is necessary, it will be carried out in conformance with TOTAL corporate requirements and Lebanese emission limit values and allowable ambient concentrations will be respected.
Rig emissions and vessel emissions	Following recommendation in draft SEA, 2019: • Ratification of MARPOL Annex VI to decrease emissions from vessels.	Requirements of Annex VI MARPOL 73/78, see Section 2.10.1.1.	Utility fuels with the lowest possible sulphur content shall be selected.	Emissions from rig and vessel operations to comply with MARPOL 73/78 Annex VI.

Parameter	Lebanese requirements	Applicable international requirements	Total corporate requirements*	Project adopted standard
Ozone depleting substances (generally used in firefighting and refrigeration systems)	Decree No. 2604/2009 Control of Materials that Deplete the Ozone Layer (amended by Decree No. 3277/2016) - aims to control substances that deplete the ozone layer which are listed in the annexes of the Montreal Protocol. Government of Lebanon issued HCFC import quotas for 2018 at 52.58 ODP tonnes, which is lower than the Montreal Protocol control targets and the maximum allowable consumption set in its Agreement with the Executive Committee.	Requirements of Montreal Protocol on Substances that Deplete the Ozone Layer (1987)	Ozone depleting substances and all products listed in the Montreal Protocol: any use of CFC, HCFC and halons, which contribute to decreasing the ozone layer, is prohibited except for essential use, under derogation. Alternatives shall be used.	Compliance with requirements of Montreal Protocol and Lebanon's HCFC import quotas
Airborne noise, logistics base operation	Decision 52/1/96 specifies maximum allowable noise levels and the permissible noise exposure standards, see Section 2.10.1.3.	IFC Environmental Health and Safety Guidelines (2007): Noise Level Guidelines (Outdoors) One hour LAeq (dBA) Industrial, commercial: 70 dBA (based on World Health Organization 1999 Guidelines) Or noise impacts should not result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site	Onshore, the design shall ensure that the noise levels recorded out of doors of typical receptors, beyond the property boundary of the facilities during normal operation of the site, do not exceed the limits set out below or result in a maximum increase in background levels of 3dB at the nearest receptor location off-site, at any time. Noise Level Guidelines (Outdoors) One hour LAeq (dBA) Industrial, commercial: 70 dBA	Compliance with Lebanese maximum allowable noise levels (Decision 52/1/96), see Section 2.10.1.3. Lebanese requirements have more stringent night-time standards for industrial areas than IFC guidelines and TOTAL's corporate requirements.

Parameter	Lebanese requirements	Applicable international requirements	Total corporate requirements*	Project adopted standard
Underwater noise from drilling operations, vessel movements and VSP activities	-	Best practice: • Criteria for onset of marine mammal injury based on NOAA Technical Memorandum NMFS-OPR-59 (2018). Marine mammal disturbance thresholds based on other studies, see Section 2.10.3.1.	-	Impact assessment based on NOAA (2018), Southall et al. (2007) and McCauley et al. (2000), see Section 2.10.3.1.

*Total General Specification 'Environmental Requirements for Projects Design and E&P Activities' (GS-EP-ENV-001)

Table 2.18: Chemical selection standards for Block 4 exploration drilling campaign

Parameter	Lebanese requirements	Applicable international requirements	Total corporate requirements*	Project adopted standard
Drilling and cementing chemical selection	-	-	Requires that chemicals are selected according to the following criteria: lowest toxicity, lowest bioaccumulation potential and highest biodegradation. GS EP ENV 001 also states that offshore, chemicals will be selected according to a pre-screening scheme based on the OSPAR methodology in force and provided with their material safety data sheet (MSDS). See Section 2.10.2.3	Chemical selection in line with the OSPAR Harmonised Mandatory Control Scheme and Offshore Chemical Notification Scheme. Preference for HQ Band Gold, OCNS Group E and PLONOR chemicals, see Section 2.10.2.3.

*Total General Specification 'Environmental Requirements for Projects Design and E&P Activities' (GS-EP-ENV-001)

3 PUBLIC PARTICIPATION

3.1 Introduction

Public participation and stakeholder engagement are integral parts of the environmental and social impact assessment (EIA) process and the foundation for developing and maintaining a project's social licence to operate. They help to develop and sustain trusting relationships and build a project's reputation as a venture that is socially responsible and acts with integrity.

Public participation and stakeholder engagement for this project are being undertaken in accordance with the requirements of Lebanese legislation, TOTAL policies for stakeholder engagement and international best practice (Appendix 3.1).

A project-specific stakeholder engagement plan (SEP) has been developed for the EIA of the Block 4 offshore exploration drilling study (hereafter called the project) to support meaningful and effective engagement throughout the EIA process. The SEP forms the basis of this chapter. The first version of the SEP was submitted to the Ministry of Environment (MoE) in May 2019. An updated version of the document was submitted in August 2019.

This chapter describes how stakeholder engagement activities have been undertaken since the outset of the project and outlines how stakeholder engagement will be continued after EIA. This chapter includes

- objectives of the stakeholder engagement
- stakeholder analysis
- activities undertaken
- analysis of issues and concerns raised by stakeholders
- lessons learnt and recommendations.

3.2 Objectives of the stakeholder engagement

The objectives of the stakeholder engagement are to

- *inform* stakeholders about the project, the EIA process, the draft scoping report and the draft EIA report
- *provide* stakeholders with an opportunity to raise questions, concerns, comments and suggestions to the project and EIA and ensure these are addressed in the EIA
- *disclose* the findings of the draft scoping report and ensure stakeholders understand and accept the validity of these findings
- *obtain* stakeholder input into the scope of the EIA with regards to environmental and socio-economic indicators, impact identification, potential sources of cumulative impact and to discuss how best to avoid, mitigate or compensate impacts
- *provide* feedback to the stakeholders on the impact assessment and associated management or mitigation measures

- *provide* a mechanism for ongoing stakeholder engagement and outline the ways in which stakeholders can be involved in the process.

3.3 Stakeholder identification and analysis

3.3.1 Stakeholder identification

Stakeholders are defined as persons or groups external to the project who may be impacted by the project, have influence over it or have an interest in it. Project stakeholders were identified by RSK, DAR and TOTAL jointly based on the following:

- understanding of the project activities
- the SEA conducted for the oil and gas sector (published March 2019, (MoEW, 2019))
- identification of the AOIs for the project
- knowledge of the social and administrative structure in the project AOIs
- early scoping of impacts and consideration of categories of people potentially affected by the project
- knowledge of the EIA process and the national bodies involved in permitting
- consultation with MOE and Lebanese Petroleum Administration (LPA) and their recommendations
- area of interest/mandate and capacity to influence and mobilise activities potentially linked to the project (NGOs)
- snowballing, where encountered stakeholders identify additional stakeholders.

Many stakeholders were identified and grouped into categories, as presented in Table 3.1.

Table 3.1: Stakeholder categories

Stakeholder groups	Stakeholders
Relevant authorities	National government ministries and authorities Municipal/local authorities
Agencies	Associations, syndicates
International agencies	International organisations, e.g., United Nations agencies
Civil society	Non-governmental organisations (international, national and regional) Political organisations Community organisations, e.g., civil society groups, development associations, women's groups, farming, fishing or other activity-based cooperatives Cultural heritage organisations
Academia	Relevant universities and research centres
Business	Industries, traders and service providers, tourism providers, beach resorts, hotels and restaurants,

Stakeholder groups	Stakeholders
	Informal businesses
Potentially affected communities/groups	Coastal community members Livelihood groups including: fishermen, farmers, natural resource users Potentially vulnerable and/or marginalised groups including youth, women, elderly, minority or marginalised groups, artisanal fishermen,

The SEP[1] sets out a complete methodology for stakeholder identification. The process of stakeholder identification is dynamic and ongoing throughout the life of the EIA.

3.3.2 Identification of vulnerable groups

During stakeholder identification relevant to the project, vulnerable groups have been outlined using the following World Bank definition:

> "A vulnerable group is a group that has some specific characteristics that make it at higher risk of falling into poverty than others living in areas targeted by a project. Vulnerable groups include the elderly, the mentally and physically disabled, at-risk children and youth, ex-combatants, internally displaced people and returning refugees, HIV/AIDS-affected individuals and households, religious and ethnic minorities and, in some societies, women."

Youth, women, the elderly, and minority or marginalised groups (who generally lack social status or community decision-making power) were identified as the main vulnerable groups. Efforts were made to engage these groups in the meetings. Meetings sought to collect baseline data and to provide information about the project. The stakeholder engagement team attempted to ensure that representatives of these groups were included in the meetings. Focus group discussions were held with artisanal fishermen, female-only and youth groups (see Section 3.4). During the meetings and throughout the stakeholder engagement activities, women were specifically encouraged to voice their comments and ask questions.

3.3.3 Stakeholder analysis

The SEP[2] sets out a methodology for stakeholder analysis (see Figure 3.1). This includes analysis of the following aspects:

- **level of influence stakeholders may have on the project**, rated as low, medium, important and critical
- **level of impact the project may have on stakeholders**, rated as low, medium, important and critical
- **intensity of interest stakeholders may have in the project**, rated as high, medium, low or critical.

The level of impact and influence determines the level of intensity of collaboration between the project and the stakeholder:

[1] See SEP for details on the stakeholder identification methodology.

[2] See SEP for details on the stakeholder analysis methodology.

- **type of collaboration with the stakeholder**, rated as collaborate, keep informed and monitor, based on contact with the stakeholder.

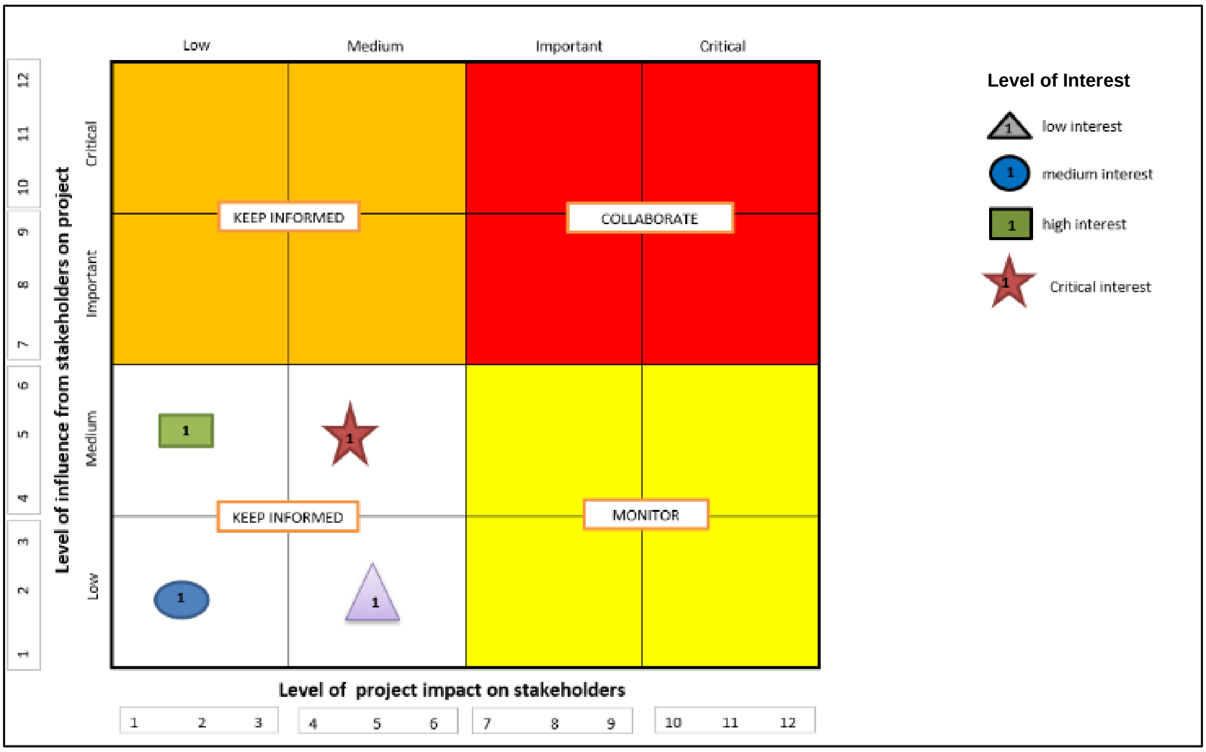

Figure 3.1: Stakeholder analysis methodology

It should be noted that the stakeholder analysis, to a certain extent, is subjective, depending on personal experience with different stakeholders. To reduce subjectivity in analysing stakeholders, the process was carried out as a collaborative exercise.

Stakeholders were analysed in terms of the type and level of impact they may endure from the project, the type and level of influence the may have over the project and the interest they may have in the project. Once the analysis was completed, the mapping of each stakeholder was undertaken. At local level, stakeholder categories were mapped collectively.

Stakeholder mapping is an ongoing exercise, as stakeholders' relationships to the project may change at any time. The detailed mapping results, however, are an internal confidential document of the project proponent, which reflects the company's understanding of external risks affecting their commercial decisions. A complete table of all stakeholders and their analysis can be found in Appendix 3.2.

3.4 Scoping public consultation meeting

3.4.1 Activities undertaken

According to Lebanese Decree No 8633/2012, projects in Lebanon that require an EIA to be undertaken should ensure public participation at several stages of the EIA process.

Public participation was undertaken during the scoping phase. The objective was to raise awareness of the project and the EIA among the general public and all interested parties and to receive input from stakeholders into the EIA scoping report and the terms of reference for the EIA. The public participation process is described below.

3.4.2 Public consultation preparation

The draft scoping report was published online at rsklebanon.com/total/blocks4and9/scoping-comments/ for one month from 3 May to 2 June 2019. The general public, public authorities and other interested parties were invited to provide feedback on the scoping report via a comments and questions form. Comments and questions were submitted automatically to the LPA and MoE and were collated and addressed in the updated scoping report. The website also provided the date and location of the planned public consultation meeting.

Additionally, an advert was placed in two local newspapers (*Al Akhbar* and *An-Nahar*) on 3 May, 15 working days before the public consultation meeting, advertising the online publication of the draft scoping report and inviting stakeholders to review and provide feedback. The newspaper advertisement explained that an EIA is required for the project and provided the date and location of the planned public consultation meeting (Appendix 3.3).

Announcements related to the project and the planned public consultation meeting were prepared, sent and displayed at municipalities in the AOI (Appendix 3.4).

3.4.3 Presentation materials used for public consultation

Several materials were prepared ahead of the public consultation meeting to enhance communication and ensure an informed discussion. These included:

- a background information document (BID) introducing the project and outlining the EIA process (produced in Arabic and English) (Appendix 3.5)
- PowerPoint Presentations introducing the project, the EIA process and draft scoping study results (produced in Arabic) (Appendix 3.6 and Appendix 3.7)
- videos (in Arabic) introducing TOTAL and summarising the offshore environmental baseline study (EBS) survey conducted in April 2019.

3.4.4 Reference material for stakeholder engagement materials

The stakeholder engagement team used a frequently asked questions document (FAQ) to assist with responding to stakeholder questions during the public consultation meeting. The document was prepared by RSK and approved by TOTAL (Appendix 3.8).

3.4.5 Undertaking the public consultation meeting

The public consultation meeting was held by the EIA team, which consisted of consultants from RSK and DAR, and representatives from Total E&P Liban. The facilitator in the meeting was a representative from DAR.

The meeting was held in Arabic, with provision of simultaneous interpretation services for English-speaking participants. BIDs were distributed to all stakeholders.

The meeting began with introductions and opening remarks by the facilitator who outlined the purpose and format of the meeting.

This was followed by two presentations; the project description given by Total E&P Liban and the EIA process presented by the EIA consultants (Appendix 3.6 and Appendix 3.7). Videos were used to introduce TOTAL, present the exploration activities and the EIA process, and summarise the offshore environmental baseline study (EBS) survey conducted in April 2019.

After the presentations, the floor was opened and a question and answer session was conducted. Efforts were made to enable all stakeholders present to have their concerns heard. The EIA team responded to questions using the FAQ document outlined above.

Participants were also provided with an additional sheet of paper on which they could submit comments or questions in writing.

A grievance mechanism was laid out, including contact details, enabling stakeholders to comment on the project or ask any further questions. Refreshments were provided to all participants.

Attendance sheets were completed and signed by participants and business cards were exchanged to facilitate ongoing communication.

3.4.6 Recording the public consultation meeting

During the public consultation meeting, all verbal questions, comments and concerns and responses provided were transcribed in an RSK template (Appendix 3.9). This information was recorded, forwarded to the RSK database manager and entered into a relational Microsoft Access stakeholder engagement database, and has been considered in the updating of the draft scoping report.

Written comments received during the public consultation were also entered into the database. Where consent was not given alongside a question or concern, names were **not** recorded.

Photographs were taken after permission was granted by participants (Appendix 3.10). Attendance sheets were completed (Appendix 3.11), forwarded to the database manager and logged in the database.

3.4.7 Analysis of stakeholder issues raised

This section presents the main concerns and questions raised by stakeholders during the public consultation in the scoping phase. Appendix 3.12 includes a more comprehensive list of the concerns and responses disaggregated for the public consultation and stakeholder engagement meetings, which is described below.

The scoping phase public consultation meeting took place on 24 May 2019 at Radisson Blue Hotel, Verdun, Beirut, and was attended by the general public. The meeting also included 40 stakeholders from national authorities, municipal authorities, agencies, civil society, academia, businesses and other interested parties.

The concerns and questions are first categorised into topics (see Table 3.2)[3] and secondly in terms of gender.

[3] It should be noted that the allocation of questions and comments to topics is not mutually exclusive. In some cases, an issue has been allocated to more than one category.

Table 3.2: Stakeholder issue categories

Topic	Description
Project characteristics	Methods to acquire data Objective of the survey Extent of the area of influence Project infrastructure
EIA related	Baseline studies Mitigation measures Request for data Request for further involvement
Environment	Biodiversity/protected areas

Figure 3.2 provides the number of questions and comments from stakeholders during the public consultation for the different concern categories. The figure shows that during the public consultation the majority of questions and comments raised were EIA related, followed by questions or comments about project characteristics.

Stakeholders inquired about the timeline of the EIA activities and how the results of the EIA may influence the design and selection of the exploration vessel and the drilling location. Other comments related to the methodologies of social and environmental baseline studies, the potential environmental impacts associated with waste generated by the exploration activities and the onshore capacity to manage this waste.

Data was further analysed by gender; see Figure 3.3. The figure shows that men, in general, raised more issues than women during the public consultation meeting. From the figure, concerns and questions about the EIA were raised more frequently amongst males than females. Males also raised all concerns in the topic of project characteristics, whereas females raised all environmental concerns and questions raised during the public consultation meeting.

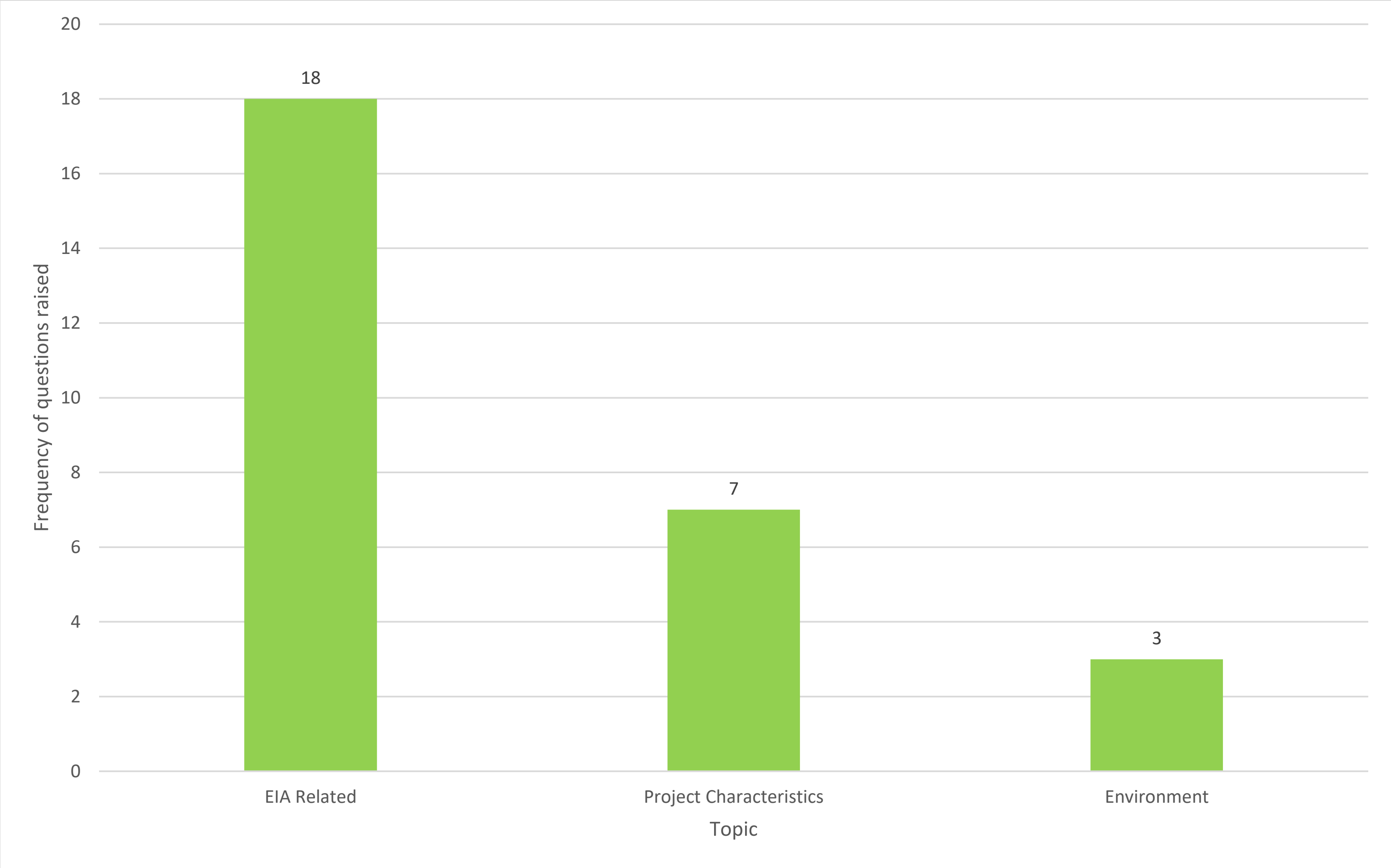

Figure 3.2: Frequency of issues raised by topic during public consultation

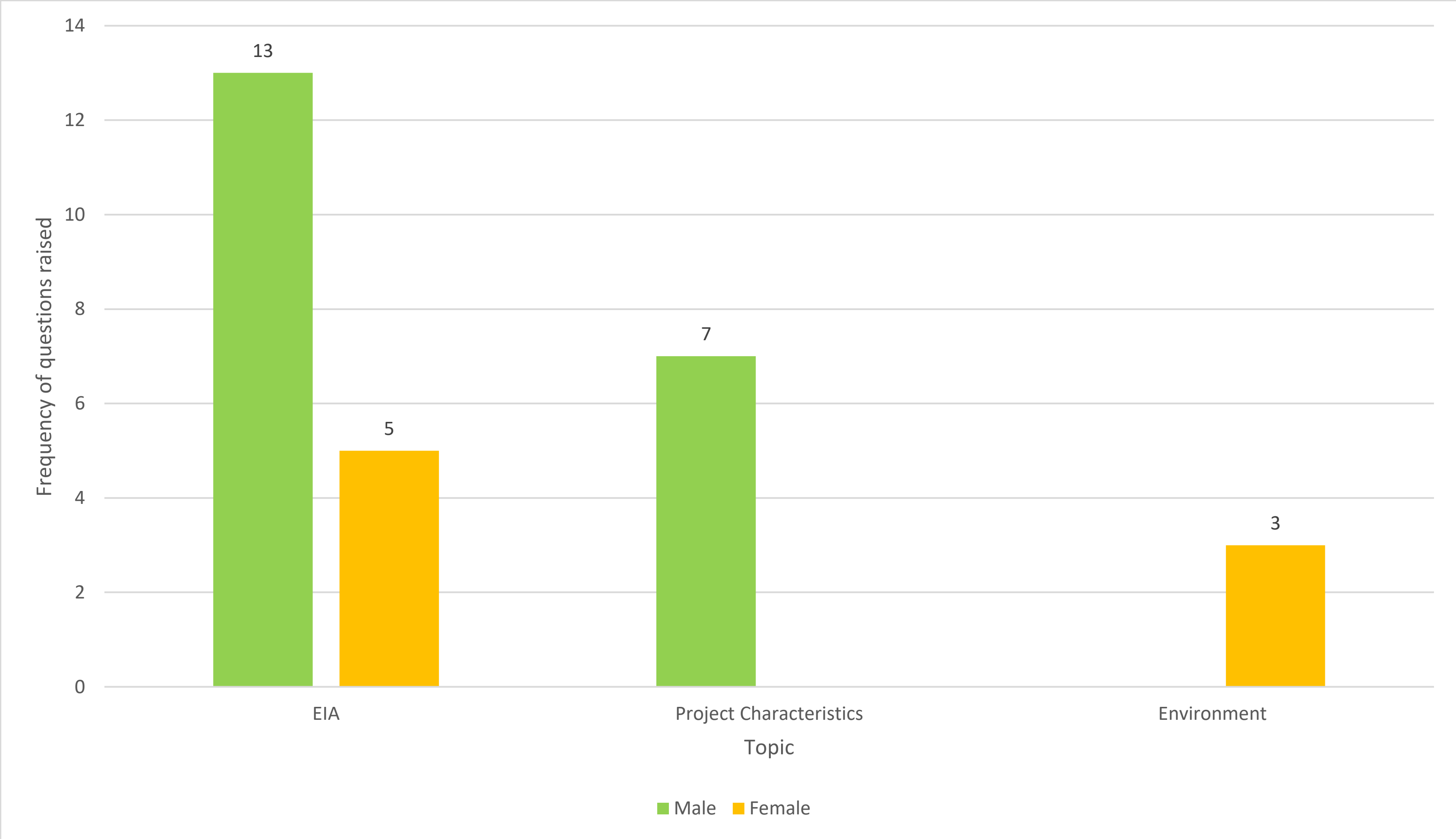

Figure 3.3: Frequency of issues raised by gender during public consultation

3.5 Scoping phase stakeholder engagement

3.5.1 Activities undertaken

Whereas public participation is targeting the general public, stakeholder engagement targets specific groups and individuals who may be impacted by the project, have influence over it or have an interest in it. This includes authorities, international and national agencies, civil society and NGOs, academia, businesses and potentially affected groups.

The main aim of scoping phase stakeholder engagement was to ensure that the different categories of stakeholders were informed about the project and had an opportunity to provide input into the terms of reference for the EIA. The stakeholder engagement process during the scoping phase is described below.

3.5.2 Arrangement of scoping stakeholder engagement meetings

Scoping phase stakeholder engagement meetings were arranged as follows.

Meetings were arranged with identified stakeholders. At the national, governorate and municipality levels, letters of invitation were sent before the stakeholder engagement meetings (a sample letter is provided in Appendix 3.13) and followed up by telephone calls to confirm dates, times and venues. A full list of stakeholders invited to meetings during the scoping phase is presented in Appendix 3.14.

Certain stakeholders (NGOs and some local level stakeholders) were invited to attend a scheduled meeting via emails or phone calls.

The timing of each meeting was arranged to ensure maximum attendance and minimise potential interference with daily commitments.

3.5.3 Presentation materials used during scoping engagement meetings

The following information materials were prepared for use by the stakeholder engagement teams:

- BID document as mentioned in Section 3.4.3 above
- PowerPoint Presentations PowerPoint Presentations introducing the project, the EIA process and draft scoping study results (produced in Arabic) (Appendix 3.15 and Appendix 3.7)
- videos as described in Section 3.4.3 above
- question and answer recording templates.

3.5.4 Reference materials used for scoping engagement meetings

The stakeholder engagement team used an FAQ document, as mentioned above (see Section 3.4.4), for scoping phase meetings.

3.5.5 Undertaking the scoping phase engagement meetings

Scoping stakeholder engagement meetings were attended by national authorities, municipal authorities, international agencies, agencies, NGOs and businesses. Attendance lists for the meetings are provided in Appendix 3.11. The meetings began with introductions and opening remarks by the facilitator who outlined the purpose and format of the meetings. The facilitator in the meeting was a representative from DAR.

This was followed by two presentations: the project description given by Total E&P Liban and the EIA process presented by the EIA consultants. Videos were used to present the exploration activities and the EIA process.

After the presentation, the floor was opened and a question and answer session was conducted. The EIA team responded to questions using the FAQ document outlined above.

Participants were also provided with an additional sheet of paper on which they could submit comments or questions in writing.

A feedback mechanism was laid out including contact details, enabling stakeholders to comment on the project or ask further questions.

Refreshments were provided to all participants.

Attendance sheets were completed and signed by participants and business cards were exchanged to facilitate ongoing communication.

3.5.6 Recording the scoping phase engagement meetings

During the scoping phase engagement meetings, all verbal questions, comments and concerns and responses provided were transcribed in an RSK template (Appendix 3.9). This information was recorded, forwarded to the RSK database manager and entered in to a relational Microsoft Access stakeholder engagement database, and was considered in the updating of the scoping report.

Written comments received during the scoping engagement have also been entered into the database. Where consent was not given alongside a question or concern, names were **not** recorded. All questions, comments and concerns received during the scoping engagement (verbal and written) have been shared with TOTAL.

Photographs were taken after permission was granted by participants (Appendix 3.10). Attendance sheets were completed (Appendix 3.11), forwarded to the database manager and logged in the database.

3.5.7 Analysis of stakeholder issues raised

Five scoping phase stakeholder engagement meetings took place on 14 and 15 May 2019.

Concerns and questions are first categorised into topics (see Table 3.3)[4] and secondly in terms of gender.

[4] It should be noted that the allocation of questions and comments to topics is not mutually exclusive. In some cases, an issue has been allocated to more than one category.

Table 3.3: Stakeholder issue categories

Topic	Description
Project characteristics	Methods to acquire data Objective of the survey Extent of the area of influence Project infrastructure
EIA related	Baseline studies Mitigation measures Request for data Request for further involvement
Community development	Communities benefitting from the project
Employment	Employment opportunities from the project
Livelihoods	Water-based livelihoods Land-based livelihoods
Health and safety	Health and safety issues relating to the project
Cultural heritage	Protected sites World Heritage Sites
Environment	Biodiversity/protected areas
Data collection	Stakeholder engagement Further data collection
Consultation and feedback	Consultation and feedback
Other	Other comments made

Figure 3.4 illustrates the relative frequency of the categories of questions or comments for the stakeholders during the five stakeholder engagement meetings. The figure shows that most commonly reported questions and comments across all meetings were EIA related, followed by questions and comments about project characteristics.

Stakeholders at all meetings were interested to know more about the methodologies applied in the various studies and whether the final EIA would be made publicly available to them. Some questions related to the location and duration of environmental offshore surveys, the sampling design and the equipment that was used. Other frequently asked questions related to further detail on the mitigation of environmental impacts, development of management plans and what would be carried out in the case of accidents.

The questions raised relating to project characteristics concerned project design and description, logistics, as well as specific queries relating to the selection of well site location. The impression given was that stakeholders were genuinely interested in the project.

A higher number of questions relating to 'livelihoods' were raised at the meeting with agencies. This could be because the attendees were mostly from fishermen's syndicates. Most of their questions related to fisheries and the supply chain. Concerns related to potential effects of exploration activities on fish stocks and impacts associated with the exclusion zone surrounding the drill ship. One stakeholder raised concerns about the potential risks to navigation and suggested that there should be close coordination between the operator and authorities in charge of fishing vessels.

Very few questions were raised relating to cultural heritage. Only one question was raised relating to cultural heritage by a stakeholder from an NGO, who advised that the laws on protected sites in Lebanon were detailed several years ago and may not be robust enough to protect the sites from potential impacts of oil and gas development.

Figure 3.4 shows that a considerable number of questions and comments categorised as 'Other' were raised by NGOs. These questions did not fall into any of the categories and were mostly beyond the remit of the EIA.

Data was also analysed by gender (see Figure 3.5). The figure shows that males raised the greatest number of questions and concerns throughout the scoping phase meetings, with the majority of questions raised relating to the EIA and project characteristics topics. Females also raised the highest number of concerns relating to the EIA. The 'livelihood' topic also raised a number of concerns from both men and women.

A complete list of questions and responses is provided in Appendix 3.12.

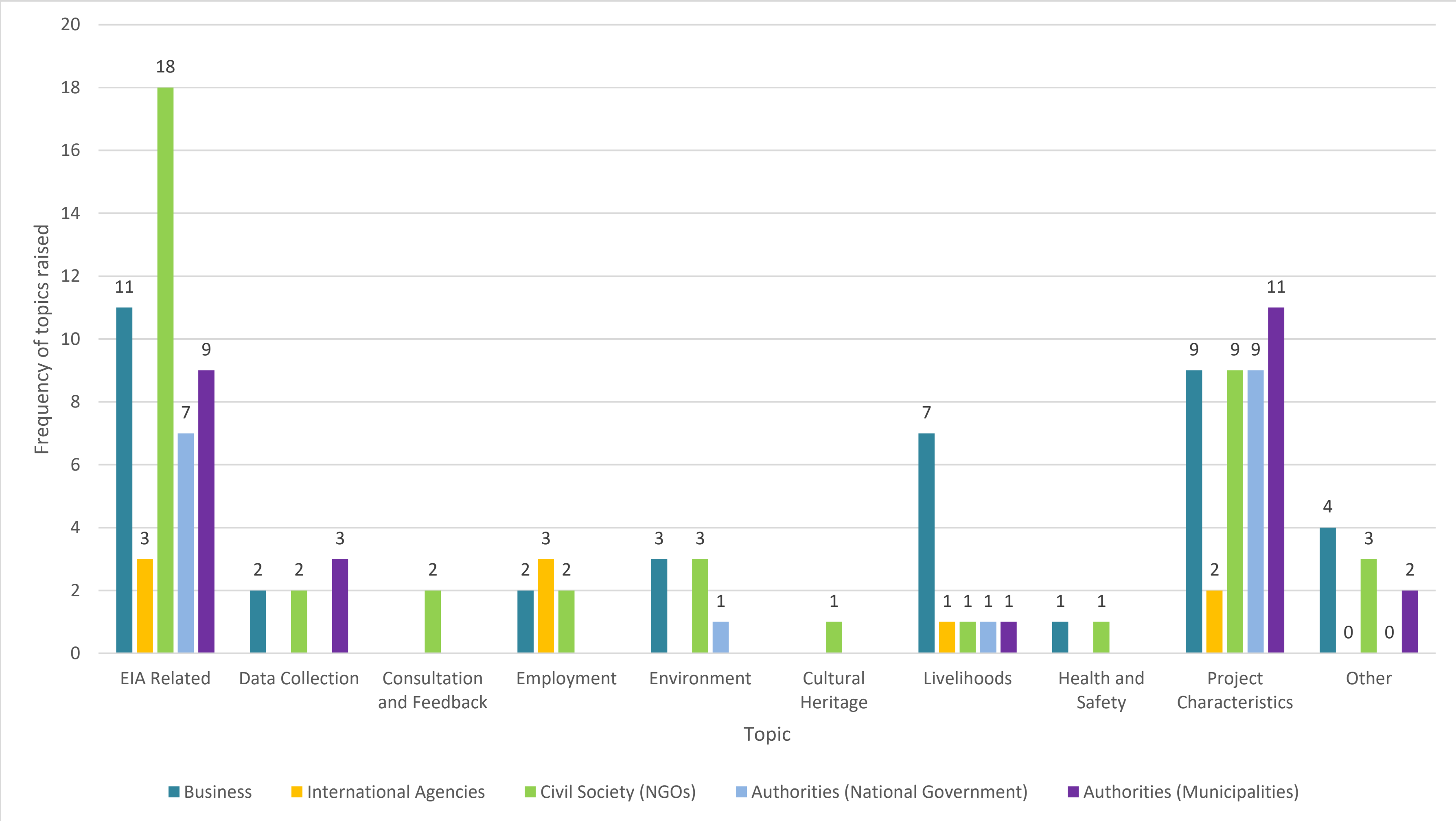

Figure 3.4: Frequency of issues raised during the scoping phase stakeholder meetings

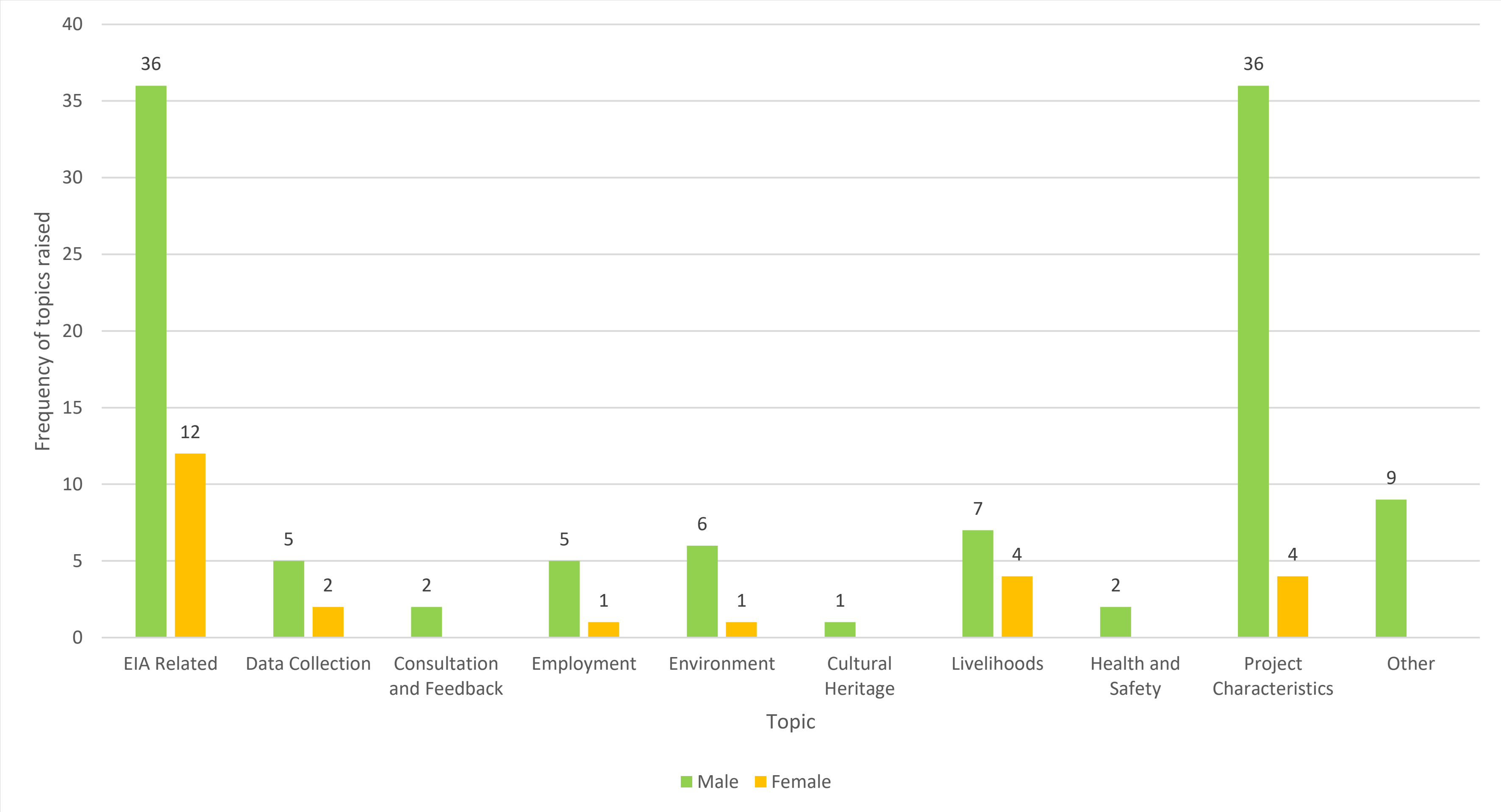

Figure 3.5: Frequency of concerns raised by gender during scoping phase

3.6 Baseline phase stakeholder engagement

3.6.1 Activities undertaken

During the baseline phase, the EIA stakeholder engagement activities were linked to the social and additional environmental data collection process. Full environmental baseline data collection was conducted as a separate process.

Social baseline data collection focused on gathering relevant information at the local and national level (meaning authorities and agencies with mandates covering the entire country) to understand and describe the importance and sensitivity of the receptors potentially affected by the project. The methodology for the social baseline data collection is described in the Chapter 5 of this EIA.

In addition, stakeholders who were identified during the scoping phase and who had not been met were also met to inform them about the project and the EIA and to receive their comments, which have been included in this EIA.

Baseline phase stakeholder engagement also enabled engagement with vulnerable groups including

- youth
- women
- minority or marginalised groups, e.g., artisanal fishermen and natural/coastal resource users.

3.6.2 Arrangement of baseline stakeholder engagement meetings

Baseline phase meetings were arranged as follows.

As a natural result of scoping activities, some additional NGOs were identified for consultation. These included

- Operation Big Blue
- Terre Liban
- Diaries of the Ocean
- Green Area
- Legal Agenda.

Potentially affected communities were selected according to the social baseline methodology (see Chapter 5). These communities were selected based on a range of land uses in the coastal zone, including fishing ports, tourist resorts, industrial areas, protected areas and UNESCO World Heritage Sites (WHS). Municipalities were identified as the gate keeper to communities and the stakeholders to be met within those communities. The national level stakeholders included are those whose activities are relevant to some aspect of the project and those from whom data will be collected. Some of these stakeholders were engaged with during the scoping phase.

Stakeholders were also selected for primary baseline data collection. These stakeholders were selected based on their proximity to Block 4, and by using purposive sampling[5], based on a diversity of land uses.

At the governorate, municipality and civil society level, letters of invitation were sent before the meetings (Appendix 3.13). Meetings with potentially affected groups, including women, youth, and fishermen were arranged through letters, emails, phone calls and ad-hoc encounters. Letters of invitation were sent and followed up by phone calls nearer the time to confirm dates and venues.

Venues for meetings were selected based on proximity to stakeholders, ease of access and adequate seating capacity.

3.6.3 Presentation materials used during baseline engagement meetings

Materials used for baseline phase engagement meetings included

- BID document as mentioned in Section 3.4.3 above
- posters introducing the project and the EIA process (produced in Arabic) (Appendix 3.16).

3.6.4 Reference materials used during baseline engagement meetings

The stakeholder engagement team used an FAQ document, as mentioned above (see Section 3.4.4), for baseline phase meetings.

FGD guides and the KII interview guides were prepared for the data collection. These are provided in the social baseline chapter (Chapter 5).

3.6.5 Undertaking baseline phase engagement meetings

Between 13 and 24 May, 29 KIIs and 14 FGDs took place. Meetings were attended by municipality officials, NGOs and civil society organisations (CSOs), commercial and industrial enterprises and directly affected groups. National level data collection continued until the submission of the EIA in early September 2019. A full list of baseline meetings is shown in Table 3.4 below.

Table 3.4: Baseline phase engagement meetings

KII	
Industry – salt workers/salt miners	Anfeh
Head of fishermen’s cooperative	Batroun, Dbayeh
Commercial business – diving centre/ yacht and boat services	Dbayeh
Restaurant owner	Tripoli, Jounieh, Amchit
Beach resorts	Chekka, Batroun
DPNA	Tripoli
Women in Front	Dbayeh

[5] Purposive sampling is a non-probability sample and is selected on particular characteristics of the population relevant to the objective of the study.

Green Square NGO	Amchit
UNESCO	Jbeil
Medical specialist – Lebanese Association for Safety and Emergency	Batroun
Municipality officials	Chekka, AlMina, Batroun, Safra, Okaibeh, Amchit, Jbeil, Fidar, Dbayeh, Anfeh, Bebnine, Anfeh
Ministry of Energy and Water	Beirut
Ministry of Culture – Directorate of Antiquities	
Ministry of Agriculture – Directorate of Fisheries and Aquaculture	
CNRS (RS department)	
CNRS (geology department)	
CNRS (geophysical department)	
Ministry of Public Works and Transport – Directorate General of Land and Maritime Transport	
Disaster Risk Management Unit	
Port of Beirut	
Ministry of the Displaced	
Ministry of Tourism	
Ministry of Social Affairs	
Ministry of Justice	
Ministry of Foreign Affairs	
Lebanese Atomic Energy Commission	
FGD	
Fishermen	Anfeh, Chekka, Jbeil, Okaibeh, Dbayeh, Bebnine
Anglers	Jbeil, Jounieh, Dbayeh
Fishing households (women)	Anfeh, Okaibeh, Jbeil
Youth	Anfeh
Farmers	Safra

FGD teams of two people from RSK and InfoPro, a facilitator and an assistant facilitator, conducted the FGD meetings. Additionally, a KII team of two facilitators per team, a facilitator and an assistant facilitator, conducted the KII meetings.

The timing of each meeting was arranged to ensure maximum attendance and minimise interference with the stakeholder/communities' daily commitments.

All meetings were held in Arabic and BIDs, produced in Arabic, were distributed to all stakeholders.

The meetings began with introductions and opening remarks by the facilitator who outlined the purpose and format of the meeting to set the group at ease. Facilitators explained that participation was voluntary and stakeholders were able to decline to participate at any point.

Facilitators asked participants for oral consent to participate and permission to audio-record the conversations. Facilitators explained that no names would be used when reporting the findings unless consent was given.

Data collection activities commenced with a stakeholder engagement event (the project, the EIA process and the stakeholder engagement process was presented using the stakeholder materials, e.g., BIDs and posters). After this, the floor was opened and a question and answer session was conducted. Sufficient time was allocated to the question and answer session and efforts were made to enable all stakeholders present to have their concerns heard. All verbal questions and responses were recorded and responses provided. These were entered into a stakeholder engagement database and will be collated in the final EIA report.

The FAQ document was used by facilitators to respond to questions.

A grievance mechanism was clearly laid out including contact details, enabling stakeholders to comment on the project or ask further questions.

Refreshments were provided to all participants.

3.6.6 Recording the baseline phase engagement meetings

During the baseline phase engagement meetings, all verbal questions, comments and concerns and responses provided were transcribed in an RSK template (Appendix 3.9). This information was recorded, forwarded to the RSK database manager and entered in to a relational Microsoft Access stakeholder engagement database.

Written comments received during the baseline engagement have also been entered into the database. Where consent was not given alongside a question or concern, names were **not** recorded.

Photographs were taken after permission was granted by participants (Appendix 3.10). Attendance sheets were completed (Appendix 3.11), forwarded to the database manager and logged in the database.

During these engagements, and where permission was granted by participants, minutes were audio-recorded.

3.6.7 Analysis of stakeholder issues raised

EIA stakeholder engagement activities for this project are linked to the social baseline data collection process. In May 2019, stakeholders at the local level were engaged with as part of primary data collection efforts.

Figure 3.6 provides the number of questions and comments from stakeholders during the baseline stakeholder engagement meetings for the different concern categories. The figure shows that during meetings, the most commonly raised questions or comments related to project characteristics followed by questions or comments about EIA.

Stakeholders were interested to know more about the technical design of the drilling activities, the methods to be used, the precise location of the block and the depth of the wells. Stakeholders also asked about the precise location of the logistics base and facilities.

Questions were raised during meetings about the types of environmental and social studies that would be conducted and when, and when the final EIA would be available. Some stakeholders asked about the types of waste that the project would generate and how this would be managed.

The third most common category of questions and comments was livelihoods: stakeholders in Block 4 were concerned about the risks of releases of chemicals or oils into the sea and the knock-on effects on tourism, particularly in Anfeh which is known to have some of the cleanest water in Lebanon.

Stakeholders were eager to know how job opportunities could benefit them. Stakeholders recommended that fishermen and users of the sea should be prioritised for employment opportunities.

The data was further analysed by gender; see Figure 3.7. From the figure, it can be seen that female stakeholders raised a larger number of questions relating to employment than male stakeholders. Very few questions were raised by either gender for the topics of cultural heritage, community development, and health and safety.

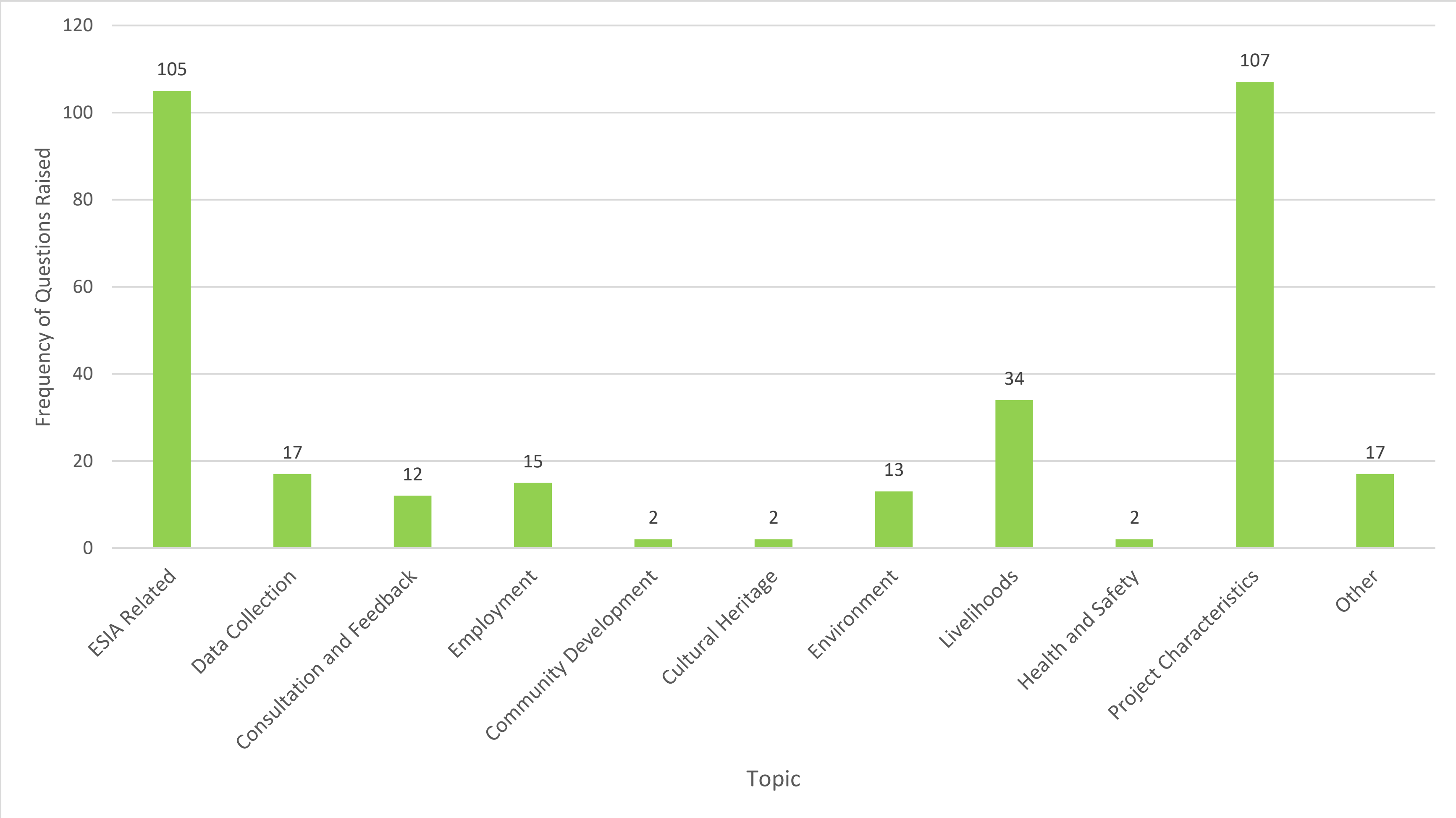

Figure 3.6: Frequency of issues raised during the baseline phase engagement meetings

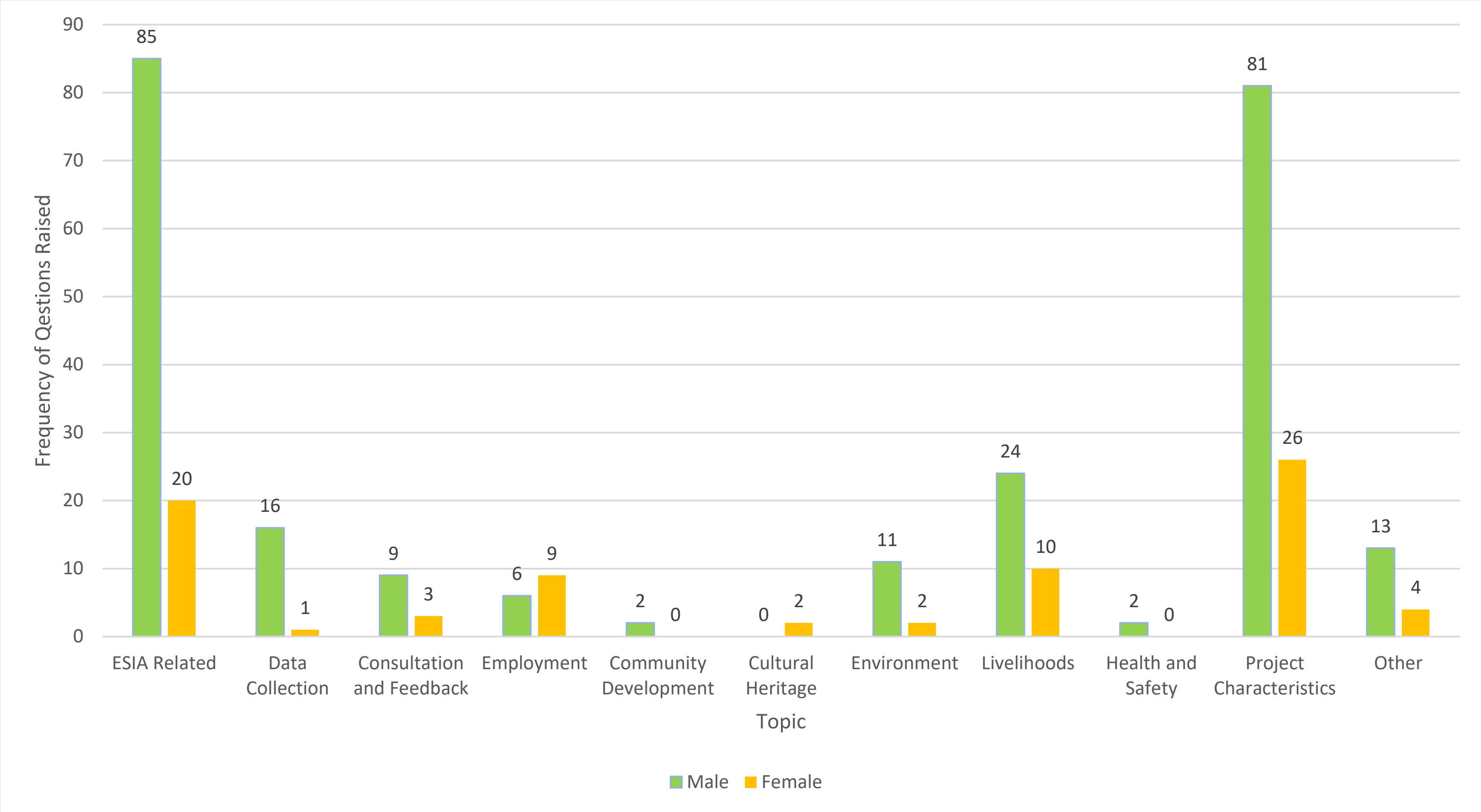

Figure 3.7: Frequency of questions raised by gender during baseline phase engagement meetings in Block 4

3.7 Disclosure public consultation meetings

The objective of the public consultation was to raise awareness of the project, the EIA outcomes and the grievance mechanism among all concerned parties, and to allow stakeholders to voice their questions, concerns and comments on project activities and the EIA.

3.7.1 Activities undertaken

The draft EIA was published online at https://www.rsklebanon.com/total/block4/eia-comments/, for one month between 4 September and 4 October. The general public, public authorities and other interested parties were invited to provide feedback on the EIA report via online comments and questions form. Any comments were sent directly to the LPA and MOE and were collated and, where necessary, have been addressed in this updated EIA.

Two public consultation meetings were undertaken during disclosure phase. The first took place on 19 September 2019 at the Radisson Blu Hotel, Verdun, Beirut. The second meeting took place on 20 September at Byblos Cultural Centre, Jbeil. Ninety-six stakeholders attended the two meetings.

3.7.2 Arrangement of disclosure public consultation meetings

An advert was published in two local newspapers (*Al Akhbar* and *An-Nahar*) informing stakeholders of the online publication of the EIA report and inviting them to provide feedback for a period of one month from 4 September 2019.

The newspaper advertisement and the website also invited all stakeholders and communities to attend two public consultation meetings in which they could voice their questions and comments, and provided the date, time and location of these (Appendix 3.3).

Additionally, stakeholders were invited to the public consultation meetings by formal letters, emails and WhatsApp messages (Appendix 3.17).

3.7.3 Presentation materials

Visual and printed materials used during public consultation meetings included PowerPoint Presentations introducing the project, executive summary, the EIA process, previous stakeholder engagement activities and the reference to project grievance mechanism (produced in Arabic) (Appendix 3.18 and Appendix 3.19).

3.7.4 Reference materials

The stakeholder engagement team used an updated version of the frequently asked questions document to assist with responding to stakeholder questions during the public consultation meetings. The document was prepared by RSK and approved by TOTAL (Appendix 3.20).

During the public consultation in Jbeil (20 September 2019), a video was shown in response to a comment on oil spills.

3.7.5 Undertaking disclosure public consultation meetings

The public consultation meeting was held by the EIA team, which consisted of international consultants from RSK and national consultants from DAR, and representatives from Total E&P Liban.

The meeting was held in Arabic, with provision of simultaneous interpretation services for English-speaking participants.

The meeting began with introductions and opening remarks by the facilitator from local EIA consultancy DAR, who outlined the purpose and format of the meeting.

This was followed by two presentations: the project description given by Total E&P Liban and the EIA process and previous stakeholder engagement, presented by the EIA consultants (Appendix 3.18 and Appendix 3.19).

A grievance mechanism was laid out in the presentation, including contact details, enabling stakeholders to comment on the project or ask any further questions.

After the presentations, the floor was opened and a question and answer session was conducted. Efforts were made to enable all stakeholders present to have their concerns heard. Full details of questions and responses are given in Appendix 3.12.

Participants were also provided with an additional sheet of paper on which they could submit comments or questions in writing.

Attendance sheets were completed and signed by participants and business cards were exchanged to facilitate ongoing communication.

Refreshments were provided to all participants.

3.7.6 Recording the disclosure public consultation feedback

Feedback was received verbally and in writing during the disclosure public consultation meetings, as well as submitted online through the draft EIA website.

All verbal questions, comments and concerns and responses provided were transcribed in an RSK template (Appendix 3.9).

During the meeting, where consent was not given alongside a question or concern, names were **not** recorded.

Photographs were taken after permission was granted by participants (Appendix 3.10).

Attendance sheets were completed (Appendix 3.11), forwarded to the database manager and logged in the database.

During these engagements, and where permission was granted by participants, minutes were audio-recorded.

Detailed responses to all stakeholder feedback, both written and verbal, is given in Appendix 3.12. The information was also entered into a Microsoft Access database and is summarised in the following section.

During the consultation period, comments were also received from the regulators and addressed in the final version of the EIA submitted for approval.

3.7.7 Analysis of stakeholder issues raised

Figure 3.8 summarises the number of questions and comments from stakeholders during the public consultation meetings. The figure shows that during the public consultation meetings, stakeholders raised a high number of questions and comments relating to the EIA findings, followed by project characteristics. Many stakeholders were interested to know about the social and environmental surveys that had taken place, and had questions and recommendations relating to the EIA online submission.

Stakeholders were interested in the duration of the exploration phase and what would happen if hydrocarbons are found in the AOI. Other stakeholders were interested in how mud and waste from the project will be treated and disposed of. Stakeholders also enquired about the management plans and mitigation measures that will be taken.

Data was further analysed by gender (Figure 3.9). From the figure, female stakeholders raised all questions and comments relating to cultural heritage; stakeholders questioned the surveys undertaken for archaeological research and stated that although nothing of interest was found during these studies, it does not mean that there are no sites in the area.

Male stakeholders raised more questions on project characteristics, whereas both male and female stakeholders raised many comments relating to the EIA.

Very few comments were raised by either gender for the topics of employment community development cultural heritage, environment, livelihoods, and health and safety.

Detailed question and responses are shown in Appendix 3.12.

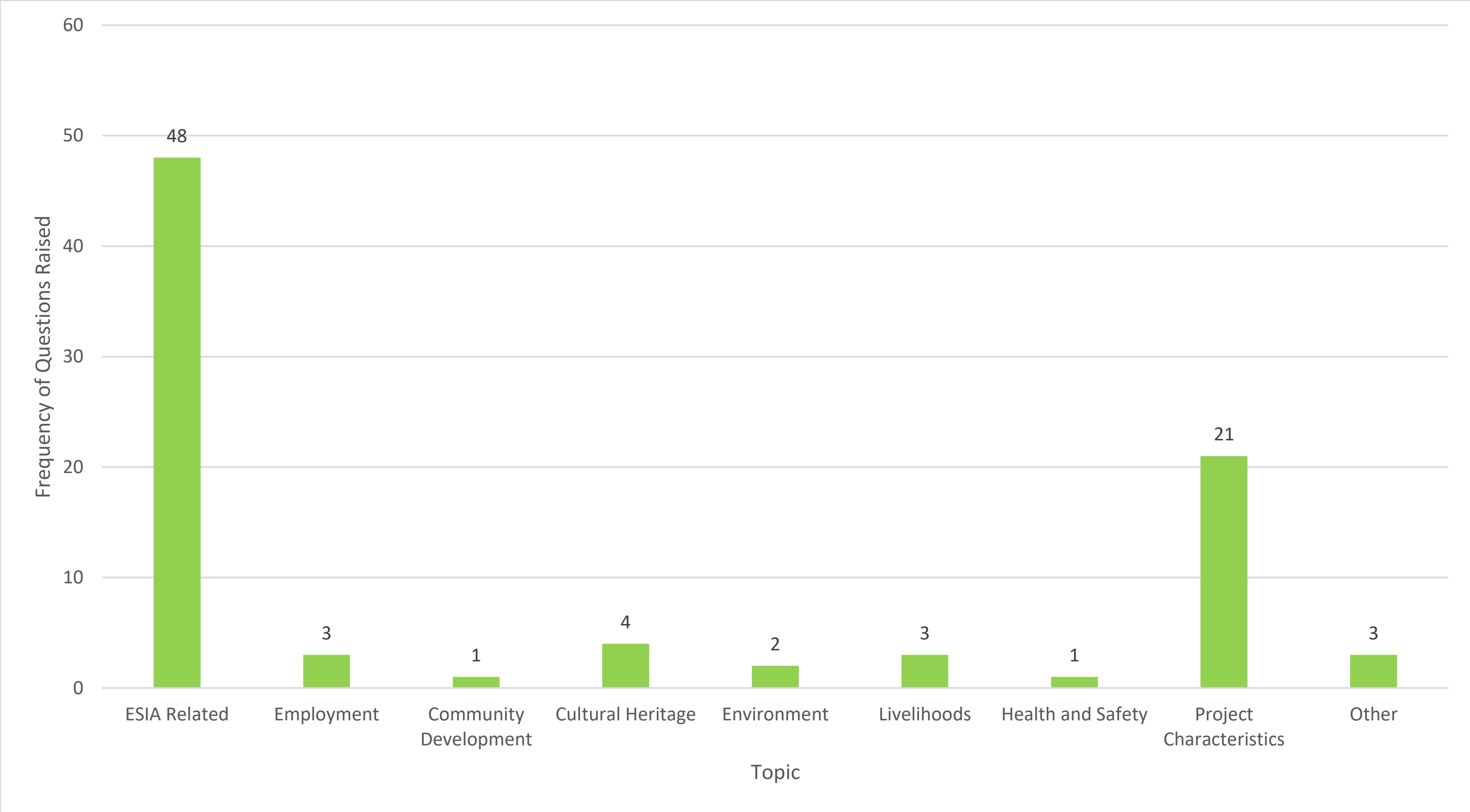

Figure 3.8: Frequency of questions raised during the disclosure public consultation meetings

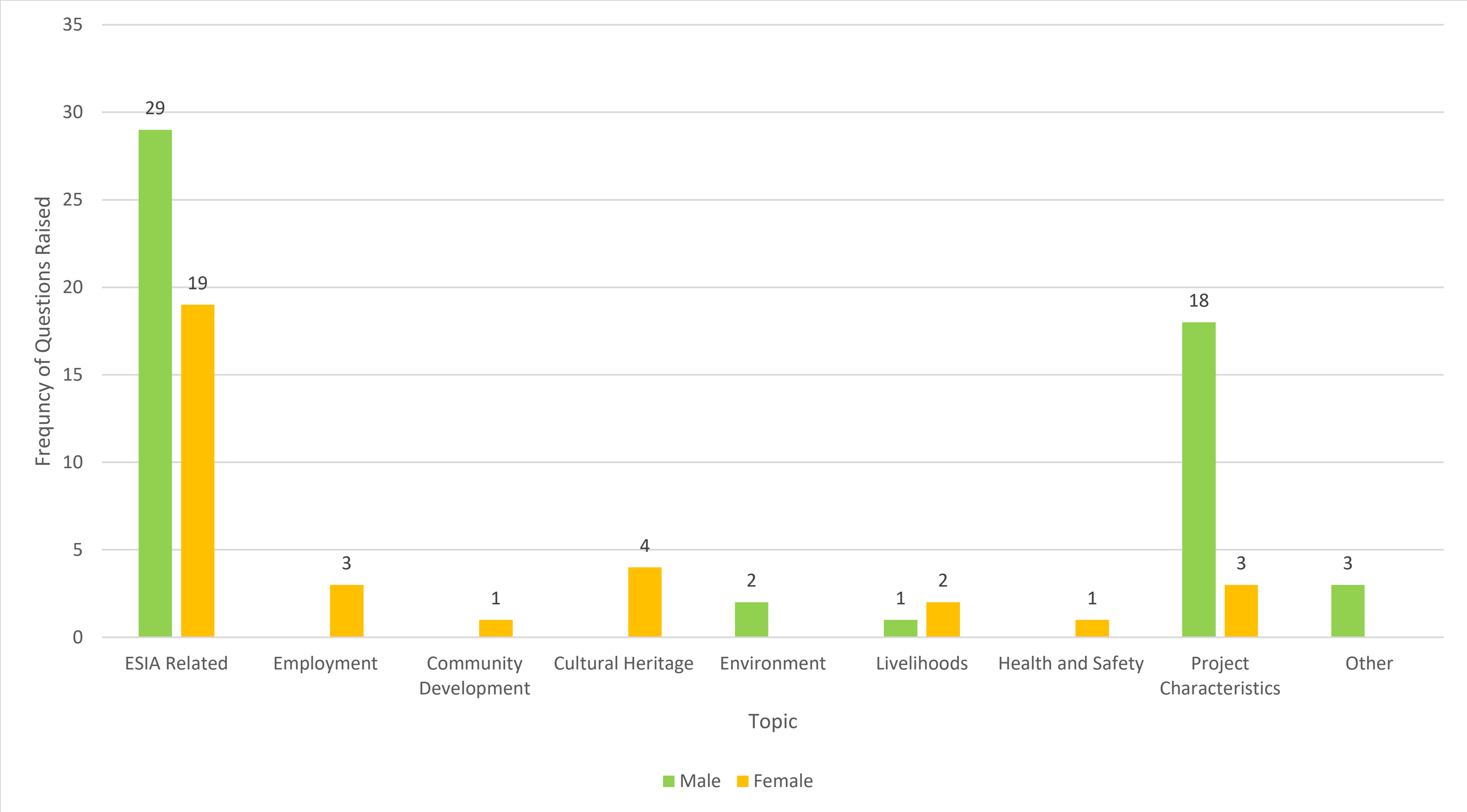

Figure 3.9: Frequency of questions raised by gender during disclosure public consultation meetings

3.8 Grievance management procedure

In line with TOTAL standards and international best practice, and to ensure any complaints and grievances that may arise due to the project's activities are resolved as quickly as possible to prevent escalation, a grievance management procedure has been developed by the company. This grievance mechanism ensures that stakeholders have an easy means of lodging grievances and are assured there will be a follow up.

The concept of the grievance mechanism was presented to stakeholders during the stakeholder engagement meetings and public consultation meetings. It was explained that grievances can be raised by stakeholders via written letters to TEP Liban, or emails sent to EP.TEPL-Info@total.com.

Grievances raised during the EIA process were logged in a database by a database manager (RSK) and communicated to TEP Liban to manage, as appropriate. Figure 3.10 shows the grievance mechanism steps. Grievances raised after the completion of the EIA study will be directly collected, registered and addressed by TEP Liban.

1	Receive	Ensure the procedure is accessible and clear for the complainant . Ensure confidentiality
2	Acknowledge	Should be tangible and committed to dead-line
3	Assess and Assign	Define scope and limits in order to conduct assessments
4	Investigate	Ensure to provide clarity on the process, establish and documents facts, ensure dialogue and that progress is communicated well
5	Propose	Clarify who proposes the solution, document and dialogue
6	Follow up and close out	Document outcomes and satisfaction levels

Figure 3.10: Grievance mechanism steps

A comprehensive version of the grievance mechanism can be found in Section 8.6.4.

3.9 Conclusion

The scoping and baseline stakeholder engagement process has been executed in line with the SEP and with Lebanese regulations and international best practice. Stakeholders were analysed and met, and their issues recorded and entered into the stakeholder engagement database.

During scoping and baseline stakeholder engagement, questions and comments about the EIA process and about project characteristics were prominent among all stakeholder categories. Stakeholder questions, concerns and comments were similar across the two phases and different stakeholder groups (national level, regional level and local level). However, there were some differences. Local level stakeholders identified issues around social topics such as employment and livelihoods whereas national and regional level stakeholders raised more questions and concerns relating to environmental topics.

The stakeholder issues and comments to date are addressed in the EIA.

The report-back phase of stakeholder engagement on the EIA began in early September 2019. The aim of the engagement is to ensure that stakeholders are informed about and comprehend the outcome of the EIA, particularly the identified impacts and mitigation measures. This phase allows for stakeholders to provide comments and queries either via online feedback tools or during public consultation meetings, with those comments and concerns to be addressed in this final EIA report.

Stakeholder engagement will continue after EIA submission. A drilling operations stakeholder management plan (DOSMP) has been developed, describing the management approach for the implementation of stakeholder engagement commitments identified during the environmental impact assessment stage (see Section 8.6.3). The DOSMP will ensure that COMPANY stakeholder engagement activities comply with Lebanese regulations, TEP Liban corporate standards and good international practice on stakeholder engagement during the operational phase of the project.

The project will be implemented by authorised contractors who will submit to TEP Liban their engagement plans to ensure project commitments on stakeholder engagement are met. TEP Liban will have overall ownership of the stakeholder engagement process and will ensure that certain project stakeholder groups continue to be engaged. These may include but are not limited to the

- LPA
- MOE
- Port Authorities of Beirut
- fishermen's syndicate
- Ministry of Tourism.

A complete table of all stakeholders and their analysis can be found in Appendix 3.2.

The format of the engagement, regularity of meetings and the attendance will be agreed with each of the stakeholder groups based on the drilling operations stakeholder management plan and/or project needs.

The meetings will focus on updates on project activities and health and safety and provide opportunities for stakeholders to voice concerns, ask questions and queries.

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4 PROJECT DESCRIPTION

4.1 Introduction

TEP Liban intends to carry out exploration drilling activities in offshore Block 4, Lebanon.

Total's reservoir specialists have assessed seismic survey data (see Section 4.2) and identified a priority area within which the drilling will take place (see Figure 4.1).

Drilling of the first exploration well (B4-1) is scheduled for February 2020 in the eastern part of the Block 4 priority area. The primary objective of the drilling is to evaluate the presence of a hydrocarbon bearing reservoir, its quality and its fluid content. If the results of exploration well B4-1 are positive, a second exploration well, and potentially an appraisal well, may also be drilled within the priority area in Block 4.

The plans for B4-1 are well advanced and this chapter confirms the available details. However, the design of the possible second exploration well and appraisal well are not advanced as yet, and where design options for either well B4-1 or the possible second and third wells remain, they are explained.

To enable as full an assessment as possible of a three-well programme, discharge estimates for the possible future wells have been assumed to be the same as those for B4-1. Notes are provided throughout this chapter to indicate where the selection of different options could result in substantial change to the discharge estimates, and in these cases the range of potential discharges are provided.

Providing information on the range of possible discharges enables the full envelope of options to be assessed (see Chapter 6) meaning that whichever options are finally selected for any future wells, the significance of all potential impacts will be covered by this EIA.

Well B4-1 will be about 11 nm (20 km) from the shore in water depths of 1520 m.

Coordinates for the Block 4 priority area[1] and well B4-1 are provided in Appendix 4.1.

4.2 Previous related activities

In the last two decades, the Lebanese government has commissioned 2D and 3D seismic surveys within Lebanese offshore waters. As part of this work, Geo-Services (PGS) conducted two 2D seismic surveys (2008 to 2011; covering about 8800 km²) complimented by six 3D seismic surveys (2006 to 2013, covering about 9700 km²) (Lebanese Petroleum Association).

Under the exploration and production agreement, TEP Liban has analysed this data to identify possible hydrocarbon-containing formations. Expectations from the seismic data analysis are that the discovery, if any, is likely to be gas with condensate. In order to confirm the presence of hydrocarbons in the formations, offshore exploration drilling is necessary, hence the proposed drilling campaign.

[1] Water depths in the priority area range from 1450 to 1760 m.

Drilling in Block 4 will be the first offshore exploration drilling activity in Lebanon.

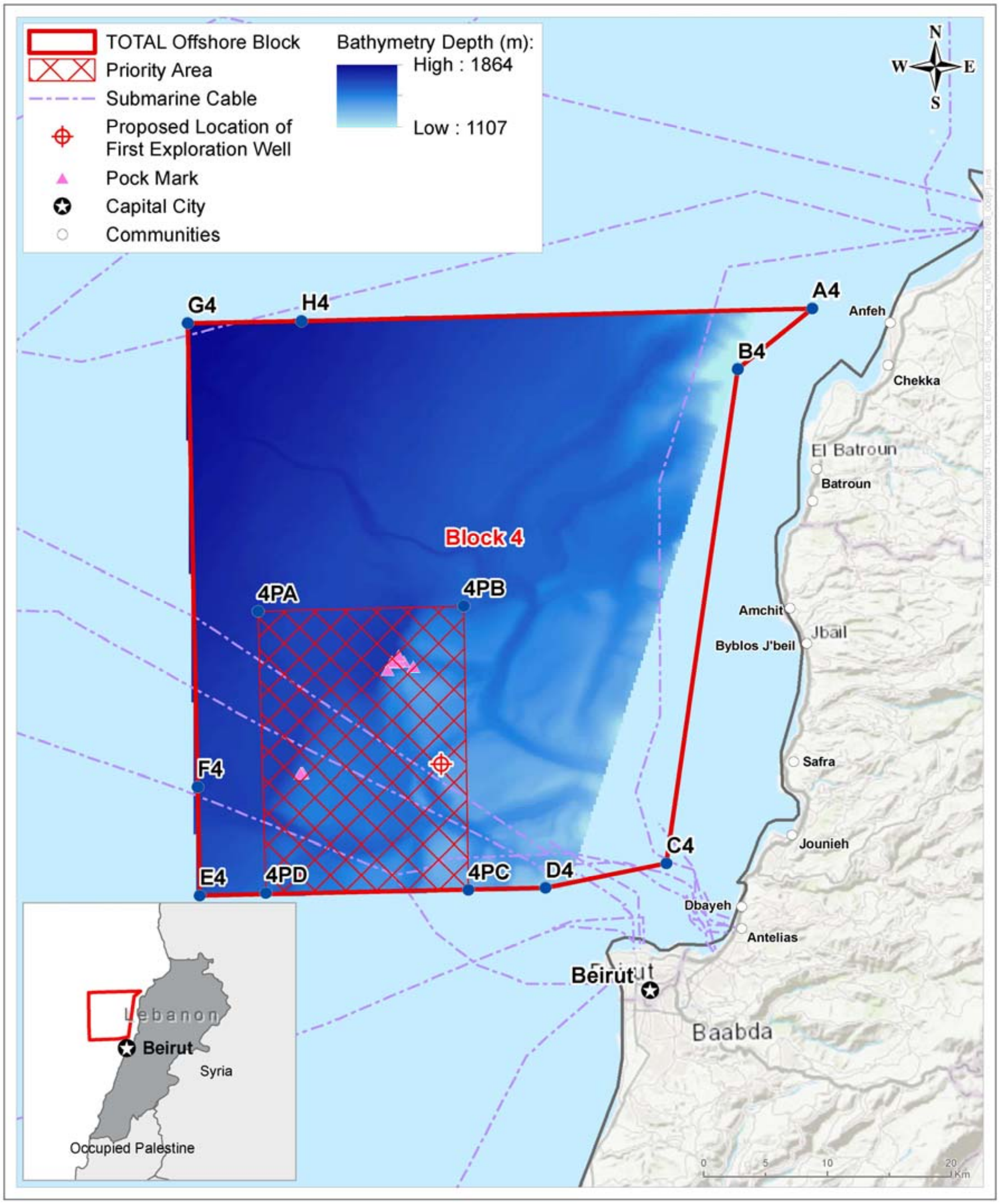


Figure 4.1: Location of Block 4, the priority area, and first exploration well (B4-1)
Source: TEP Liban

4.3 Mobile offshore drilling unit

TEP Liban proposes to use a dynamically positioned drillship (the Tungsten Explorer) to carry out the drilling of the first well in Block 4 (well B4-1). For any further exploration or appraisal wells, a drillship or a semi-submersible drilling unit could be used to undertake the works (see Figure 4.2).

A drillship or semi-submersible typically has a crew of around 180 people. Drillships and semi-submersibles are both referred to as a mobile offshore drilling units (MODU) throughout this EIA.

Specifications for the Tungsten Explorer, an ultra-deep water sixth-generation drillship, are included in Table 4.1.

Table 4.1: Tungsten Explorer drillship specifications

Drillship specifications	
Type	Ultra-deep water sixth-generation drillship
Dimensions	Approx. 238 m long and 42 m wide
Dynamic positioning	DPS 33
Year built	2013
Flag	Bahamas
Water depth rating	Design: 3,658 m Outfitted: 3,048 m
Drilling depth rating	12,190 m
Operating draft	39 ft
Tonnage	68,486 GT
Persons on board (POB)	Max. 200 with ventilated living quarters (positive pressure) equipped with fire and gas detection system
Variable deck load	25,000 t
Mud system	4 × mud pumps 8 x dual deck shale shakers
Blowout preventer (BOP) equipment	1 × BOP rated to 15,000-psi
Fuel storage capacity	9,400 m^3
Mud storage capacity	>1600 m^3
Base oil storage capacity	500 m^3
Brine storage capacity	500 m^3
Drill water storage capacity	>2000 m^3
Bulk storage capacity	Cement 4 × 3000 cubic feet Barite/bentonite 4 × 3000 cubic feet
Power generation	Main engines 6 × STX-MAN 14V32/40 diesel engines 7000 kW @ 720 rpm c/w HHI 8437 kVA AC alternators

Drillship specifications	
	Emergency engines 1 × STX-MAN B&W diesel engine c/w HHI 2625 kvA AC alternator
Sewage treatment units	1 × DVZ-SKA-150 Biomaster (max. hydraulic load 27,250 1 × unit – total sewage flow 1200 L/day 2 Vaccumarator (2 × 25 MBA)

Figure 4.2: Example drillship (left – Tungsten Explorer) and semi-submersible drilling unit (right)

Source: MarineTraffic.com (2019); Business Korea (2019)

4.3.1 MODU mobilisation, installation and demobilisation

4.3.1.1 Mobilisation

TEP Liban proposes to use a dynamically positioned drillship to carry out the drilling of the first well in Block 4 (well B4-1). It will be mobilised from its previous work location and will transfer directly to the B4-1 well site. The drillship will move into position using its own power.

If a semi-submersible rig is selected for any future exploration / appraisal wells in Block 4, it may be towed into position using tugboats or move to the drilling position using its own propulsion system.

Installation

No anchoring impacts are anticipated from the use of a drillship for well B4-1 (as would be the case if a drillship is used for any future well). The ship's position at the well site will be maintained using dynamic positioning thrusters. Dynamic positioning systems employ computer-controlled motor-driven thrusters (propellers) to adjust for the action of winds and waves. They respond automatically to satellite GPS signals coordinated with acoustic beacons placed on the sea floor.

If a semi-submersible rig is selected for any future exploration / appraisal wells in Block 4, anchoring may be required at the well site. Any anchor chain arrangement (generally 8–12 opposing anchors) will be dependent on the strength of prevailing tides and currents. When all the anchors have been deployed in their correct position, the rig will be ballasted down and the anchors firmly bedded using cable tensioning. Some semi-submersibles employ dynamic positioning systems to replace or supplement the mooring system.

4.3.1.2 Implementation

A 500-m safety zone[2] will be in place around the MODU during the drilling programme. The purpose of this zone is to protect the safety of people working on or in the immediate vicinity of the MODU and the facility itself against damage. Safety zones also protect fishermen and other mariners by reducing the risk of collision with the temporary installation and preventing loss of gear that can become snagged on underwater equipment. A support vessel will be present near the MODU to ensure the safety zone is respected.

4.3.1.3 Demobilisation

At the end of the B4-1 drilling programme (and for any future wells), the MODU will be prepared for demobilisation. For well B4-1, the drillship will leave the well site under its own power, as would be the case if a drillship is used for any future well. If a semi-submersible is used for any future well, the anchors (if used) will be lifted and the rig towed from the drill site or moved using its own propulsion system.

4.4 Drilling

4.4.1 Overview of drilling process

This section provides a general overview of the offshore drilling process. Specific information regarding the B4-1 exploration well is provided in Section 4.4.2.

The first step in the drilling process is to 'spud'[3] the well using a large-diameter conductor[4]. This large-diameter conductor is either set in place by jetting or drilling the sea floor formation. Drilling then continues from the bottom of the conductor going deeper through the sea floor. Drilling typically proceeds by applying weight on a drill string made up of drill pipe and a bottom hole assembly that includes the drill bit, drill collars, heavy-weight drill pipe, jarring devices and down-hole measuring equipment. Normally, the MODU's top drive or rotary table rotate the drill string to turn the drill bit at its lower end. The drill bit has a larger diameter than the drill string, so that an annular space is formed around the drill pipe as drilling progresses. The drill bit cuts into the rock formation and detaches cuttings. Drilling fluid is pumped down inside the drill string, through nozzles in the drill bit, and flushes the cuttings up through the annular space between the drill string and the borehole wall until they are removed from the well.

Wells are drilled in sections: the upper-hole sections are typically drilled without a riser and the drilling fluids and cuttings are ejected from the well at the seabed. For the lower-hole sections, a marine riser/BOP assembly is installed connecting the well back to the rig (see Figure 4.3). The advantages of this are that

- the drilling fluids can be circulated back to the rig, cleaned and reused

[2] The United Nations Convention on the Law of the Sea (UNCLOS) 1982 requires all ships to respect safety zones around offshore installations.

[3] Spudding is the term used in the drilling industry to describe the start of the well drilling process by removing rock and other seabed material with the drill bit.

[4] The conductor is a large-diameter pipe that is set into the ground to provide the initial stable structural foundation for a borehole or well.

- a closed circuit of drilling fluid and cuttings makes it easier for well engineers to assess the composition of the formation drilled
- additional additives can be added to the drilling fluid to increase its weight and counteract the risk of a well kick[5] or blowout
- if needed, in a blowout situation, the BOP can shear the drill pipe and seal in the well by a succession of hydraulic rams.

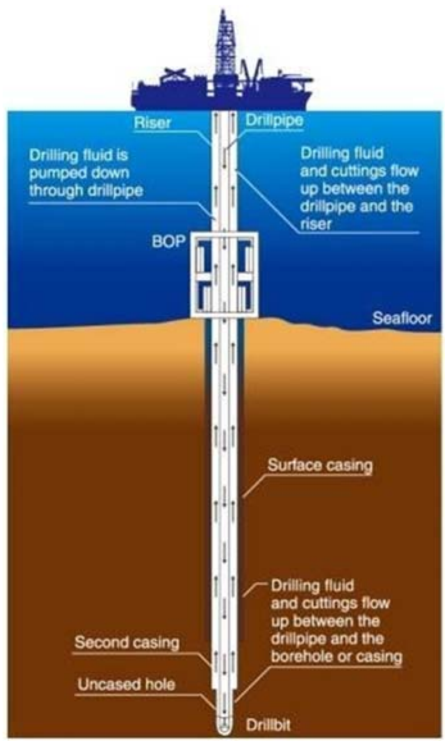


Figure 4.3: Schematic of drilling process

Source: Total E&P

4.4.2 Well design

Well B4-1 will be a pseudo-vertical (slightly deviated) exploration well, with a terminal depth about 4400 m below sea level. The design of any subsequent wells will be dependent on the results from the first exploration well.

A 36-in. conductor casing will be run through the seabed sediments either in jetting or drilling mode, to establish the wellhead in firm rock to a depth of about 60 m below seabed level. The subsequent sections will then be drilled using drill bits of progressively smaller diameter. When each section has been drilled to its target depth, a steel casing will be lowered into the hole and cemented in place.

There will be five sections for the B4-1 exploration well. Figure 4.4 presents an approximate drilling and casing plan.

[5] A ‘kick’ is the entry of formation fluid into the wellbore during drilling operations. It occurs because the pressure exerted by the column of drilling fluid is not great enough to overcome the pressure exerted by the fluids in the formation drilled. The main objective of well control is to prevent a kick from occurring and if it happens, to prevent it from developing into a blowout.

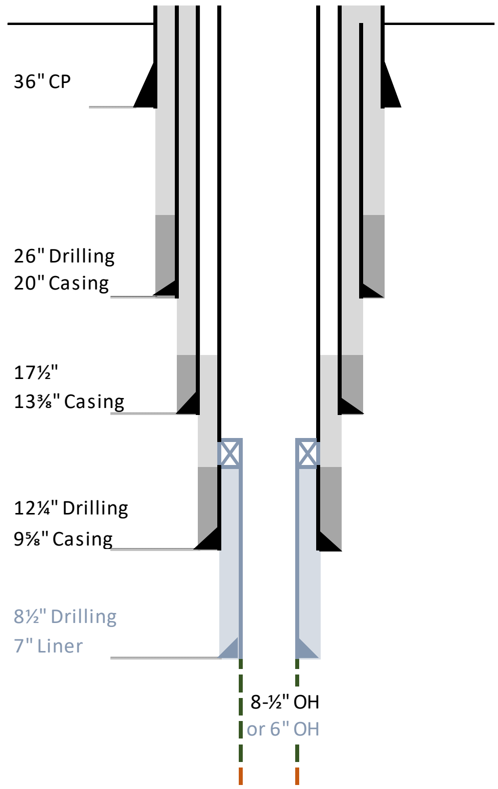


Figure 4.4: Preliminary drilling and casing plan, well B4-1

Source: TEP Liban

Note: The 8½-in. hole section may be drilled as a 6-in. hole; 8½-in. has been used in this EIA as a worst-case scenario.

4.4.3 Shallow hazards

Shallow hazards include subsurface hazards such as shallow gas, buried channels or abnormal pressure zones, along with seafloor hazards such as fault scarps or unstable slopes, and man-made hazards such as submarine cables or pipelines.

During the EBS survey, performed late March 2019, ROV observations showed a flat muddy bathyal seafloor. There was a high abundance and frequency of anthropogenic waste observed on the seafloor (various in size and nature) with an average of one piece of waste per 50 m of video transect.

The seafloor consisted of relatively homogeneous soft sediment, except within a pre-identified pockmark area (see Figure 5.60) where hard-relief outcrops 1-2 m high were observed. These features possibly originated from the chemical reaction / precipitation of seeping cold gases coming into contact with seawater at the sediment surface.

For Block 4, shallow gas is considered to be the main drilling hazard. This is defined as any gas pocket encountered above the setting depth of the containing envelope, i.e., blowout preventer on top of the well, during drilling operations.

Using the seabed features and slope results from the EBS, and seismic attributes that detect the presence of subsurface hazards, an assessment of the drill site was carried out to evaluate the geohazards for well B4-1. The study results are presented below:

- bathymetry/slope - 1515 m MSL / 4º to the north-west
- seabed features - wellhead location selected as far as possible from steep seabed slopes. The seabed displays a smooth signature with no seabed drilling geohazards detected within a 100 m radius of the wellhead location. The wellhead is located on a seabed high, eastwards from a canyon / linear depression related to a salt deformation
- sub-surface - no shallow gas hazard (no abnormal pressure) detected along the studied trajectory. An interval of anhydrite detected above the top of salt is not considered a drilling hazard
- no pipelines or cables - risks were mapped based on the information communicated by relevant Lebanese authorities and then checked visually with an ROV during the EBS survey.

The geohazard assessment concluded that there were no geohazards in the interval covered for B4-1 that would affect the drilling programme.

4.4.4 Drilling fluids

The functions of drilling fluid are to

- control formation pressure and prevent well control issues
- transfer cuttings from the wellbore to the surface
- preserve wellbore stability
- minimise formation damage and seal permeable formations
- cool and lubricate the drill string
- provide information about the wellbore
- minimise risk to personnel, the environment, and drilling equipment (well barrier).

4.4.4.1 36-in. and 26-in. upper-hole sections (riserless)

The first two upper-hole sections of the Block 4 wells will be drilled using a seawater system. Seawater will be pumped down the drill string forcing the cuttings back up the borehole into the water column and onto the seabed. While drilling, the borehole will be cleaned out using high-viscosity sweeps[6]. Before cementing, the hole will be displaced to a pad mud[7] to keep the hole open. The cuttings and drill fluids (pad mud and sweeps) generated during this section will be discharged at the seabed.

4.4.4.2 Lower-hole sections (17½ in., 12¼ in. and 8½ in.)

The 26-in. surface casing will have been installed and the BOP and marine riser deployed for the drilling of these sections.

There are two options with respect to drilling fluid use in these lower-hole sections:

[6] A sweep is a relatively small volume of viscous fluid, typically a carrier gel that is circulated to sweep, or remove, debris or residual fluids from the circulation system.

[7] A pad mud is a 'pump and dump' drilling fluid that is specifically designed to be environmentally friendly for safe discharge during riserless drilling of large top-hole sections.

- Option 1: Use of a non-aqueous drilling fluid (NADF) to ensure compatibility with the geological formations encountered
- Option 2: Use of a high-performance water-based drilling fluid (HPWBDF).

Once the marine riser/BOP assembly is in place, the drilling fluid and cuttings from these sections will be returned to the rig and recovered using the onboard solids control equipment (shale shakers and centrifuges), thus maximising reuse of the drilling fluid (see Figure 4.5).

In the case of Option 1 (NADF), cuttings and associated drilling fluids from these lower-hole sections will not be discharged to the environment; they will be contained and shipped to shore for treatment and disposal (see Section 4.6.5.2).

In the case of Option 2 (HPWBDF), the cuttings will be discharged to sea from the MODU.

Option 1 has been selected for the first B4-1 exploration well as the geological formations downhole are currently not well known and NADF provides enhanced borehole stability. Any subsequent wells in Block 4 will utilise either Option 1 or 2 depending on the findings from the first well.

Table 4.2 summarises the drilling fluids proposed for the Block 4 drilling programme.

Table 4.2: Proposed Block 4 drilling fluids

Casing size	Hole size	Hole section length (m)	Drilling fluid system	
			Option 1 – selected for well B4-1 and option for possible future exploration / appraisal wells in Block 4	Option 2 - option for possible future exploration / appraisal wells in Block 4
36”	Jetting	72	Seawater	Seawater
20”	26”	683	Seawater, gel sweeps, and salt saturated pad mud	Seawater, gel sweeps, and salt saturated pad mud
13 5/8”	17 ½”	850	NADF	HPWBDF
9 5/8”	12 ¼”	285	NADF	HPWBDF
7”	8 ½”	1080	NADF	HPWBDF

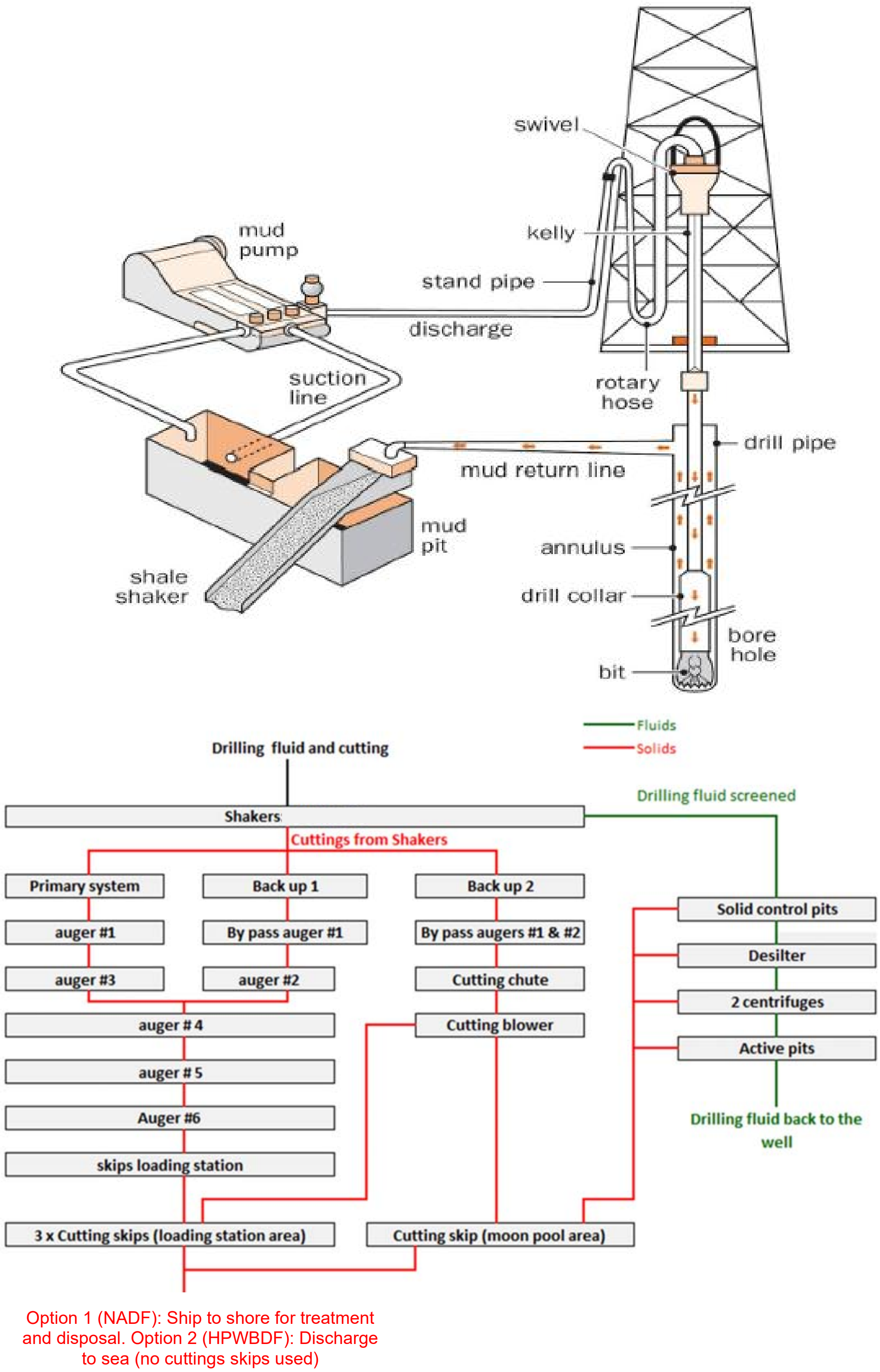


Figure 4.5: Non-aqueous drilling fluid circulation process and solids control onboard the MODU

Source: Total E&P

4.4.5 Drilling chemicals

Drilling fluids range from simple water or oil, to more complex water-based or oil-based systems. Drilling fluid additives include weighting materials; viscosifiers; filtration control additives; pH/alkalinity control chemicals; dispersants/deflocculants/thinners; surfactants and emulsifiers; shale inhibitors; corrosion inhibitors/hydrogen sulphide (H_2S) scavengers; lubricants; biocide and lost circulation materials.

All drilling chemicals proposed for the Block 4 wells have been selected in accordance with Total's General Specification document 'Environmental Requirements for Projects Design and E&P Activities' (GS EP ENV 001), which requires that chemicals are selected according to the following criteria: lowest toxicity, lowest bioaccumulation potential and highest biodegradation; and are selected in accordance with the pre-screening scheme based on the OSPAR methodology in force (see Section 2.10.2.3).

The 36-in hole section of all Block 4 wells will be drilled using seawater only. Approximate drilling fluid chemical usage for the 26-in. hole section of the Block 4 wells is presented in Table 4.3.

Approximate drilling fluid chemical usage for the 17½-in., 12¼-in. and 8½-in. hole sections for Option 1 (use of NADF) is presented in Table 4.4, and for Option 2 (use of HPWBDF) in Table 4.5. Block 4 contingency chemicals have been listed in Table 4.6.

As stated previously, Option 1 has been selected for the first B4-1 exploration well. Any subsequent wells in Block 4 will utilise either Option 1 or 2 depending on the findings from the first well.

Table 4.3: Approximate chemical composition of WBDF to be used for the 26-in. hole section of Block 4 wells

Product *	Function	HQ Band/ OCNS Group/ PLONOR **	Estimated consumption per drilling fluid type (t)			Estimated consump-tion for well B4-1 (t)	Estimated consump-tion for all three possible wells (t)
			Gel sweeps	Salt saturated PAD mud	Salt saturated KCl mud		
Barite	Weighting agent	E (PLONOR)			140	140	420
Bentonite	Viscosifier	E (PLONOR)	30			30	90
Caustic soda	pH and hardness treatment	E	1.5	0.8	1.5	3.8	11.4
MIL BIO SEA 98	Prevent bacterial degradatio n	Gold			0.7	0.7	2.1
NaCl	Shale inhibitor	E		500	150	650	1950
XAN-PLEX DSP	Viscosifier	Gold	1	1.5	1.5	4	12
MIL PAC / MIL STARCH	Fluid loss reducer	E			5.5	5.5	16.5
Soda ash	Alkalinity control	E		2	2	4	12
Sodium bicarbonat e	Fluid loss control	E			0.2	0.2	0.6
Guar gum	Viscosifier	E		2.4		2.4	7.2
Potassium chloride	Shale stabiliser	E			37	37	111

Notes:

* Name of product may vary depending on supplier.

**See Section 2.10.2.3 for explanation of chemical ranking.

Information on MSDS, chemical packaging and number of packages provided in TEP Liban's Chemical Management Plan.

Table 4.4: Approximate chemical composition of drilling fluid to be used for the lower-hole sections of Block 4 wells (17½-in., 12¼-in. and 8½-in. lower-hole sections): Option 1, NADF

Product *	Function	HQ Band/OCNS Group/PLONOR **	Estimated consumption for well B4-1 (t)	Estimated consumption for all three possible wells (t)
EDC 170 SE	Base oil	E	1300	3900
Barite	Weighting agent	E (PLONOR)	1000	3000
Calcium chloride	Shale inhibitor	E (PLONOR)	130	390
DELTA MOD	Viscosifier	Gold	2	6
DELTA GEL	Viscosifier	E	56	168
Ecco Block	Shale stabiliser	E	23	69
Ecco Mul E	Emulsifier	D	102	306
MAGMA GEL SE	Viscosifier	E	27	81
Lime	Alkalinity control	E	90	270

Notes:

* Name of product may vary depending on supplier.

**See Section 2.10.2.3 for explanation of chemical ranking.

Information on MSDS, chemical packaging and number of packages provided in TEP Liban's Chemical Management Plan.

EDC base fluid is a Group III non-aqueous drill fluid according to IPIECA's OGP classification with a much lower aromatic content than this category requires (Group III classification; <0.5% aromatic content and polycyclic aromatic hydrocarbons lower than 0.001%).

Option 1 (NADF use in lower-hole sections) has been selected for well B4-1 and is an option for possible future exploration / appraisal wells in Block 4.

Table 4.5: Approximate chemical composition of drilling fluid to be used for the lower-hole sections of Block 4 wells (17½-in., 12¼-in. and 8½-in. lower-hole sections): Option 2, HPWBDF

Product *	Function	HQ Band/ OCNS Group/ PLONOR **	Estimated use (t)			Estimated consumption per well (if Option 2 selected for any future wells)
			17½ in.	12¼ in.	8½ in.	
Barite	Weighting agent	E (PLONOR)	93	65	117	275
Caustic soda	Alkalinity control	E	2.7	1.9	3.4	8
Soda ash	Alkalinity control	E (PLONOR)	2.7	1.9	3.4	8
Starch Dextrid E (or equivalent)	Fluid loss control	E	19	13	23	55
Sodium chloride	Shale inhibitor	E (PLONOR)	280	196	350	826
Potassium chloride	Shale inhibitor	E (PLONOR)	56	39	70	165
Cellulosic polymer PAC-L (or equivalent)	Fluid loss control	E (PLONOR)	4.7	3.3	5.9	13.9
BARAZAN D (or equivalent)	Viscosifier	Gold	6.4	4.5	8.1	19
BORE-HIB (or equivalent)	Shale stabiliser	D	2.3	1.7	3	7
CLAY GRABBER (or equivalent)	Shale stabiliser	Gold	0.82	0.58	1.05	2.5
CLAY SYNC II (or equivalent)	Shale stabiliser	Gold	4.7	3.3	5.9	13.9
BARACARB 5 (or equivalent)	Lost circulation material	E (PLONOR)	14	10	17	41
BARACARB 50 (or equivalent)	Lost circulation material	E (PLONOR)	14	10	17	41
Starcide (or equivalent)	Biocide	Gold	1.0	0.7	1.3	3
RADIAGREENE ME Salt (or equivalent)	Ester base lubricant for WBDF	Gold		21		21

Notes:

* Name of product may vary depending on supplier. **See Section 2.10.2.3 for explanation of chemical ranking.

Information on MSDS, chemical packaging and number of packages provided in TEP Liban's Chemical Management Plan.

Option 2 (HPWBDF use in lower-hole sections) is an option for possible future exploration / appraisal wells in Block 4.

Table 4.6: Information on drilling fluid contingency chemicals for Block 4 wells

Product *	Function	HQ Band/OCNS Group/PLONOR **	Initially mobilised stock (t)	Notes
KWIK-SEAL F/M/C	Loss circulation material	E	0	Mobilised only if needed
LC LUBE PLUS	Bridging material	E	9.1	
CHECKLOSS Plus	Bridging material	E	6.3	
MIL SPOT II	Stuck pipe spot	A	3.1	Used only if equipment is stuck in the well.
Mil Carb 150	Bridging material	E	80	
Mil Carb 50	Bridging material	E	80	
Walnut plug or Mil plug	Loss circulation material	E	15	
MD	Reduce bit balling	Gold	3.3	
MICA F/M/C	Loss circulation material	E	0	Mobilised only if needed
Seal or Mil seal	Loss circulation material	E	15	
Citric acid	Alkalinity control	E	2	
WO DEFOAM	Foam prevention	Gold	1.7	
Super sweep	Fibre sweep	Gold	0.1	Used only for pills to improve hole cleaning. Recovered and mixed with cuttings.
PERMALOSE HT	Fluid loss reducer	B	10	
DELTA LIFT	Viscosifier	B	18	
Milgard XPR	H_2S scavenger	Gold / silver	3.3	In case of H_2S it will be mixed in waste tank to protect health of rig personnel.

Notes:

* Name of product may vary depending on supplier.

**See Section 2.10.2.3 for explanation of chemical ranking.

Information on MSDS, chemical packaging and number of packages provided in TEP Liban's Chemical Management Plan.

4.4.6 Cementing

Cementing involves mixing a slurry of cement, cement additives and water and pumping it down into the casing and up the annulus (void) formed between the casing and the well bore. The cement sheath anchors and supports the casing string and protects the steel casing from corrosion by formation fluids. It also provides a hydraulic seal that prevents fluid communication between producing zones in the borehole and blocks escape of fluids to the surface.

4.4.6.1 Cementing chemicals

Class G cement will be used for the Block 4 wells along with several chemical constituents such as cement setting retarders and accelerators, surfactants, stabilisers and defoamers. The type and amount of chemicals used may vary depending on subsurface conditions encountered during the drilling programme. Table 4.7 presents the estimated chemical use based on current understanding of conditions. Table 4.8 provides information on contingency chemicals.

Table 4.7: Approximate chemical composition of cement for Block 4 wells

Product *	Function	HQ Band/OCNS Group/PLONOR **	Consumption (t)		Consumption for well B4-1 (t)	Estimated consumption for all three possible wells (t)
			Cement for WBDF sections	Cement for NADF sections		
D907	Cement powder	E (PLONOR)	400	280	680	2040
Sodium chloride	Salt	E (PLONOR)	25	7	32	96
D256	Fluid loss control	Silver	45	8	53	159
D206	Antifoaming agent	Gold	1.8	0.5	2.3	7
D155	Extender	E	119	24	143	429
D230	LT dispersant	Gold	6	1.6	7.6	23
D275	Additive	Gold	0.2	-	0.2	0.6
D075	Silicate additive	E (PLONOR)	-	7.5	7.5	23
D081	Retarder	Gold	-	0.5	0.5	1.5
D110	Retarder	Gold	-	0.7	0.7	2
D500	Gas migration control additive	Gold	-	7.5	7.5	22.5
D077	Accelerator	E (PLONOR)	-	8.3	8.3	25
Barite	Weighting agent	E (PLONOR)	-	30	30	90

Product *	Function	HQ Band/OCNS Group/PLONOR **	Consumption (t)		Consump-tion for well B4-1 (t)	Estimated consump-tion for all three possible wells (t)
			Cement for WBDF sections	Cement for NADF sections		
U066	Solvent	Gold	-	12	12	36
F103	Surfactant	Gold	-	12	12	36
D182	Additive	Gold	-	3.5	3.5	10.5

Notes:

* Name of product may vary depending on supplier.

** See Section 2.10.2.3 for explanation of chemical ranking.

Information on MSDS, chemical packaging and number of packages provided in TEP Liban's Chemical Management Plan.

Table 4.8: Information on cementing contingency chemicals for Block 4 wells

Product*	Function	HQ Band/OCNS Group/PLONOR **	Initially mobilised stock (t)	Notes
D801	Retarder	E (PLONOR)	1.5	
D095	Additive	E	0.9	
D600G	Gas migration control additive	Gold	8.2	
D111	Lost circulation additive	C	5	Used only if heavy losses are faced (well integrity)

Notes:

* Name of product may vary depending on supplier.

** See Section 2.10.2.3 for explanation of chemical ranking.

Information on MSDS, chemical packaging and number of packages provided in TEP Liban's Chemical Management Plan.

4.4.7 Well logging

Well logging will be carried out to make a detailed evaluation (a well log) of the geological formations penetrated by the well bore. Wireline logging will be performed by lowering a logging tool (or a string of one or more instruments) on the end of a wireline into the well bore and recording petrophysical properties using a variety of sensors. In addition, logging while drilling (LWD) will be conducted with logging tools incorporated into the drill string. LWD measurements provide drilling engineers with critical real-time well information.

Wireline logging and LWD will involve the use of sealed radioactive sources[8]. Table 4.9 presents the sealed radioactive sources that will be used during logging of the Block 4 wells. It is anticipated that the same sources would be used for any future wells.

Table 4.9: Well logging radioactive sources

Sealed radioactive sources
Compensated spectral natural gamma ray. Activity: 0.0005 Curie, 0.0000185 GBq Dual-spaced neutron tool. Activity: 15 Curie, 555 GBq Spectral density logging tool. Activity: 1.78 Curie, 65.86 GBq Thorium blanket (for calibration at surface). Activity: 0.0000017 Curie, GBq 0.0000629

4.4.8 Well test

It should be noted that a well test will not be undertaken for either of the Block 4 exploration wells, as it is anticipated that well logging will provide sufficient reservoir data. If an appraisal well is drilled in Block 4, well testing (drill stem test) will be an option.

Drill stem testing involves deploying a series of tools known as a test bottom hole assembly (BHA). A basic drill-stem-test BHA consists of a packer or packers, which act as an expanding plug to be used to isolate sections of the well for the testing process, valves that may be opened or closed from the surface during the test, and recorders used to document pressure during the test.

During the well test, the zone to be tested is perforated and the formation fluids are allowed to flow up the string to the processing equipment on the rig. Pressure-recording tools in the BHA record the bottom hole pressure and temperature while the well is flowing and when it is shut in. This data provides information on the likely production performance of the reservoir.

Once on the rig, the gas and hydrocarbon fluids are generally separated, analysed and flared off through the rig flare boom. Estimated well testing emissions for a potential future appraisal well in Block 4 are provided in Table 4.11, Table 4.12 and Table 4.17.

4.4.9 Vertical seismic profile

During drilling of the Block 4 exploration wells, or subsequent appraisal well, there will be an option to carry out vertical seismic profile (VSP) activities.

VSP refers to measurements made using geophones inside the wellbore and a source, usually an airgun array, at the surface near the well. This methodology obtains images of higher resolution than a surface-towed seismic survey.

At this stage, it is proposed that an airgun array of four guns (1000 cubic inches) would be deployed from the MODU crane and activated 5 m below the sea surface. The resulting sound waves will be recorded using receivers stationed at various depths within the well bore, see Figure 4.6. It is estimated that 8–12 hours of VSP operations (2–3 hours of seismic shooting time, about 200 shots) may be required for each well.

[8] Used to measure the formation properties by the interaction of reservoir molecules with radiation emitted by the logging tool.

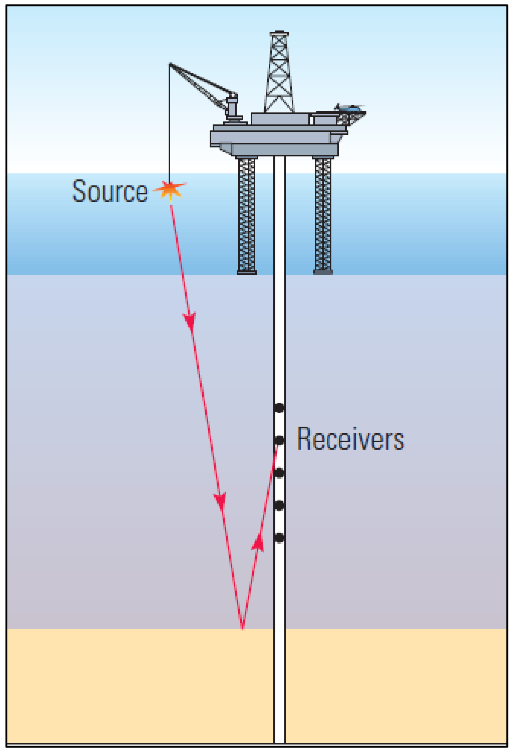


Figure 4.6: VSP schematic

Source: Blackburn et al. (2007)

4.4.10 Abandonment

All wells will be plugged permanently and abandoned following standard procedures.

Typical abandonment activities include displacing the well with inhibited fluids (to prevent tubular metal corrosion) and isolating all the zones of interest (formations containing fluids) from the surface.

Cement plugs will be used to isolate the wells. The plugs will be designed to withstand the conditions generated by the geological formations. All cement plugs will be pressure/ weight tested.

In each case, the drill string will be retrieved to the drilling rig and reused on future drilling projects. The subsea wellhead will be left in place on the seabed in line with TOTAL corporate standards, which state that wellheads in water depths more than 500 m will not be recovered. A comparative risk assessment to support this decision has been performed by TEP Liban. It assessed the impact of leaving the wellhead in place on the seabed and established that the impact was low due to the following:

- lack of fisheries in the area. Fishing is not permitted between 6 and 12 nm from the shoreline for security reasons (B4-1 well site is 11 nm from shoreline) and seabed trawling is not anticipated at such depths
- currently no foreseen cable laying or pipe deployment in the wellhead area
- wellhead will only have a height of 3 m, a radius of a few metres and be detectable by sonar
- wellhead location will be mapped and communicated to local authorities.

The challenges inherent to wellhead removal operations in deep water place a significant amount of risk on wellhead removal operations (with an associated risk of failure) that could in turn create more damage to the environment than the presence of the wellhead itself. The risk assessment concluded that the environmental and societal risk of leaving the wellhead in place is lower than that of removing it.

It should be noted that the actual wellhead will have no impact on the well integrity once the well is plugged for abandonment, whether left in place or removed. Integrity will be guaranteed by plugging the well with two independent barriers (cement plugs), irrespective of the wellhead status.

4.4.11 Lifting and loading

Lifting and loading operations will be carried out at the MODU in order to transfer materials onto the MODU from the supply vessels.

Cranes will carry out the lifting operations and all cranes and lifting equipment will be certified and have a preventative maintenance system in place. Crane operators will also be certified. Heavy loads will be transferred in a safe handling zone.

4.4.12 Upset conditions

Potential upset conditions on the MODU are described in the accidental impact assessment section of the ESIA, see Section 6.5.

4.5 Shore-based operations and transfers

4.5.1 Logistics base

A logistics base for the Block 4 exploration drilling campaign will be established within the Port of Beirut.

Main activities at the logistics base will be

- reception of drilling and wells equipment and products
- storage of drilling and wells equipment
- storage of chemicals and hydrocarbons
- lifting and handling operations
- loading and back loading of supply boats
- chemicals storage, drilling fluids mixing and transfer of logging equipment (sealed radioactive sources).

Facilities at the logistics base will include

- a pipe yard (outdoor storage up to 7000 m^2)
- warehousing (indoor storage minimum of 300 m^2, 100 m^2 for chemical storage/ dangerous goods and 6 m^2 for cold room)
- a 100-m linear jetty with 1000 m^2 for laydown area and mobile cranes for vessels operations
- a drilling-fluids mixing plant and bulk facilities (1250 m^2)
- areas for offices (100 m^2), canteen, vehicles, marshalling areas, cargo containers, waste transfer and temporary storage (no waste treatment).

The location of the logistics base, within the existing commercial Port of Beirut (Quay 3), is shown in Figure 4.7. The area surrounding the logistics base is used for car storage with no known flammable sources, hazardous chemical storage, etc.

Port authority approval for the logistics base is included in Appendix 4.2.

The logistics base will be built and operated by a contractor. It should be noted that no heavy construction is involved as an existing covered storage area and warehouse will be used. The rest of the logistics base is an open surface that will be fenced in order to store pipes and some containers of equipment. There will also be some offices in prefabricated containers.

4.5.2 Drilling fluids mixing plant and bulk facilities

This plant is designed to provide the offshore MODU with drilling fluids (drilling fluids mixing plant) and cementing materials (cement bulk storage facilities).

The facility will be operated by two contractors – the drilling fluids mixing plant by the drilling fluids contractor and the cement bulk plant by the cementing contractor.

The drilling fluids mixing plant will include the following equipment:

- premixing tanks
- premixing and transfer pumps – centrifugal pumps used for premixing and transferring fluids
- fluid mix hopper – allows additives to be added to the fluids
- agitators – high-efficiency fluid mixing units
- fluid storage tanks – used for the storage of fluids produced or returned from the offshore MODU
- centrifuge – used to remove barite from heavy drilling fluids
- piping and flexible transfer lines – allows plant to conduct loading/unloading of fluids from vessels and barite/bentonite loading/offloading.

The bulk facilities will include the following equipment:

- bulk storage silos – used for the storage of bulk products such as cement
- air compressor – low-pressure, high-volume compressors used to operate the pneumatic bulk systems associated with the bulk plant
- dust control – dust generated by the receipt and transfer of dry bulk materials will be controlled
- cutting bottle – used to cut and bulk big bags of cement or other materials.

Figure 4.8 shows the layout of the drilling fluids mixing plant and bulk facilities, while Figure 4.9 presents a photographic example of such a facility.

The total storage capacity of the drilling fluids mixing plant is 6500 bbls.

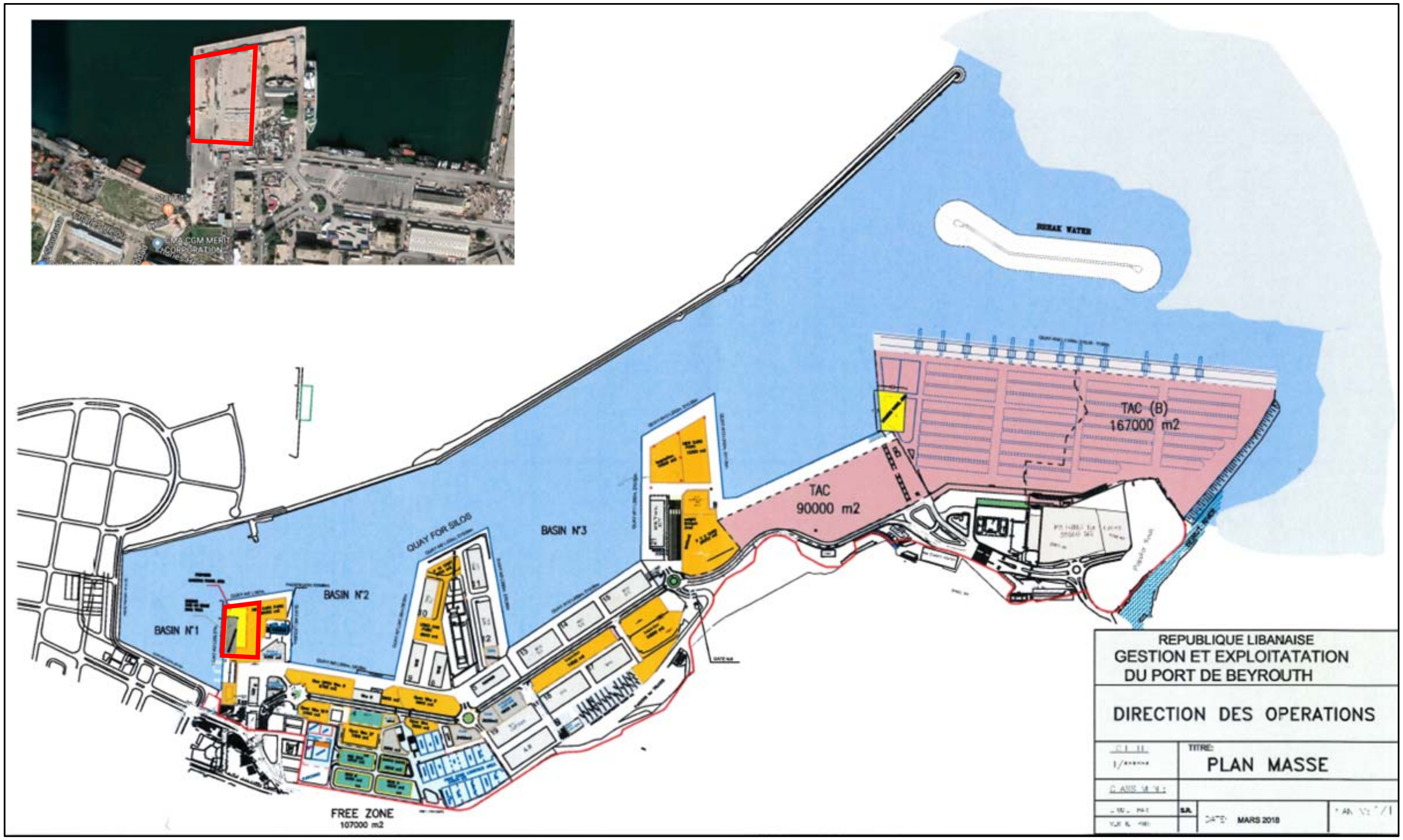
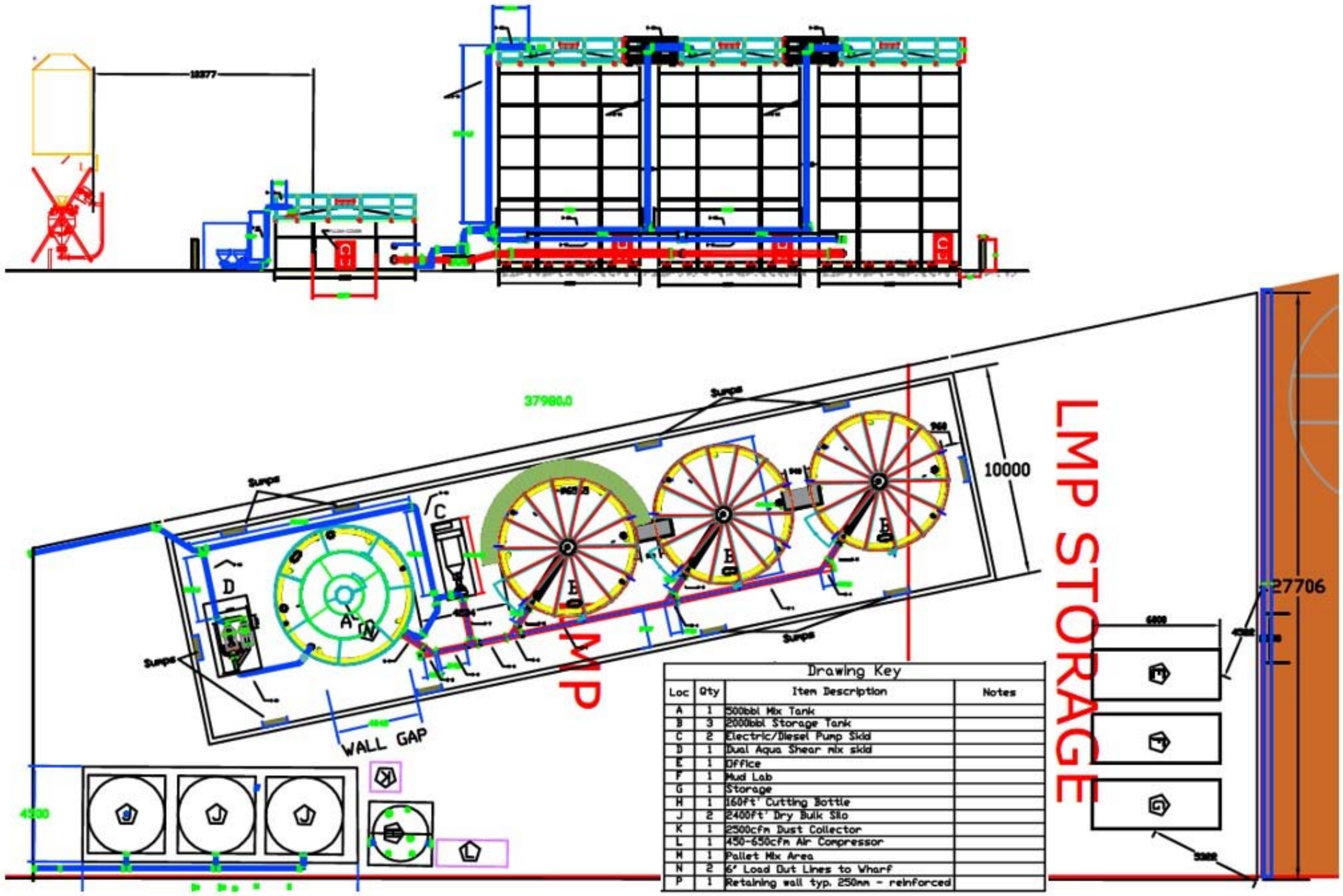


Figure 4.7: Proposed location of the logistics base in Port of Beirut (red rectangle)



Loc	Qty	Item Description	Notes
A	1	500bbl Mix Tank	
B	3	2000bbl Storage Tank	
C	2	Electric/Diesel Pump Skid	
D	1	Dual Aqua Shear mix skid	
E	1	Office	
F	1	Mud Lab	
G	1	Storage	
H	1	160ft^3 Cutting Bottle	
J	2	2400ft^3 Dry Bulk Silo	
K	1	2500cfm Dust Collector	
L	1	450-650cfm Air Compressor	
M	1	Pallet Mix Area	
N	2	6' Load Out Lines to Wharf	
P	1	Retaining wall typ. 250mm - reinforced	

Figure 4.8: Schematic of the drilling fluids mixing plant and bulk facilities

Figure 4.9: Photographic example of a drilling fluids mixing plant

Source: Total E&P

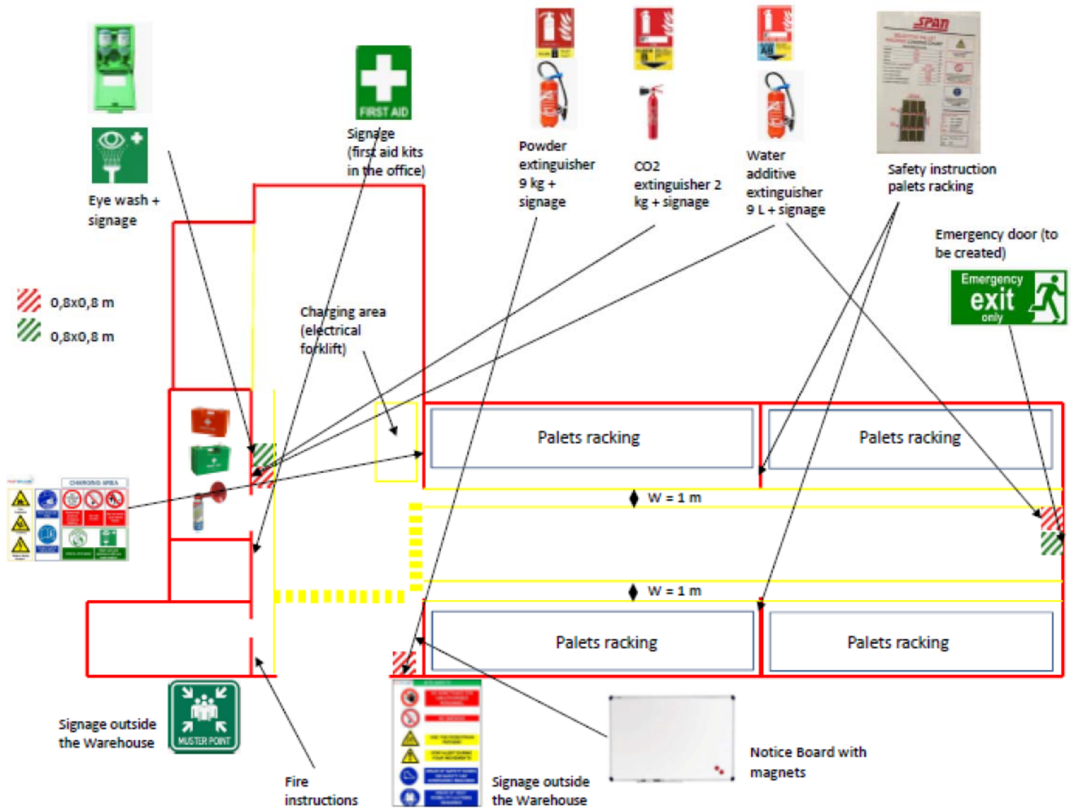
4.5.3 Use and storage of chemicals

The logistics base contractor will operate a dedicated hazardous materials storage area within the existing logistics base warehouse (see Figure 4.10) that is cool, well ventilated and free of any ignition source. Retention / drip trays will be provided that are 110% of the volume of the stored chemical, or 25% of the largest volume in case of multiple containers. Spill kits that are suitable for the materials being stored will be in place, along with extinguishers, sand, emergency response procedures and hazard signage. Security procedures will be enforced, and personnel permitted to handle hazardous materials will have undergone appropriate training and will respect suppliers' instructions (Material Safety Data Sheets (MSDS)) and compatibilities / incompatibilities between materials.

It should be noted that project drilling fluid and cementing chemicals will be stored off site at the service contractor's warehouses (Aramex and Key Freight warehouses) in Beirut Port. Management of these facilities will be in line with the service contractor's chemical and waste management plans. The drilling fluids mixing plant will have a small area dedicated to the temporary storage of chemicals to keep a small stock for mixing needs. Chemicals will be transferred from the warehouses to the logistics base by supply vessel.

All powder and fluid transfers to the supply vessels from the mixing plant will be by dedicated transfer hoses and centrifugal pumps. Chemical products that are required at the MODU (and have not been pre-mixed onshore) will be packed into mini containers, or open cargo carrying unit baskets, that are DNV certified and appropriately colour coded for safe transfer from jetty to supply vessel and supply vessel to MODU.

All chemical transfers will be accompanied by MSDS and hazardous labels.



Maximum height of stored products: 5 m for liquids; 8 m for solids

Storage in cells of 5,000 m^2, in small areas 600 m^2, separated by 1.5 m each except for flammable products where firefighting and prevention standards are applicable.

Figure 4.10: Schematic of dangerous good storage at the logistics base warehouse

Source: Fast Bollore, 2019

4.5.4 Waste storage and transfer

The quantity and duration of waste storage at the logistics base will be kept to a minimum. It should be noted that the logistics base is not designed for permanent waste storage and will only have a temporary 'in-transit' waste storage area.

Information on the waste streams generated and their treatment and disposal routes is provided in Section 4.6.5. The equipment mobilised in order to collect, store and transport waste, and the associated lifting apparatus, will be detailed in each contractor's waste management plan.

All project supply vessels will be certified and authorised according to International Maritime Organization (IMO) and International Maritime Dangerous Goods (IMDG) standards / requirements for sea transport of dangerous goods (hazardous waste, including drill cuttings).

4.5.5 Refuelling of vessels

One identified licensed bunkering company operates in Beirut Port. The method of fuel transfer will be dependent on the timing of operations and the availability of services. There are two options:

- An auto propelled barge will come alongside the supply vessels when berthed at the logistics base jetty inside the Port of Beirut, subject to prior authorisation.
- A specialised tanker will carry out the refuelling of the supply vessels at a dedicated area outside the Port of Beirut perimeter (anchorage area).

A dedicated oil spill response package will be available and will be deployed close to the logistics base jetty for rapid deployment in case of a spill.

The MODU and support vessel will be refuelled out at the drill site from the supply vessels. Vessels will have Shipboard Oil Pollution Emergency Plans (SOPEPs) in line with MARPOL 73/78 Annex I requirements.

4.5.6 Power and water supply

The logistics base will be connected to the electrical grid of the Port of Beirut. In addition, there will be one back-up generator present on site (to be used only in case the electrical grid power supply is unavailable and the port generators are also unavailable).

Generator details are as follows:

- 60 KVA rated
- able to supply the entire base (including the drilling fluids mixing plant and cement bulk plant)
- open exhaust on top of the generator (~ 2m)
- supplied from a 1000 L diesel tank
- stationed together with the diesel tank within a 3000 L containment bund
- located in utilities area on the base (remote from all activities).

In terms of water supply, the logistics base will be connected to the Beirut city water line and fresh water will be stored on site in a storage tank/basin to supply large amounts of water in a short period of time to the drilling fluids mixing plant.

Estimated water requirement at the logistics base is 2300 m^3 for well B4-1 (2200 m^3 required for drilling fluids mixing, 100 m^3 required by logistics base personnel for washing, etc).

It should be noted that the offshore MODU is self-sufficient in terms of daily water use from onboard desalination.

4.5.7 Security

The logistics base will be fenced and equipped with 24/7 surveillance and security guards. A pass will be required for access through the port gates, users will need to undergo a safety induction and provide identification in order to obtain a pass. Control and record of any movement (personnel and vehicles) will be carried out as well as POB management.

4.5.8 Decommissioning of logistics base

The duration of the logistics base will be dependent on the success of the B4-1 well and any subsequent wells. Decommissioning of the logistics base is the responsibility of the logistics base contractor (Fast Bolloré) and is specified in their contract. It has to be returned to the port authorities in the same state that it was received. There will be a formal handover of responsibility.

The drilling fluids mixing plant will be composed of tanks that will be set up for the operations and then sent back abroad. It will not be a permanent construction. The drilling fluids mixing plant will be demobilised after the drilling of the B4-1 well and remobilised for any subsequent well. Demobilisation of the drilling fluids mixing plant is the responsibility of the drilling fluids contractor and a dedicated expert will be at site to properly decommission all equipment and leave the area as it was prior to installation of the plant.

Drilling fluids from the B4-1 drilling activity will be temporarily stored inside the tanks of the drilling fluids mixing plant and then exported to Egypt for reuse as per applicable regulations (see Section 4.6.5.2). Any slops generated during cleaning of the drilling fluids mixing plant and bulk facilities during decommissioning (which are considered as waste) will be stored by the drilling fluids contractor, or their subcontractors, and then exported in accordance with the Basel Convention.

4.5.9 Road transportation of waste and materials

Onshore transport of materials and waste will be limited within Lebanon.

Drilling and cementing chemicals will be delivered by vessel to the logistics base; the only onshore transport of these chemicals will be within the boundaries of the port.

In terms of waste, incoming non-hazardous domestic waste from the MODU will be transported by a locally approved waste collection company via a specialised truck that can be mounted with Cargo Container Units (CCUs). One truck will be dedicated exclusively for the project. The waste will be transported to the Karantina sorting facility. The non-hazardous waste generated at the bulk facilities will be transported and managed by the cement contractor’s subcontractor. More information on waste transportation provided in Section 4.6.5.

For the transport of hazardous waste from the logistics base to the authorised treatment / disposal location, the waste will be collected by the company responsible for the treatment / disposal facility in specialised trucks. It should be noted that certain hazardous waste streams do not have treatment / disposal facilities in-country (e.g. drill cuttings). These hazardous waste streams will be transferred direct from the MODU to the country of treatment / disposal during operations, and to a storage facility during the demobilisation phase before being exported, see Section 4.6.5.

4.5.10 Shore-based transfers

Two to three vessels will support the drilling operations from the logistics base. One support vessel will be permanently at the drill site providing security and safety duties. The other vessel(s) will be involved in transferring supplies, materials, equipment and waste between the drillship and the logistics base. About 8–10 return trips are estimated in total per week. Table 4.10 provides example vessel specifications.

Transit routes of the supply vessel between Block 4 and the logistics base will be a direct line between the two. Shipping lanes at the Port of Beirut are as per port guidelines and navigation channels.

Helicopter transfers of personnel will take place from Beirut International Airport, with an estimated 8-minute trip and around 10 return trips per week. Two helicopters will support the operations, each with a capacity of 8 to 12 passengers. It is assumed that the helicopter transit route between Block 4 and the airport will be a direct line between the two.

Table 4.10: Example support/supply vessel specifications

	 **Support vessel × 1**	 **Supply vessel × 2**	
Type	Large PSV	Medium PSV	Medium PSV
Year built	After 2009	After 2009	After 2009
DP2	Mandatory	Mandatory	Mandatory
Deck cargo capacity	Approx. 900 m^2 1800 t min	Approx. 750 m^2 1200 t min	Approx. 750 m^2 1200 t min
Length	Approx. 90 m	Approx. 85 m	Approx. 85 m
Draft	7 m maximum	7 m maximum	7 m maximum
Tonnage (gross)	Approx. 3600 t	Approx. 3000 t	Approx. 3000 t
Estimated fuel consumption per day during support at well site	8.2 t	-	-
Estimated fuel consumption per day during transit	-	10t	10t
Fuel oil capacity	Approx. 1000 m^3	Approx. 700 m^3	Approx. 700 m^3
Fresh water tank capacity	Approx. 900 m^3	Approx. 500 m^3	Approx. 500 m^3
Drill water tank capacity	Approx. 1000 m3	Approx. 700 m^3	Approx. 700 m^3
Dry bulk tank capacity	Approx. 300 m^3 in 4 tanks minimum	Approx. 250 m^3 in 4 tanks minimum	Approx. 250 m^3 in 4 tanks minimum
Liquid mud tank capacity	Approx. 1000 m^3	Approx. 750 m^3	Approx. 750 m^3
Base oil capacity	Approx. 300 m^3	Approx. 200 m^3	Approx. 200 m^3
Brine tank	Approx. 100 m^3 with mud capacities	Approx. 750 m^3 with mud capacities	Approx. 750 m^3 with mud capacities
Sewage treatment	Mandatory		

4.6 Emissions, discharges and wastes

The following sections provide estimated quantities of emissions, discharges and wastes generated during drilling of the B4-1 well. To enable as full an assessment as possible of a three-well programme, discharge estimates for the possible future exploration / appraisal wells have been assumed to be the same as those for B4-1.

Notes are provided throughout this chapter to indicate where the selection of different options could result in substantial change to the discharge estimates; in these cases, the range of potential discharges are provided.

Predicted emissions, discharges and wastes for the whole of the Block 4 drilling programme (assuming one further exploration well and one appraisal well) are provided throughout and summarised in Table 4.17.

4.6.1 Air emissions

Atmospheric emissions related to the B4-1 exploration drilling campaign will be generated by

- engine exhaust emissions during MODU transfer to and from the drill site (likely to be two days in total; however, a worst-case scenario of five days has been used to calculate emissions)
- exhaust emissions from power generation on the MODU during the well programme (calculations based on a 60-day drilling programme[9])
- vessel engine exhaust emissions from support/supply vessel operations (based on 10 supply vessel return trips to Port of Beirut per week throughout the drilling programme (4-hour duration return trip), plus one support vessel permanently at the well site providing security)
- vessel engine exhaust emissions from transportation of NADF cuttings to Cyprus for treatment and disposal (see Section 4.6.5) - Option 1 only (based on three supply vessel return trips per week from Port of Beirut to Port of Limassol in Cyprus throughout the drilling programme, 48-hour duration return trip[10])
- helicopter engine exhaust emissions during the transport of personnel to and from Beirut International Airport (estimated at maximum 10 return trips per week throughout the drilling programme, and approximate 20-minute duration return trip)
- operations at the logistics base. The base will be connected to the electricity grid of the Port of Beirut. In addition, there will be one back-up generator present on site (to be used only in case electrical grid power supply is unavailable and the port generators are also unavailable). The calculations here are based on a worst-case scenario of one generator used 24 hours a day during the drilling programme.

There will be no incinerator on the Tungsten Explorer MODU therefore air emissions from onboard incineration are not applicable to Well B4-1. For future wells it is possible that a different MODU will be utilised for the drilling and may have an onboard incinerator. Air

[9] The International Air Pollution Prevention Certificate (MARPOL 73/78) for the Tungsten Explorer is provided in Appendix 4.3.

[10] Transfer of cuttings is considered outside the scope of the EIA, calculations of air emissions included here for completeness.

emissions from onboard incineration on the MODU have therefore been included in Tables 4.11 and 4.12 for completeness (for two possible future wells).

It should be noted that a well test will not be undertaken for either of the Block 4 exploration wells, as it is anticipated that well logging will provide sufficient reservoir data. If an appraisal well is drilled in Block 4, well testing (drill stem test) will be an option. Air emissions from well test of a possible future appraisal well have therefore been included in Tables 4.11 and 4.12 for completeness.

Dust emissions from the drilling fluids mixing plant have not been included in the emissions estimate as the products will be delivered and stored in sealed bags and a dust collector unit will be used on the dry bulk silos to minimise dust migration to the surrounding environment.

Table 4.11 outlines the projected emissions of criteria pollutants, including particulate matter of 10 µm or less (PM_{10}), sulphur oxides (SO_x), nitrogen oxides (NO_x), volatile organic compounds (VOCs) and carbon monoxide (CO) from the B4-1 drilling programme.

Table 4.12 presents the estimated greenhouse gas (GHG) emissions for B4-1, based on predicted amounts of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) generated.

Table 4.11: Estimated air pollutant emissions from B4-1 drilling programme (and the full possible 3 well programme)

Activity	Total estimated emissions (t)				
	PM_{10}	SO_x	NO_x	VOC	CO
MODU mobilisation/demobilisation	0.8	0.9	32.2	0.9	8.7
MODU power generation	4.4	4.8	168.0	4.6	45.6
Helicopter transfers	0.0	0.0	0.1	0.0	0.0
Support/supply vessel operations at well site and during transfer to Beirut Port	1.2	1.3	38.5	1.6	5.2
Supply vessel operations transfer of NADF cuttings to Cyprus (Option 1 only)	0.9	1.0	30.3	1.2	4.1
Logistics base operation	0.3	0.3	10.1	0.3	2.3
Total for B4-1	**7.6**	**8.4**	**279.3**	**8.5**	**66.0**
Total for three wells	**22.8**	**25.3**	**837.8**	**25.5**	**198.1**
Appraisal well test (if carried out)	0	0	2.7	11.7	14.8
MODU incinerator (if present on MODU for two future wells) [11]	0.4	0.0	0.0	0.0	0.0
Total for three wells (including well test of appraisal well and incinerator present on MODU for two wells)	**23.2**	**25.3**	**840.5**	**37.2**	**212.9**

[11] Dioxin and furan emissions from any incineration on MODUs for future well drilling are insignificant. An emissions factor of 3.5 mg International Toxic Equivalents (ITEQ) for dioxins and furans / tonne of waste incinerated combined with the 14.4 t of waste predicted for a 60-day drilling programme gives a predicted emission of 50 mg.

Calculations based on following fuel consumptions: Drillship during mobilisation/demobilisation approx. 92 t/day, 5 days max; Drillship during drilling programme (power generation) approx. 40 t/day, 60 days; Supply vessels during transit 10 t/day, for 20 days; Support vessels at well site 8.2 t/day for 60 days; Helicopter 0.297 t/hr, 12 hours per month, 2 months.

Emission factors: E&P Forum - Report No. 2.59/197 - Tonnes of Emissions per Tonnes of Fuel Used.

Total for 3 wells assumes drillship used for each well, same number of days for drilling programme, and that NADF is used and cuttings shipped to Cyprus.

Table 4.12: Estimated greenhouse gas emissions from B4-1 drilling programme (and the full possible three-well programme)

Activity	Total estimated emissions (t)			
	CO_2	CH_4	N_2O	GHG (CO_2 equivalent)
MODU mobilisation/demobilisation	1472	0.1	0.1	1504
MODU power generation	7680	0.3	0.5	7849
Helicopter transfers	27	0.0	0.0	28
Support/supply vessel operations at well site and during transfer to Beirut Port	2089	0.2	0.1	2138
Supply vessel operations transfer of NADF cuttings to Cyprus (Option 1 only)	1646	0.1	0.1	1684
Logistics base operation	487	0.0	0.0	488
Total for B4-1	**13,401**	**0.7**	**0.9**	**13,691**
Total for 3 wells	**40203**	**2.2**	**2.7**	**41073**
Appraisal well test (if carried out)	5935	93.8	0.2	9175
MODU incinerator (if present on MODU for two future wells)	0.6	0	0	0.6
Total for three wells (including well test of appraisal well and incinerator present on MODU for two wells)	**46139**	**96.0**	**2.9**	**50249**

Calculations based on fuel consumptions and emission factors as per Table 4.11.

GHGs calculated in line with Total Guide and Manual 'Estimation, Monitoring and Reporting of Atmospheric Emissions (GM EP ENV 124)', the emissions to be considered are the gases having a direct greenhouse effect namely: CO2, CH4, N2O. Their respective weighting is given by the Intergovernmental Panel on Climate Change (IPCC 2013-AR5): GHG (tCO2e – 100-year time horizon, climate feedbacks included) = 1 CO2 + 34 CH4+ 298 N2O.

Total for 3 wells assumes drillship used for each well, same number of days for drilling, and that NADF is used and cuttings shipped to Cyprus.

4.6.2 Drilling discharges

The following waste streams will be discharged from the MODU during the exploration drilling campaign:

- WBDF and cuttings

- cementing discharges
- pipe dope
- BOP testing discharges.

These are discussed in more detail below.

4.6.2.1 WBDF and cuttings

The first hole section of the well (36-in.) will be drilled using seawater only. The 26-in. section will be drilled using seawater, gel sweeps and salt saturated pad mud. After the drilling of the 26-in. section, water-based mud will be used to washout the hole. Drilling chemicals used in the 26-in. section are all water-based and classified as environmentally benign (Table 4.3). The cuttings and drilling fluids will be discharged at the seabed in the estimated quantities shown in Table 4.13.

For Option 1 where the lower-hole sections of the well are drilled with NADF, the cuttings will be transported to Cyprus for treatment and disposal (see Section 4.6.5.2).

For Option 2 where the lower-hole sections of the well are drilled with HPWBDF, cuttings with associated HPWBDF will also be discharged to sea from the MODU. Table 4.13 provides estimated quantities.

As stated previously, Option 1 has been selected for the first B4-1 exploration well. Any subsequent wells in Block 4 will utilise either Option 1 or 2 depending on the findings from the first well. All wells will use seawater and water-based drilling fluids for the 36 and 26 in. upper-hole sections.

Table 4.13: Estimated quantities of water-based cuttings and drilling fluids discharged per well in Block 4

Hole section	Drilling fluids	Cuttings/ section (t)	Drilling fluids/ section (t)	Treatment/ disposal route
Option 1 (use of NADF in lower-hole sections)				
36 in.	Seawater	189	0	Direct release to seabed
26 in.	Seawater, gel sweeps and salt saturated pad mud	936	3488 + 625 (washout)	
TOTAL		**1125**	**4113**	
No discharge of cuttings from lower-hole sections				
Option 2 (use of HPWBDF in lower-hole sections)				
36 in.	Seawater	189	0	Direct release to seabed
26 in.	Seawater, gel sweeps and salt saturated pad mud	936	3488 + 625 (washout)	
17½ in.	HPWBDF	528	1350	Release from MODU cuttings chute (10 m below sea surface)
12¼ in.	HPWBDF	90	945	
8½ in.	HPWBDF	138	1688	
TOTAL		**1881**	**8096**	

If a second exploration well and an appraisal well are drilled, and both utilise Option 1, the water-based drill fluid and cuttings discharges will total

- (3 × 1125) 3375 t cuttings
- (3 × 4113) 12339 t drilling fluids.

If these wells are drilled and the first two utilise Option 1 and the other uses Option 2, the water-based drill fluid and cuttings discharges will total

- (2 × 1125 + 1881) 4131 t cuttings,
- (2 × 4113 + 8096) 16322 t drilling fluids.

If these wells are drilled and the first utilises Option 1 and the following two wells both utilise Option 2, the water-based drill fluid and cuttings discharges will total

- (1181 x 2 + 1125) 4887 t cuttings,
- (8096 x 2 + 4113) 20305 t drilling fluids.

4.6.2.2 Cementing discharges

After drilling each hole section, cement is pumped down the casing and up the annulus formed between the casing and the well bore. During this process, some excess cement will be displaced into the water column and onto the seabed (20 in. casing only). The approximate quantity of cement discharge per well will be 1 m^3, up to a maximum of 10 m^3 depending on the actual hole size.

During the drilling of the subsequent sections, a small amount of solid cement will be drilled out from the top of each interval and comingled with the drill cuttings.

Any leftover cement from the drilling operations will be pumped downhole during the well plug and abandonment activities therefore no waste cement will be generated offshore.

4.6.2.3 Pipe dope

Before any drilling activities, the rig crew will apply pipe dope to the drilling equipment joints to prevent thread damage. Pipe dope is a lubricating grease that seals the joints to stop them rubbing and wearing. A small amount of this lubricating grease will enter the water column during drilling. The drilling programme for the first well will use the heavy-metal free pipe dope Kopr-Kote (OCNS Category B).

4.6.2.4 BOP discharges

The BOP will be tested weekly for safety reasons, resulting in the discharge of small volumes (3.5 m^3) of BOP testing fluid (99% water, 1% Stack Magic) to sea. Stack Magic is a biodegradable water glycol hydraulic control fluid (OCNS Category E). Total volume of BOP testing fluid released during 60-day B4-1 well 28 m^3. If a second exploration well and an appraisal well are drilled using a similar well design, the maximum BOP testing fluid to be released is estimated as 84 m^3.

4.6.3 Other discharges

Routine wastewater discharges from the MODU and support/supply vessels include

- sanitary wastewater
- food waste

- desalination unit discharges
- drainage (including deck drainage, bilge water, slop water and fire water)
- cooling water
- ballast water.

These are discussed in more detail below.

4.6.3.1 Sanitary wastewater

Estimated quantities of sanitary wastewater[12] generated during the B4-1 drilling programme are presented in Table 4.14 together with estimates for a three-well programme. These estimates are based on

- 180 POB the MODU for the 60-day drilling programme
- three support / supply vessels with 22 POB maximum for the support vessel, and 20 POB maximum for the two supply vessels, for the 60-day drilling programme.

Grey water will be discharged to sea (without treatment) from the MODU and vessels providing no floating matter or sheen is observable. Black water will be treated onboard in accordance with MARPOL 73/78 Annex IV prior to discharge (see Table 2.10). Wastewater treatment sludge will be collected and maintained onboard, if there is a requirement to empty the sewage sludge tanks (if they are full) sludge will be transported to shore for treatment by a company approved by the competent authorities. The International Sewage Pollution Prevention Certificate (MARPOL 73/78) for the Tungsten Explorer is provided in Appendix 4.3.

Table 4.14 : Estimated quantities of sanitary waste generated during B4-1 drilling (and the full possible three-well programme)

	Grey water	Black water
MODU (m^3)	1188	270
Support/supply vessels (m^3)	409	93
Total for B4-1 (m^3)	**1597**	**363**
Total for three wells (m^3)	**4791**	**1089**

Estimates based on standard multiplication factors of 0.025 m^3 of black water per person per day and 0.11 m^3 of grey water per person per day (factors provided by Total E&P Liban).

4.6.3.2 Food waste

In MARPOL ‘special areas’, such as the Mediterranean Sea, food waste may only be discharged to sea following grinding in onboard macerators (particle size less than 25 mm) and providing the vessel / MODU is more than 12 nm from nearest land.

[12] Onboard sanitary wastewater consists of two main streams: black water and grey water. Grey water as defined in MARPOL 73/78 Annex IV is drainage from dishwater, galley sink, shower, laundry, bath and washbasin drains and does not include drainage from toilets, urinals, hospitals and animal spaces, and does not include drainage from cargo spaces. Black water is a term often used for sewage. Black water, which comes from onboard toilets, consists of faecal matter, urine, toilet paper and flush water.

As the B4-1 well site is only 11 nm from nearest land, macerated food waste will not be discharged. In this case, it will be shipped to shore for treatment and disposal. If at any time the support / supply vessels or MODU are outside 12 nm from nearest land during the B4-1 drilling programme they will be permitted to discharge food waste in accordance with MARPOL Annex V.

If future well sites in Block 4 are further offshore, discharge of macerated food waste will be permitted.

4.6.3.3 Desalination unit discharges

The MODU and support/supply vessels will have an onboard desalination unit that will produce freshwater from lifted seawater by reverse osmosis.

In terms of the MODU, it is estimated that around 750 m^3/day of higher salinity water will be discharged to sea from the desalination unit. The system will be dosed with the anti-scaling chemical ‘HDC-ASI-ECO’. This organic product is inherently biodegradable and classed as an environmentally sound product (see Appendix 4.4).

4.6.3.4 Drainage (including deck drainage, bilge water, slop water and fire water)

Deck drainage consists of wastewater resulting from rainfall, sea spray, deck and equipment cleaning, rig washing and fire drills. The volume of deck drainage varies with the amount of rainfall and differences in deck surface areas. Assuming a typical surface area of about 10000 m^2 for the MODU, 2400 m^2 (×3) for the support/supply vessels and an average monthly rainfall of about 160 mm[13], the monthly deck drainage volume would be 2752 m^3 (a maximum of 5504 m^3 for the 60-day B4-1 drilling campaign, and an estimated 16512 m^3 if all three wells are drilled). Deck washes may account for an additional 3000 L per month, a total of 6000 L for the B4-1 drilling campaign (and an estimated 18000 L if all three wells are drilled). There will be no discharge of free oil in deck drainage that would cause a film or sheen or discolour the surface of the water.

Bilge water is defined in MARPOL 73/78 Annex I as water that may be contaminated by oil resulting from issues such as leakage or maintenance work in machinery spaces. Any liquid entering the bilge system including bilge wells, bilge piping, tank top or bilge holding tanks is considered oily bilge water. Oily bilge water collected on the MODU and support/supply vessels will be treated by passing through a separation system. The discharge will be monitored to ensure that the oil in water content does not exceed the MARPOL 73/78 Annex I discharge specification for oil in water of 15 ppm (see Table 2.10). Residual oil (sludge) will be collected and maintained onboard, if there is a requirement to empty the sludge tanks (if they are full) sludge will be transported to shore for treatment by a company approved by the competent authorities. The International Oil Pollution Prevention Certificate (MARPOL 73/78) for the Tungsten Explorer is provided in Appendix 4.3.

Slop water is made up of contaminated drilling and completion fluids, cleaning residue from the rig pits, tanks, pipes and decking and contaminated rain and wash water. Slop water will be treated onboard the MODU in a slop treatment unit. In the treatment unit, flocculants will be used to coagulate the drilling fluid from the mixture. A membrane filter

[13] Based on average rainfall data from December to February in Beirut (2008 – 2017).

(0.05-micron pore size) will then be used to separate out the solids. The slops will be sent to shore for treatment/disposal and the separated water discharged to sea providing the oil in water content does not exceed 15 ppm. It should be noted that the flocculant products used in this process will be bound to the separated drilling fluids and not the water phase being discharged. It is estimated that slop water discharge will be approximately 300 m^3 per well (an estimated total of 900 m^3 if all three wells are drilled). The system is completely automated and uses an integrated oil-in-water analyser to ensure the clean water meets the environmental requirements. If the system detects an output near the discharge limits, it will automatically divert the water back to the feed tank for re-processing. The data is saved to memory for tracking purposes. If liquid slops can't meet the 15 ppm after treatment, they will be transferred to Cyprus with the drill cuttings for treatment. Slop water on the project support and supply vessels will be treated and discharged in accordance with MARPOL Annex I.

The MODU will be equipped with a firewater distribution system, and the firewater pumps will be tested on a weekly basis. A foam concentrate system may be in place to enhance the effectiveness of the fire system's deluge water spray. The foam concentrate system, carbon dioxide firefighting equipment and dry powder extinguishers will only be discharged in emergency situations. The fire-fighting foam on the Tungsten Explorer MODU for well B4-1 will be Fomtec AFFF 3% A foam concentrate that will be used at 3 parts concentrate in 97 parts of water. Fomtec AFFF 3% A foam contains no perfluorooctanesulfonic acid (PFOS), see Appendix 4.5.

4.6.3.5 *Cooling water*

Drilling rigs use seawater for engine cooling. This filtered seawater passes through ducts in non-contact heat exchangers where heat is transferred from a closed loop system that circulates through the rig's engines and pumps. The water is returned to the sea with an elevated temperature.

On the MODU, seawater will be uplifted and discharged below the sea surface at an estimated rate of around 105000 m^3/day. The discharge temperature will comply with Lebanese maximum allowable limits (Decision No 8/1/2001) and corporate requirements for not exceeding 3°C above ambient 100 m from discharge point. The antifouling system will be a marine growth prevention system (MGPS), which supplies an impressed current to a copper anode. The copper anode produces ions that are carried away by seawater into the system. The concentration of copper in the solution is less than 2 ppb, which is sufficient to prevent marine life from settling.

The International Anti-Fouling System Certificate (International Convention on the Control of Harmful Anti-Fouling Systems on Ships, 2001) for the Tungsten Explorer is provided in Appendix 4.3.

4.6.3.6 *Ballast water*

Ballasting, using untreated seawater, will be undertaken daily to maintain stability of the MODU for effective drilling. Oil and chemicals will not come into contact with ballast water.

The potential exists for introduction of invasive alien species[14] in ballast water if the MODU and support/supply vessels are mobilised from outside the Mediterranean, or if the vessels are engaged in traffic between ports in the Mediterranean Sea area.

Ballast water exchange will be carried out in line with the requirements of the International Convention for the Control and Management of Ships' Ballast and Sediments (2004), see Section 2.10.2.2.

The International Ballast Water Management Certificate (Ballast Water Convention 2004) for the Tungsten Explorer is provided in Appendix 4.3.

4.6.4 Discharges from logistics base

Discharges from the logistics base (areas without containment) will be limited to rainwater runoff. This will only be permitted from non-contaminated areas such as the pipe yard, jetty, marshalling areas and the warehouse area. For other areas where there is the potential for spillages (liquid fluids mixing plant, dangerous goods storage area), containment will be in place.

The drilling fluids mixing plant will have a concrete containment wall around the tanks of 1.8 m in height. This will be capable of containing up to 3000 bbls, equivalent to one and a half complete storage tanks. If rainwater collects in the retention area it will be tested (sheen test and / or retort) and discharged only if free of drilling fluid. Minor spills into the retention area will be treated using spill kits. In case of significant spill volume, the drilling fluids will be collected (by hose from the drainage points), fed back into the drilling fluids mixing plant, and reused in the drilling operations. Any spills at the drilling fluids mixing plant will be covered by the drilling fluid contractor's Liquid Mud Plant Spill Prevention Control and Containment Plan.

In the logistics base hazardous materials storage area, any spills would be treated using spill kits. Soiled spill kits will be disposed of with the oily rags and grease hazardous waste stream.

Sanitary waste generated from the offices and canteen/rest areas will be disposed of to the port sewerage system.

4.6.5 Solid wastes

4.6.5.1 General

The waste strategy used by TEP Liban will be based on the following waste hierarchy:

- prevent and avoid – avoid the production of waste and design products for a longer life
- minimise - reduce the amount of waste produced
- reuse - use items as many times as possible, refurbishing / repairing whole items or spare parts
- recycle – recycle where possible and only after reuse
- recover – e.g. incineration with recovery

[14] Invasive alien species are plants, animals, pathogens and other organisms that are non-native to an ecosystem and which may cause economic or environmental harm or adversely affect human health (definition provided by Convention on Biological Diversity).

- disposal – dispose of residual waste in a responsible way.

TEP Liban has developed a Waste Management Plan for the Block 4 drilling campaign, see Section 8.5.1.

Supply vessels will be used to transfer waste from the MODU to the onshore logistics base. Responsibilities for waste management will be as follows:

- waste from logistics base activities – belongs to and is managed by logistics base contractor
- waste from project support/supply vessels – belongs to and is managed by logistics base contractor
- waste from MODU operations – belongs to drillship contractor and is managed by logistics base contractor
- waste from drilling activities on MODU (NADF drill cuttings) – belong to TEP Liban and managed by the drilling fluids contractor
- reusable/recyclable chemicals packaging – belongs to and managed by drilling fluids contractor and cementing chemicals contractor.

All wastes received at the logistics base will be logged by the logistics base contractor and receipts generated that include waste type, quantity, waste-generating facility, and date and time of receipt. The original receipt will be given to the supply vessel master, a copy will be kept at the logistics base and a second copy of the receipt will be given to the waste remover. A copy of all waste transfer documentation will also be provided to TEP Liban.

Figure 4.11 shows the waste management processes onboard the MODU and the transfer of waste streams to shore for recycling, treatment and/or disposal.

Table 4.15 presents an indicative list of non-hazardous and hazardous waste generated by the drilling activity, disposal / treatment routes, estimated monthly quantities, and totals for the B4-1 well and the full possible three-well programme.

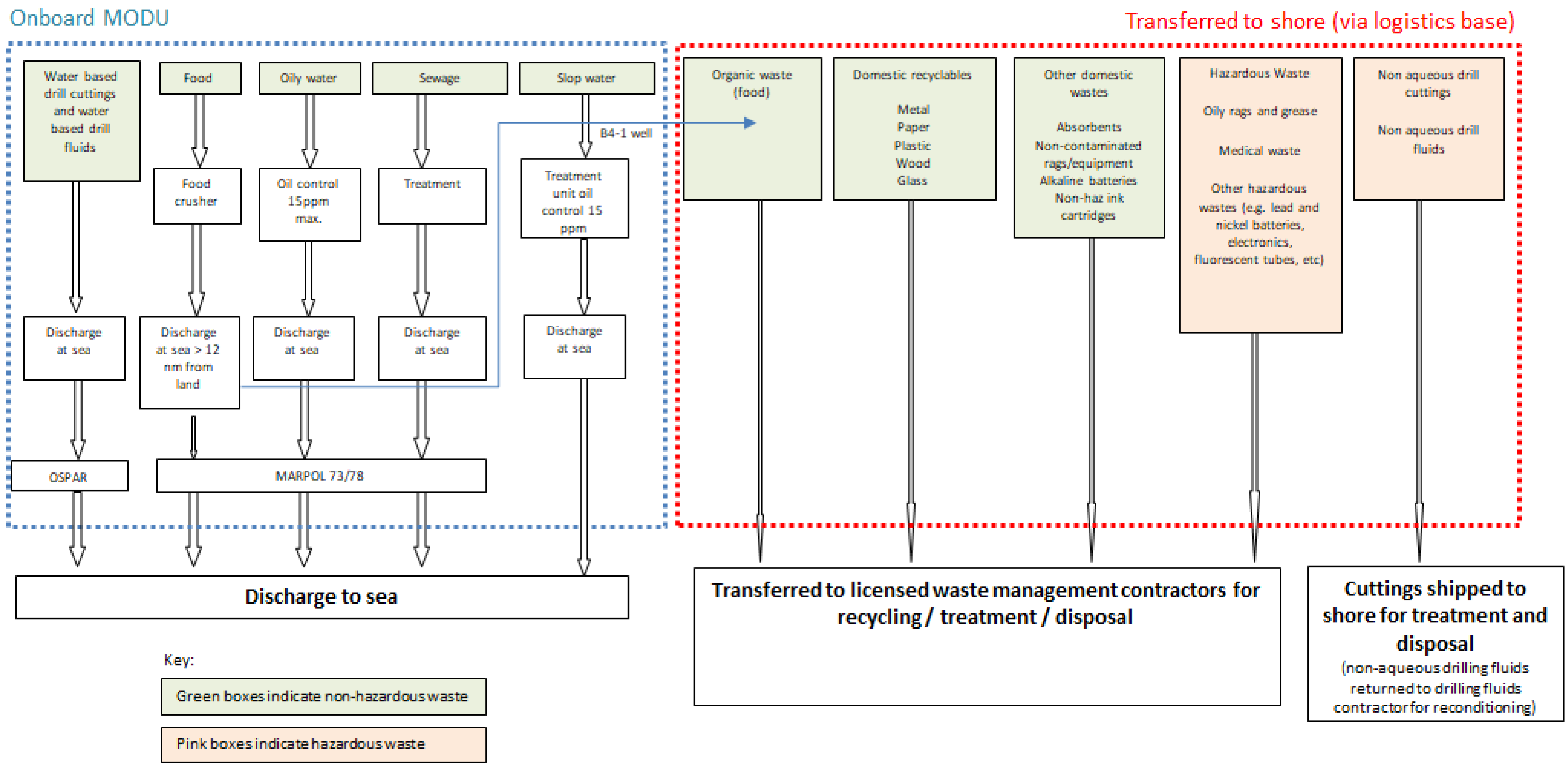


Figure 4.11: Waste management processes onboard the MODU and the transfer of wastes to shore for recycling, treatment and/or disposal

Table 4.15: Indicative list of wastes, disposal contractors and treatment / disposal routes, and estimated quantities from Block 4 drilling programme

Waste	Disposal contractor / treatment	Monthly estimated quantities (t unless states)	Total estimated quantity for well B4-1 (t unless stated)	Total estimated quantity for possible three-well programme (t unless states)
Domestic[15] and non-hazardous waste[16]				
Organic waste (including food waste)	Ramco transportation. Karantina sorting facility (general domestic waste belt) – composting facility and landfill at Burj Hammoud / Jdeideh Landfill	9 m^3	18 m^3	54 m^3
Metal	Ramco transportation. Karantina sorting facility (recyclables waste belt) – recycling facility and landfill at Burj Hammoud / Jdeideh Landfill	4.5	9	27
Paper/cardboard (packaging)		3.5	7	21
Plastic		8.4	16.8	50.4
Wood packing		8.2	16.4	49.2
Glass		2	4	12
Edible oil and grease	Ramco transportation. Sold to specialised third party for recycling and reuse	0.5	1	3
Absorbents, filters, rags, uncontaminated PPE	Ramco transportation. Karantina sorting facility (general domestic waste belt) – landfill at Burj Hammoud / Jdeideh Landfill	3.5	7	21
Alkaline batteries (without mercury)		0.005	0.01	0.03
Ink cartridges without hazardous substances		0.001	0.002	0.006
Non-hazardous cement packaging	Cement contractor's subcontractor (Solution) – recycled in MoE listed waste facility	-	-	-
Hazardous waste[17]				
Oily and greasy rags	Fast Bollore transportation. Sibline cement factory - incineration	-	0.25	0.75
Medical waste	Arc En Ciel transportation.	-	Few kgs total	

[15] Domestic waste - generated by personal use

[16] Non-hazardous waste - generated by industrial processes or activities

[17] Hazardous waste - any waste that has one or more properties likely to render it harmful

	Arc En Ciel facility – shredding and autoclaving (30 mins at 130ºC) then landfill at Burj Hammoud / Jdeideh Landfill			
NADF drill cuttings	Transported direct from MODU to IESC in Cyprus for treatment and disposal (see Section 4.6.5)	See Table 4.16		
Chemical wastes and packaging (including wastes from vessel tank cleaning) during operations	Transported direct from MODU to IESC in Cyprus for treatment and disposal	-	-	-
Chemical wastes and packaging (including wastes from vessel tank cleaning) during demobilisation phase	Transported to Lebanon and stored in Ray Mondo warehouse. Exported all together to IESC in Cyprus after demobilisation			
Drilling slops	Transported to shore only if MODU slop treatment unit doesn't meet 15 ppm oil in water). In this case, transported to IESC in Cyprus for treatment and disposal	-	-	-
Sludges from tanks (oil sludges and sewage sludges)	If there is a requirement to empty MODU / vessel sludge tanks (if they are full) sludge will be transported to shore for treatment by a company approved by the competent authorities	-	-	-

Note: There is no expectation to have other hazardous wastes such as electric and electronic waste, printer cartridges, fluorescent tubes and lead, nickel-cadmium batteries. If such waste is generated it will be in limited quantities. It will be managed by listed waste providers from MoE.

4.6.5.2 Drilling wastes

Non-aqueous drill cuttings and drilling fluids

In the case of Option 1, where NADF will be used for the lower-hole sections, the drilling fluid/cuttings slurry will be returned to the MODU and the drilling fluids separated out using the onboard solids control equipment (shale shakers and centrifuges, see Figure 4.5) so that they can be reused in the next hole section of the well.

The separated cuttings from these lower-hole sections, which will contain small quantities of NADF, will not be discharged to the environment; they will be contained and shipped to shore for treatment and disposal. Table 4.16 presents the generated quantities.

Non-aqueous-based cuttings will be stored on the MODU in specially designed cuttings boxes equipped with sealed closure and certified release (see Figure 4.12).

Table 4.16 : Estimated quantities of cuttings and drilling fluids returned to shore during drilling of B4-1 well (Option 1 only, NADF) (and for a 3 well programme)

Hole section	Drilling fluids	Cuttings / section (t)	Drilling fluids / section (t)	Treatment / disposal route
17½ in.	NADF	528	1350	Onshore treatment and disposal of cuttings and reuse of drilling fluids
12¼ in.	NADF	90	945	
8½ in.	NADF	138	1688	
Total for well B4-1		**756**	**3983**	
Total for a possible three-well programme if all wells drilled using Option 1		**2268**	**11949**	

Figure 4.12 : Example cuttings box

The cuttings boxes will be transferred directly from the MODU to a treatment facility in Cyprus (authorisation from Lebanese authorities for direct export granted, see Appendix 4.6). The skips will be transferred by project supply vessel in batches of 70 - 80 boxes to Limassol Port (Cyprus), and from there to the IESC (Innovating Environmental Solutions Center) treatment facility. IESC will treat the NADF based cuttings using a process known as thermal desorption. This is a non-oxidising process to vaporise volatiles and semi-volatiles through the application of heat. Treatment of the cuttings at IESC and subsequent disposal will be in line with local and international standards. Appendix 4.7 includes permits and certificates for IESC. Transboundary permitting and transportation will be compliant with the Basel Convention, requirements of the Lebanese MoE and the receiving country (Cyprus).

The drilling fluids contractor will be responsible for the collection, segregation and management of drill cuttings. They will be responsible for provision of cuttings boxes, emptying and cleaning of cuttings boxes at the treatment facility and return to site, specification of cuttings waste treatment, and collection of certificates of waste treatment and disposal issued by IESC.

At the end of the drilling campaign, the drilling fluids will be sent to shore, stored within the drilling fluids mixing plant at the logistics base, and then transferred to the drilling fluid contractor's main eastern Mediterranean base in Egypt for re-use. It should be noted that drilling fluids are classed as materials and not waste for this transfer.

4.6.5.3 Naturally occurring radioactive material

Naturally occurring radioactive material (NORM) consists of materials, usually industrial wastes or by-products, enriched with radioactive elements found in the environment such as uranium, thorium and potassium and any of their decay products such as radium and radon. These natural radioactive elements are present in very low concentrations in the earth's crust and can be brought to the surface through human activities such as oil and gas production.

NORM can occur in production wells where formation water is extracted to surface (usually mixed with hydrocarbons). For an equipment to be considered NORM contaminated, the universal threshold is 5 cps or 0.5 μSv/h above background radiation. Such radioactivity readings usually take prolonged periods of time to be reached as NORM scales are deposited at a very slow rate on production well equipment.

The presence of NORM is not applicable to a two-month exploration well. Firstly, no formation water is produced (the Block 4 exploration and appraisal wells will not go on to production), and experience from previous drilling campaigns in this part of the Mediterranean suggests that the probability of encountering such radioactive material in the formation water is unlikely.

Despite the above, proof that the drill cuttings resulting from the Block 4 drilling programme are not NORM contaminated is required by the Ministry of Environment in Cyprus (for cuttings transferred to this country for treatment and disposal). A certified Radiation Protection Officer from the drilling fluids contractor company will perform radiation monitoring of the cuttings and cuttings skips before loading from the MODU onto the supply vessel. A NORM survey double-check will be carried out at the arrival of the cuttings skips at the IESC waste treatment facility.

4.6.6 Summary of discharges, emissions and wastes from entire Block 4 drilling programme

Table 4.17 summarises estimated emissions, discharges and wastes for the entire Block 4 exploration drilling programme (assuming one further exploration well and one appraisal well).

Table 4.17: Summary of estimated emissions, discharges and wastes for entire Block 4 exploration drilling programme

	Exploration well B4-1	Possible future exploration well	Possible future appraisal well
Air emissions (t)	PM_{10} 7.6 SOx 8.4 NOx 279.3 VOC 8.5 CO 66.0 CO_2 13401 CH_4 0.7 N_2O 0.9 GHG (CO_2 eqiv) 13691 Emissions above are based on Option 1 (use of NADFs in lower-hole sections and transportation of cuttings to Cyprus)	Similar to B4-1 Lower emissions if Option 2 selected as no transportation of cuttings to Cyprus	Similar to B4-1 with addition of possible well test emissions[18], see below: NOx 2.7 t VOC 11.7 t CO 14.8 t PM 5.5 t Black carbon 1.3 t CO_2 5935 t CH_4 93.8 t N_2O 0.2 t GHG (CO_2 eqiv.) 9175 t Lower emissions if Option 2 selected as no transportation of cuttings to Cyprus
Cuttings and drilling fluids discharges	Option 1 selected: 1125 t cuttings 4113 t drilling fluids (seawater, gel sweeps and pad mud)	Same as B4-1, or if Option 2 selected 1881 t cuttings and 8096 t of drilling fluids (HPWBDF)	Same as B4-1, or if Option 2 selected 1881 t cuttings and 8096 t of drilling fluids (HPWBDF)
Cement discharges	1–10 m^3	Similar to B4-1	Similar to B4-1
Pipe dope discharges	Small quantities	Similar to B4-1	Similar to B4-1
BOP discharges	28 m^3	Similar to B4-1	Similar to B4-1
Sanitary wastewater discharges	Grey water 15979 m^3 Black water 363 m^3	Similar to B4-1	Similar to B4-1
Deck drainage discharges	5504 m^3 (deck wash 6 m^3)	Similar to B4-1	Similar to B4-1
Slop water discharges	300 m^3	Similar to B4-1	Similar to B4-1

[18] Well test emissions based on 3 days of flow: 24h at 20 mmscfd gas & 5 bbl/mmscf condensate; 24h at 30 mmscfd gas & 5 bbl/mmscf condensate; and 24h at 40 mmscfd gas & 5 bbl/mmscf condensate.

	Exploration well B4-1	Possible future exploration well	Possible future appraisal well
Desalination unit discharges	MODU approx. 750 m^3/day	Similar to B4-1	Similar to B4-1
Cooling water discharges	MODU approx. 105000 m^3/day	Similar to B4-1	Similar to B4-1
Waste (returned to shore)	Non-hazardous waste approximately 61 t (plus 18 m^3 organic waste) Hazardous waste 0.25 t NADF cuttings 756 t Drilling fluids 3983 t	Similar to B4-1 (if > 12 nm from shore organic waste discharged) If Option 2 selected no return of cuttings to shore	Similar to B4-1 (if > 12 nm from shore organic waste discharged) If Option 2 selected no return of cuttings to shore

4.7 Work force

Estimated work force numbers for the project are summarised below:

- 50 persons at the logistics base, mainly Lebanese nationals
- 180 persons onboard the MODU, mostly expatriate personnel, as specific skills and experience will be required on the drillship that are not currently available in Lebanon
- 20–22 persons on each support/supply vessel, mostly expatriate personnel with significant offshore operations experience
- 6–10 helicopter pilots, mostly expatriate personnel with significant international experience in offshore operations experience
- small number of persons for helicopter passenger handling management, mainly Lebanese nationals.

4.8 Schedule

The exploratory drilling programme is scheduled to begin in February 2020. The programme, including mobilisation; drilling, casing and logging; and well suspension and demobilisation will be two months for the B4-1 well. Table 4.18 presents the proposed drilling schedule for well B4-1.

Table 4.18: Drilling schedule B4-1 exploration well

Activity	Estimated number of days
MODU mobilisation	1
Drilling operations	
Pre-jetting activity on site (rig preparation, rig positioning)	~10
Drilling	~33
Retrieval of equipment from the well, logging (including any VSP), plug and abandon and recover BOP	~17

Activity	Estimated number of days
Drilling operations Total	~60
MODU demobilisation	1

The duration of any subsequent wells could be slightly longer, possibly 2–3 months by comparison with the 2 months estimated for well B4-1. However, it is considered that the discharge estimates provided in this chapter, which are based on operational periods, are sufficient to allow the impact assessment for the whole programme to be completed.

5 DESCRIPTION OF THE SURROUNDING ENVIRONMENT

5.1 Introduction

This chapter describes the environmental and social baseline characteristics of the area that could be affected by the project's activities. It focuses on the physical and biological components of the marine environment and the socio-economic conditions in the coastal and offshore areas of Western Lebanon and the eastern Mediterranean where Block 4 is located.

The key information sources used to compile this chapter are listed in Section 1.8.5. A full detailed environmental description is available in the Offshore Environmental Baseline Study – Literature Review Report Blocks 4 & 9 (Keran Liban/Creocean, 2019a) and the Offshore Environmental Baseline Survey (Keran Liban/Creocean, 2019b).

The offshore environmental baseline survey (EBS) took place between 19 March and 12 April 2019. The scope of the EBS was discussed and agreed with the MoE and the LPA, and consisted of seawater and seabed sediment sampling, biota sampling (microorganisms, phytoplankton, zooplankton and infaunal and epifaunal benthic communities) and observations of other biota (e.g., marine mammals, turtles, sharks and seabirds). The scope and the rationale behind the methodology employed and results of the sample analyses is outlined in the relevant sections below. Survey locations within Block 4 are shown in Figure 5.21.

Primary data collection for the social baseline study (SBS) began on 21 May 2019 and has been ongoing throughout the scoping and EIA phases of the project.

5.1.1 Objectives

This chapter's objectives are to

- understand the environmental, socio-economic and cultural heritage context in which the onshore and offshore activities related to the exploration drilling will take place
- identify environmental, socio-economic and cultural heritage receptors in terms of the potential impacts from exploration drilling activities
- ascertain the sensitivity of the identified receptors for inclusion in the assessment of impact significance (see Chapter 6).

Furthermore, the baseline data collected will serve to enable accurate monitoring of any changes that may take place as a result of the project.

5.1.2 Receptors

As a result of the desktop data reviews, the strategic environmental assessment (SEA), project description, impacts scoping, professional experience and stakeholder engagement, several environmental and social receptors were identified for inclusion in the study. These are shown in Table 5.1 for the environmental receptors and in Table 5.2 for the social receptors, along with their reason for inclusion. These receptors are described in the different sections of this chapter and where relevant, their sensitivity and trends identified and summarised in Section 5.6. The receptors in Section 5.6 are subsequently included within the impact assessment.

Table 5.1: Identified environmental receptors and indicators

Receptor	Reason for inclusion	Indicator
Physical environment		
Air quality	Exploration drilling activities may have potential direct impacts on air quality.	Offshore and onshore air emissions
Climate change	Exploration drilling activities may have potential direct impacts on climate.	Greenhouse gas emissions
Metocean conditions	Provide context for the physical environment in which the exploration drilling will take place and the background conditions for marine fauna habitats. This receptor was considered in the scoping report as oceanography and has been expanded on in this EIA chapter, Not included as a receptor for impact assessment.	Wave action, wind, circulation, current and tides, surface temperature and velocity, background underwater noise
Water quality	Exploration drilling activities may have potential direct impacts on water quality that may indirectly impact on other receptors. This receptor was considered in the scoping report and has been expanded on here.	Temperature, salinity, pH, turbidity, nutrient levels, pollutant levels, bacteria
Bathymetry	Provides context to the study area and marine fauna habitats. This receptor was considered in the scoping report and has been expanded on here, however, it is not included as a receptor for impact assessment.	Bathymetry
Geology and geohazards	Provides context to the study area and offshore environmental risks. This receptor was considered in the scoping report and has been expanded on here, however, it is not included as a receptor for impact assessment.	Geological framework, regional and local tectonic framework, seismicity, gas hydrates, over-pressured zones, gas chimneys and gas pockets, submarine landslides
Sediment quality / composition	Exploration drilling activities may have potential direct impacts on sediment quality/composition that may indirectly impact on other receptors. This receptor was considered in the scoping	Physical descriptors and pollutant levels

Receptor	Reason for inclusion	Indicator
	report and has been expanded on here.	
Seascape	Provides a visual context to the study area, particularly along the coast. This receptor was considered in the scoping report and has been expanded on here, however, it is not included as a receptor for impact assessment.	Seascape
Biological environment		
Benthos	Exploration drilling activities may have potential direct impacts on benthic communities and habitats. This receptor was considered in the scoping report and has been expanded on here.	Offshore benthic communities, coastal benthic communities, coastal benthic habitats
Plankton	Exploration drilling activities may have potential direct impacts on planktonic communities that may have indirect impacts on other receptors. This receptor was considered in the scoping report and has been expanded on here.	Phytoplankton and zooplankton
Fish	Exploration drilling activities may have potential direct impacts on fish and fishery resources. This receptor was considered in the scoping report and has been expanded on here.	Fish and fishery resources
Marine mammals	Exploration drilling activities may have potential direct impacts on marine mammals. This receptor was considered in the scoping report and has been expanded on here.	Cetaceans and seals
Marine turtles	Exploration drilling activities may have potential direct impacts on marine turtles. This receptor was considered in the scoping report and has been expanded on here.	Turtles
Seabirds	Exploration drilling activities may have potential direct impacts on marine turtles. This receptor was considered in the scoping report and has been expanded on here.	Offshore birds
Protected/threatened species	Exploration drilling activities may have potential direct impacts on	Fish and offshore birds*

Receptor	Reason for inclusion	Indicator
	protected or “threatened” (classified vulnerable, endangered or critically endangered by the IUCN).	
Terrestrial ecology	Logistics base operations may have potential impacts on terrestrial ecology.	Onshore fauna
Protected areas	Exploration drilling activities may have potential direct impacts on protected areas in the study area. This receptor was considered in the scoping report and has been expanded on here.	Nature Reserves, Ramsar sites, UNESCO World Heritage Sites, Specially Protected Areas of Mediterranean Importance, Proposed Marine Protected Areas, Proposed Deep Sea Sites for Conservation, Key Biodiversity Areas, Important Bird Areas, Ecologically and Biologically Significant Areas

*This receptor encompasses the species of fish and offshore birds that are protected and/or threatened species. Protected and/or threatened species of marine mammal and turtle are included within the overall marine mammal and marine turtle receptors.

Table 5.2: Identified social receptors[1] and indicators

Receptor	Reason for inclusion	Indicator
Demographics	Provides context for political disaggregation of impacts according to the population groups. Not included as a receptor for impact assessment.	Population trends (growth, in-migration, age, sex, ethnicity, religion, urbanisation)
Education and skills level of the population	Potential need for employees and requirement for training More relevant for subsequent phases of the project (if exploration drilling is successful) Stakeholder concern	Education services availability and capacity. Educational level of the population
General economy/industry	Potential impact on macro economy Potential for supplying goods and services to the project (stakeholder concern) Employment opportunities (stakeholder concern) Impact on onshore coastal area (stakeholder concern)	Macro economy (trends, small- and medium-sized enterprises (SMEs), employment, informal economy) Land-based livelihoods (agriculture and natural resource use) Coastal small-and-medium-sized enterprises (SMEs)

[1] All social receptors were considered in the scoping report and have been expanded on in the EIA report.

Receptor	Reason for inclusion	Indicator
Fisheries	Potential impact on fisheries (stakeholder concern)	Fisheries, activities and supply chain, facilities, aquaculture and sea angling
Land-based livelihoods (agriculture/natural resources (ecosystem services))	Provides context and background for livelihoods. Potential impact on coastal natural resources (stakeholder concern). Receptor considered as relevant only for non-routine (accidental) events	Coastal agricultural activities (crops and livestock). Natural resource use
Tourism	Potential impact on tourism (stakeholder concern) Impact on onshore coastal area	Tourism facilities, services and activities
Infrastructure	Potential impact on infrastructure	Utilities and transport capacity and availability: roads, railway, airport, port, telecommunications, submarine cables and pipelines, electricity, water and wastewater, waste
Shipping	Potential impact on shipping (stakeholder concern)	Shipping activities, port facilities
Public health	Potential impact on health of fishermen and communities surrounding the port (stakeholder concern)	Key health indicators, health services availability and capacity
Social conditions: public safety and security	Potential impact on safety and security, including road safety at the Port of Beirut	Security services Crime and conflict Vulnerable groups
Archaeological and cultural resources	Potential impact on archaeology (stakeholder concern)	Cultural heritage and archaeological resources Cultural values and sense of place

5.1.3 Area of influence

This chapter considers the offshore and onshore area potentially affected by planned and unplanned project activities and identifies environmental and social receptors. The AOI for each receptor was identified based on the sector-specific “EIA Guidelines for Oil and Gas Reconnaissance and Exploration Drilling Activities in Lebanon” (MoE and LPA, 2019) and encompasses the area likely to be affected by the following:

Project’s planned activities and facilities directly owned, operated or managed (including by contractors) by project

The offshore area includes the drill site, the expected route and immediate surrounding of the supply/support vessels between the drill site and Beirut Port and, if permission is granted, the helicopter route from the drill site to Beirut Rafic Hariri International Airport (see Figure 1.4).

Discussions are currently ongoing between TEP Liban and the government to determine whether permission will be granted for the use of private helicopters to transfer crew from the shore to the MODU (all helicopters in the country at present are for military use only).

The onshore AOI includes the Port of Beirut and its immediate surroundings, including the expected transport routes to Beirut Rafic Hariri International Airport.

Impacts from unplanned but predictable developments caused by project that may occur later or at a different location and may impact on ecosystem services upon which affected communities' livelihoods are dependent

This includes the potential release of hydrocarbons from support/supply vessels (e.g., vessel collision), the drill ship (e.g., during transfer operations, tank leakage or, as an absolute worst-case scenario, sinking of the drill ship) or condensate release from a well blowout. Such a release could cover the coast of Lebanon from Beirut northwards, in addition to a large offshore area and immediate onshore areas including the municipalities and all communities within the coastal zone, who may depend on coastal resources.

The AOI of unplanned (accidental) events includes from Beirut northwards, which is driven by the oil spill modelling and has been defined to encompass all environmental and social receptors.

At the beginning of the section for each receptor described in this chapter, the reasoning behind the definition of the routine event AOIs is presented. AOIs have been described on a precautionary basis, based on the worst-case scenario from any phases of the exploration drilling activities (mobilisation through to demobilisation). Where it is appropriate, a broader study area has also been described. The information from within the study area is presented to give context to the data within the AOI for each receptor.

5.1.4 Sensitivity

At the end of each receptor section, there is a short justification of the assessment of the receptor's sensitivity. These assessments are based on the criteria in the Introduction chapter (see Table 1.3 in Section 1.8.7.2).

5.1.5 Assumptions and data considerations

The EBS was conducted during spring 2019 and was intended to provide a snapshot of the baseline environmental conditions in Block 4 for seabed sediment and biota, seawater quality and biotic, marine megafaunal and ornithological characteristics.

The scope of the survey presents some limitations on the representativeness of the results; the survey was undertaken over a limited period during only the spring of 2019 and used a blockwide approach to survey both Blocks: 4 and 9.

Seawater quality and plankton sampling was undertaken at selected locations throughout the block; however, it is recognised that seasonal differences in the characteristics of the eastern Mediterranean dictate that the samples collected provide only a snapshot of the annual range of conditions.

Marine mammal monitoring by both visual and acoustic means was carried out during the survey. Visual monitoring could only be undertaken during daylight hours, although passive acoustic monitoring (PAM) was also carried out during day and night to prevent gaps in survey coverage. While few animals were detected during surface visual monitoring and no detections were made using the PAM equipment, it is recognised that the waters of the eastern Mediterranean are of importance for marine mammals and other species of marine megafauna. PAM equipment has some limitations including that it can be masked by other background noise sources, and that it really only targets certain species such as small cetaceans or those with particularly high rates of vocalisation. As such, the fact that there were no detections during the survey does not indicate that marine mammal species were not present.

Visual monitoring for seabirds and aggregations of fish was also undertaken. This method presents similar limitations to the marine mammal observations; results obtained were not necessarily representative of the true populations in Block 4. A dedicated survey over a longer period in which transects are surveyed would provide a more representative picture of these populations. It is recognised, therefore, that the survey for these receptors was limited and that the abundance of marine mammals, seabirds, reptiles and fish populations of Block 4 cannot be interpreted solely based on the results of the offshore EBS. Equally, it is recognised that the impacts expected from the drilling work may not warrant such an extensive survey.

Recognising the limitations of the EBS, further information has been included in the baseline description from other sources such as, the regional strategic environmental impact assessment, other regional oceanographic/marine biological programmes, as well as academic and government publications. Where sampling and survey activities were only able to provide information that gave a snapshot of environmental conditions, these additional data sources have sought to put this information into a more spatial or temporal context in order to provide a robust baseline environmental description against which impacts can be assessed.

Environmental sensitivities are conservative estimates due to the paucity of comprehensive data sets. Comprehensive data sets on marine megafauna (fish, marine mammals, turtles and seabirds) usage of the Lebanese coast and offshore waters and on benthic and planktonic communities are lacking and so research into the wider eastern Mediterranean area was carried out to provide insight into the region.

The uncertainties and limitations of the SBS are discussed in Section 5.5.2.

5.2 Geographical context

Lebanon is a country in Western Asia between latitudes 33˚ and 35˚N and longitudes 35˚ and 37˚E. The country's total area is 10,452 km^2, of which 10,230 km^2 is land. The coastline on the Mediterranean Sea is about 225 km in length. Figure 5.1 shows the location of Lebanon in its regional context.

The exclusive economic zone (EEZ) shares maritime borders with Syria, Cyprus and Occupied Palestine.

Lebanon's waters have been divided into ten exploration blocks, as shown in Figure 5.2. Block 4 is offshore northern Lebanon, with its eastern boundary about 6 km from the nearest coastline, and its south-eastern corner boundary just north of Beirut. It is within the Levant Basin, a large offshore basin, which contains the Leviathan gas field. The Levant Basin encompasses a large part of the offshore area in the eastern

Mediterranean, covering the area offshore of the eastern coastline from southern Turkey in the north to the eastern coast of Egypt in the south (Figure 5.3).

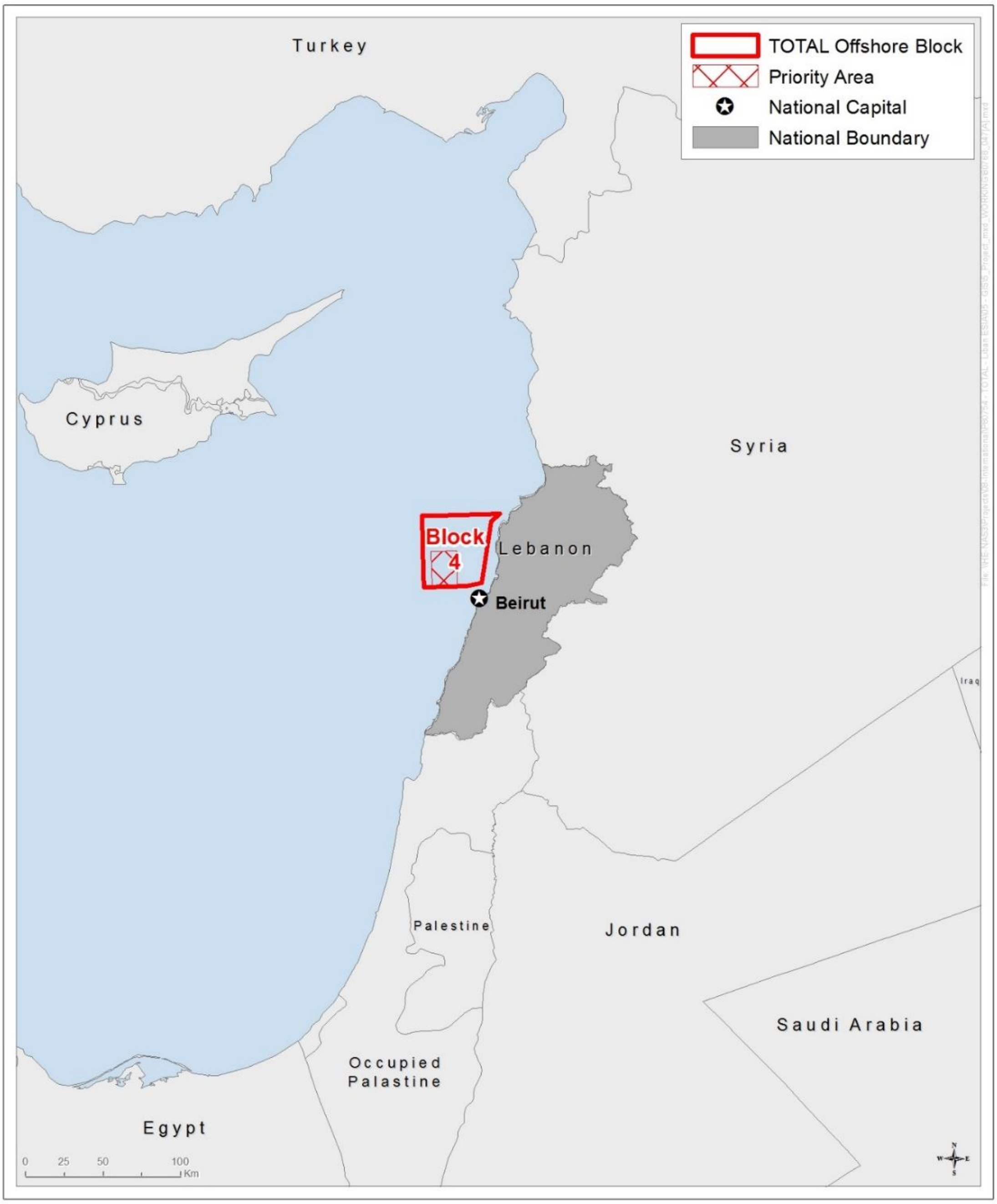


Figure 5.1: Lebanon's location in the regional context

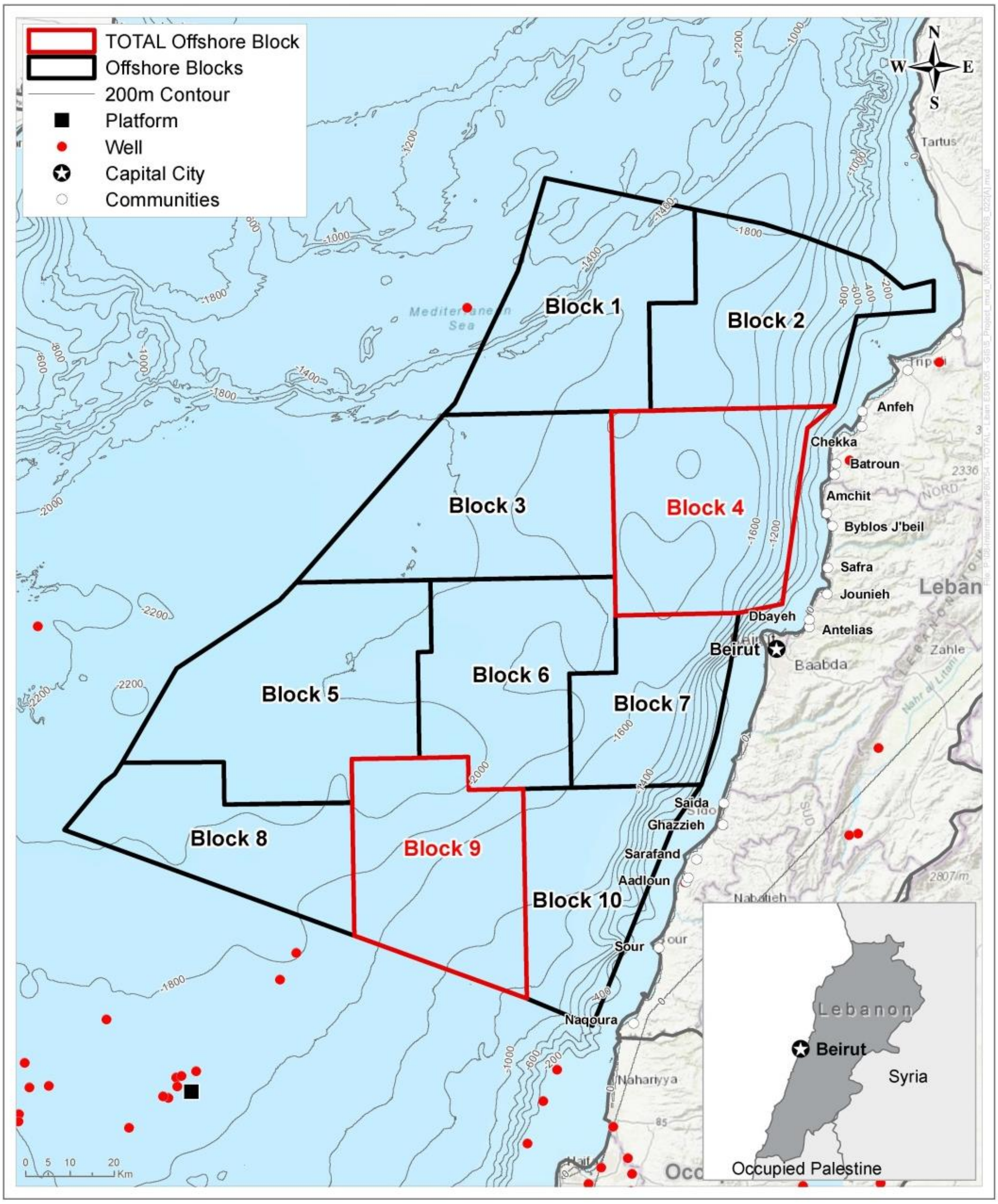


Figure 5.2: Exploration blocks and geographic features of the sea basin off the coast of Lebanon

Source: TEP Liban

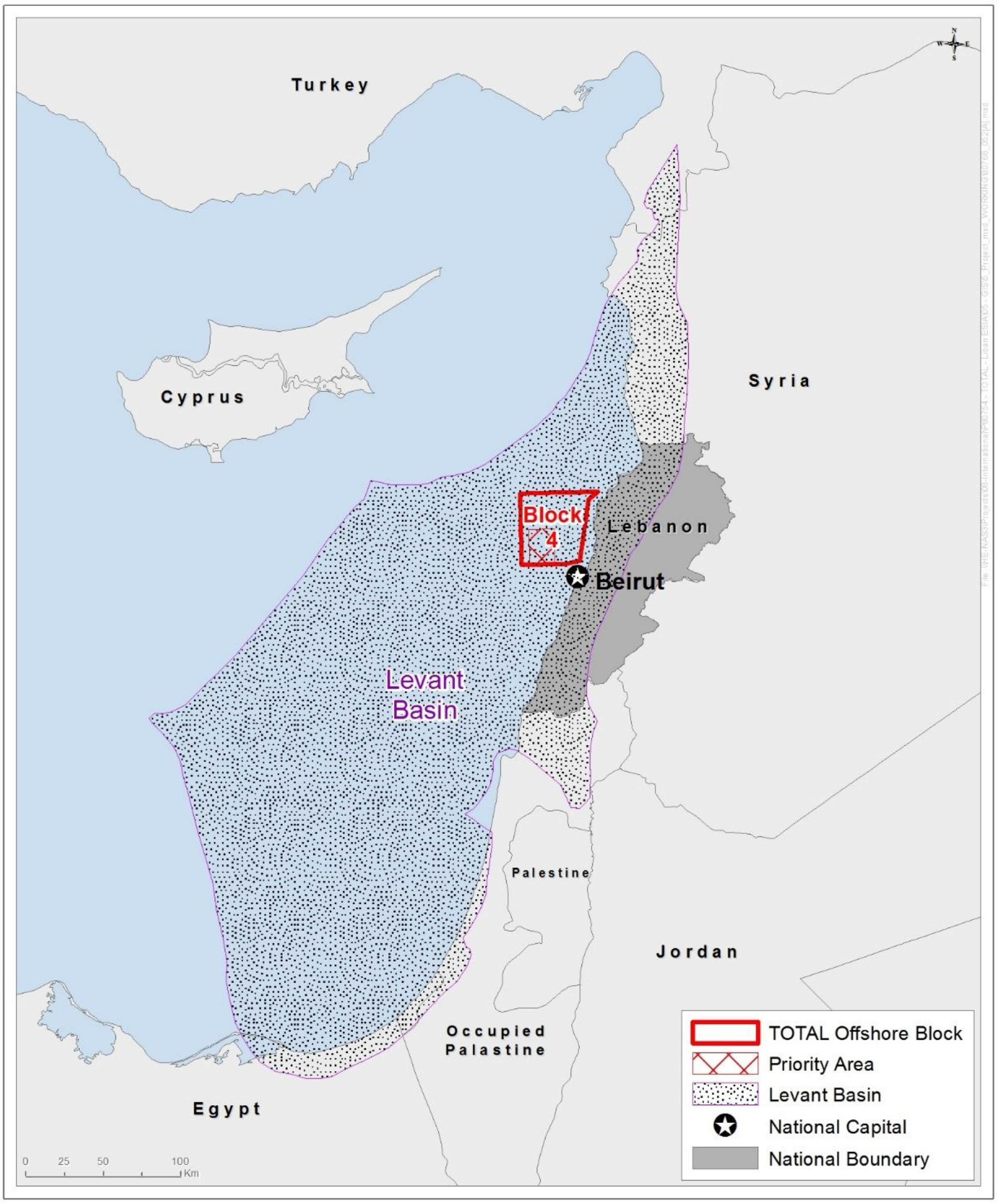


Figure 5.3: Levant Basin

Within Block 4, a priority area has been designated for exploration drilling with the first exploration well, B4-1, in the east of this area (Figure 5.4). The B4-1 well location is within Lebanon's territorial waters (<12 nautical miles, nm/22.48 km) from the coast. Any further wells (exploration or appraisal) assessed within this EIA will also be in the priority area.

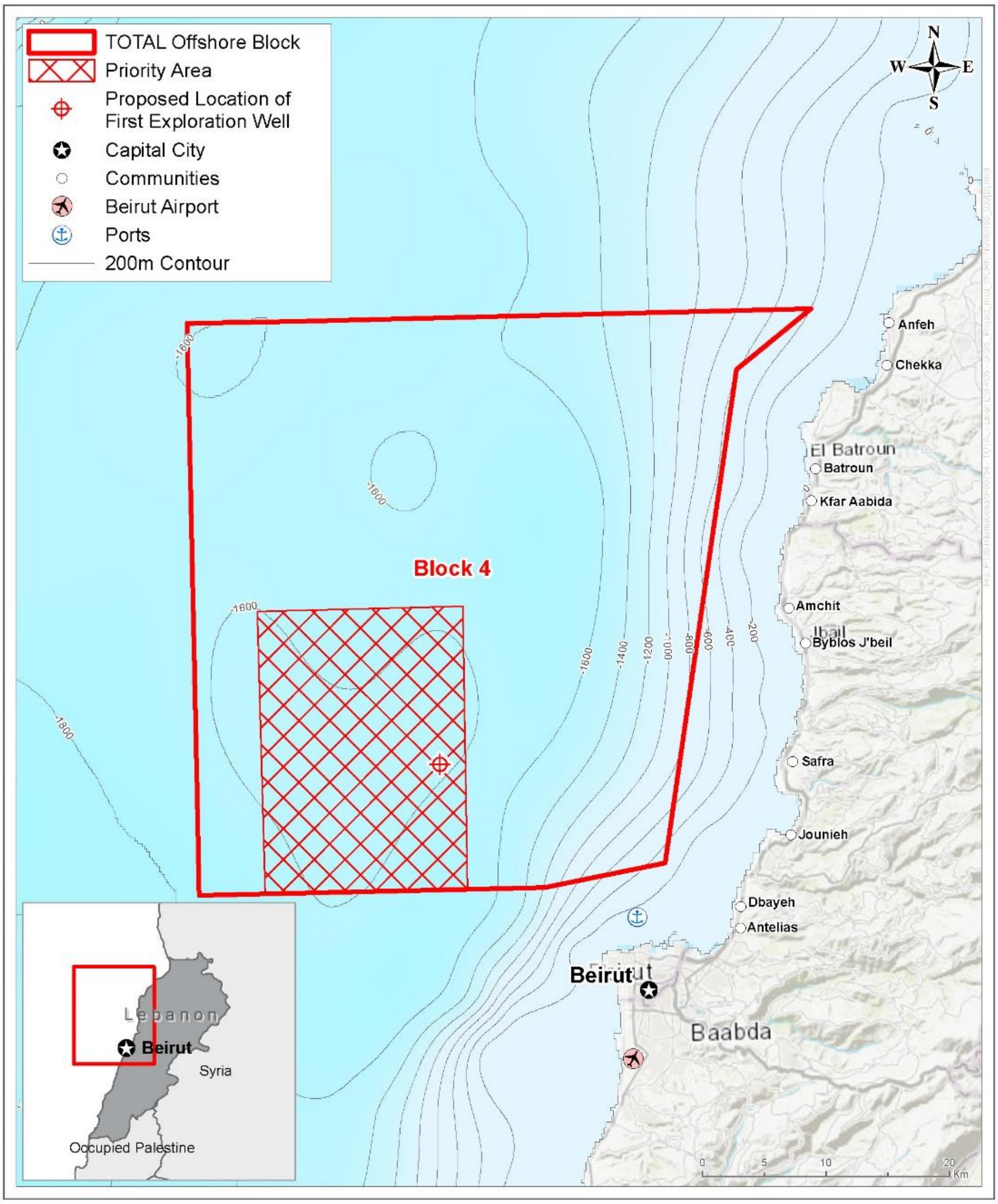


Figure 5.4:Block 4, the priority area and the B4-1 well site location

Source: TEP Liban

5.3 Physical environment

5.3.1 Metocean conditions

5.3.1.1 Climate regime

Lebanon has a Mediterranean climate with two main seasons:

- long, hot, dry summers (generally April through October) with temperatures ranging from a minimum 12.7°C in April to a maximum of 32.9°C in August. The relative humidity ranges from 34.6% to 99.4% during the same time period (MeteoGroup, 2019).

- short, cool, rainy winters (generally November through March) with temperatures ranging from 6.5 to 28.4°C and relative humidity ranging from 27.6% to 99.4% during those months (MeteoGroup, 2019).

Air quality

The AOI for offshore air quality is the proposed location of the wells and the transit corridors for the supply/support vessels. The AOI is limited to the immediate areas (a few hundred metres) of the project as impacts on air quality are localised and vessels emissions are regulated by MARPOL. The study area encompasses the eastern Mediterranean to give context to the sensitivity of the AOI.

Much of the eastern Mediterranean region is exposed to long-range transport of air-borne pollutants, mainly from southern and eastern Europe and the Central Mediterranean (CSA International, 2011). Although Block 4 is situated offshore, it may still be exposed to such pollutants.

Long-range transport of industrial and urban plumes tends to be highest in summer as a result of the regional/synoptic circulation, reduced removal processes, stable conditions, trade winds and strong solar radiation leading to photochemical pollution (CSA International, 2011). Studies have shown that long-range plumes of reduced air quality can retain their characteristics for several days (Artelia, 2014)

Moreover, the eastern Mediterranean can also be affected by the presence of particulates, mainly from dust storms, transported from the Sahara during the transient seasons of spring and autumn (Michaelides et al., 1999). A secondary source of dust entering the eastern Mediterranean is also evident from Syria and Turkey, when low-pressure weather systems are located over the Middle East (CSA International, 2011).

Considering the proximity of Block 4 to Cyprus, environmental studies carried out in Cyprus have been useful in understanding the dispersion of pollutants, ozone concentrations and sulphate concentrations across the Mediterranean region. Ozone concentrations are high along the Lebanese coastline, particularly in the morning, while sulphate concentrations are relatively low but higher at midnight than at noon.

Onshore air quality

There are plans to develop an onshore logistics base within the commercial port area of Beirut, which will act as a support for the offshore drilling campaign for Block 4. This section therefore describes onshore air quality.

The AOI for onshore air quality is the immediate area (a few hundred metres) of the logistics base as emissions are predicted to be limited and local. The study area encompasses air quality throughout Lebanon.

Before 2001, Lebanon lacked a proper air quality monitoring system and only academic sectors measured air quality on a short-term basis for research purposes. Until 2012, reported emissions were those prepared under the National Communications for the United Nations Framework Convention for Climate Change (UNFCCC), with emphasis on greenhouse gases (GHGs) (MoEW, 2019).

The Lebanese Air Quality Monitoring Network (AQMN) was launched in 2013 by the Ministry of Environment (MoE). Pre-assessments of the existing situation and technical requirements by the European Union (EU) determined the location of 15 monitoring stations which are in main cities along the coastline as shown in Figure 5.5 (MoE, 2017; MoEW, 2019). These stations were constructed between 2013 and 2017, and an additional three stations were built in the Urban Community of Al Fayhaa in North Lebanon (Tripoli, Mina and Beddawi).

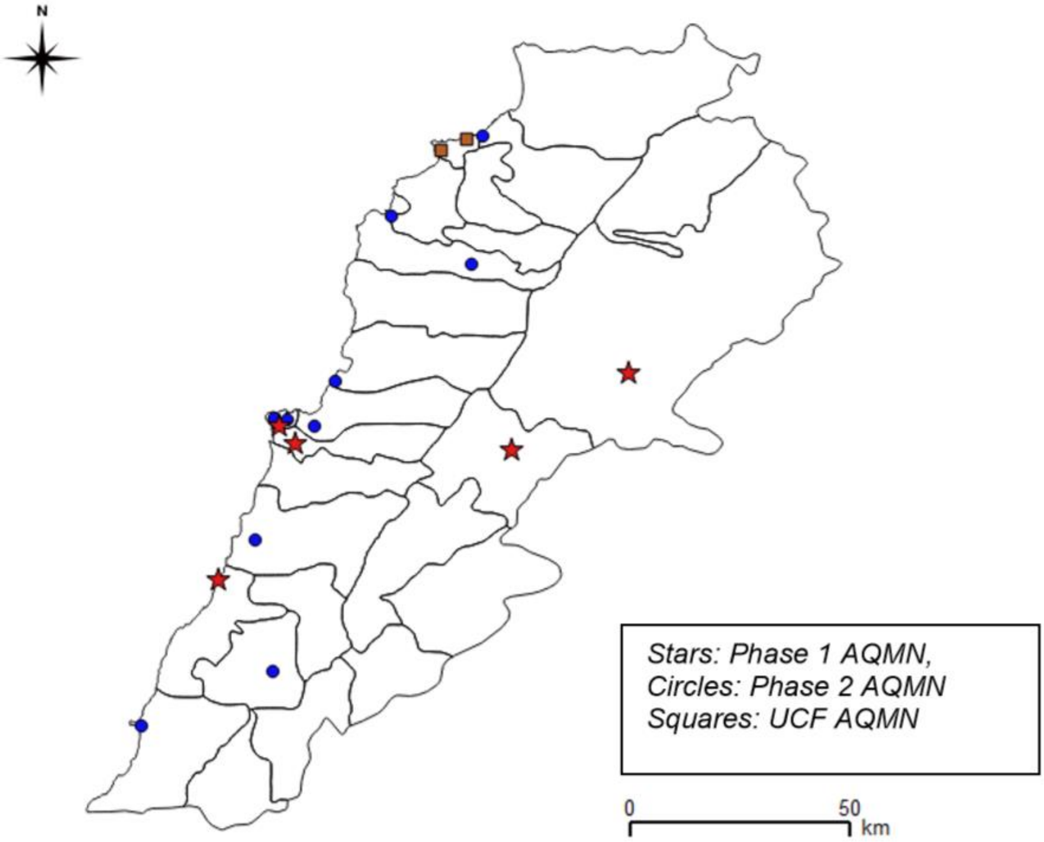


Figure 5.5: Distribution of air quality monitoring stations

Source: MoE (2017) in MoEW (2019)

Beirut is known to experience occurrences of high air pollution because of its enclosed nature, in addition to the pollutants that are transported from eastern Europe through steady winds and strong solar radiation (Waked et al., 2013). Average annual concentrations of particulate matter (PM) and nitric oxide (NO) in Beirut exceed World Health Organization (WHO) guidelines.

Monitoring pollutants including ground-level ozone (O_3), nitrogen dioxide (NO_2), particulate matter (PM_{10} and $PM_{2.5}$), sulphur dioxide (SO_2), carbon monoxide (CO) and benzene can give an overview of ambient air quality. According to the Strategic Environmental Assessment (SEA) for Exploration and Production Activities Offshore Lebanon, the existing monitoring data and results obtained from the AQMN indicate the following (MoEW, 2019):

- O_3: Levels tend to be the highest in the summer as a result of the meteorological conditions. Exceedances have been witnessed in Lebanon, with higher values in Baalback (Bekaa plain) than Beirut (coastal).
- NO_2: Several field campaigns to measure NO_2 took place between 2004 and 2013, with NO_2 consistently monitored from 2013. Levels exceeded WHO guidelines of 40 µg/m^3 but were still within national ambient air quality standards (NAAQS) of 100 µg/m^3 (Decision 52/1).
- PM_{10} and $PM_{2.5}$: Studies over the years have concluded that PM levels within the Greater Beirut area always exceed annual WHO guidelines for PM_{10}, which is 20 µg/m^3, and $PM_{2.5}$, which is 10 µg/m^3. Exceedance of the Lebanese NAAQS was also identified for PM10 levels, which is 80 µg/m^3. In Tripoli, PM_{10} and $PM_{2.5}$ levels recorded at the Tripoli Urban Centre since 2000 exceeded WHO standards.
- SO_2: Low SO_2 concentrations of 8 µg/m^3 levels were detected when measured from December 2004 to July 2006 within Beirut, which is compliant with NAAQS (80 µg/m^3) (Decision 52/1). In 2014, levels identified were compliant with the Lebanese standards for the different averaging periods.
- CO: Low concentrations of CO, even at peak hours, were identified between December 2004 and July 2006 and again starting in 2013. All levels were compliant with NAAQS (Decision 52/1).
- Benzene: In the summer of 2011 and winter of 2012, measurements of benzene were taken in suburban Beirut showing an average level of 2 µg/m^3. This is compliant with NAAQS (16.2 µg/m^3). Despite compliance, the levels found are still linked with a lifetime risk of leukaemia when found in excess according to WHO standards (less than 1/100,000).

Certain contaminants such as NO_2, PM and O_3 exceed the standards as a result of air pollution in Lebanon, predominantly from the industrial and transport sector and from electricity generation. Levels are highest and more concentrated in the main coastal cities such as Beirut, Zouk Mikael, Jiyeh and Chekka. In Lebanon, main contributors to GHG emission are as follows:

- 56% from the energy sector
- 23% from the transport sector
- 10% from industrial processes
- 7% from the waste sector.

Figure 5.6 and Figure 5.7 summarise the previous monitoring results in comparison with WHO guidelines and Lebanese air quality standards (MoE, 2017).

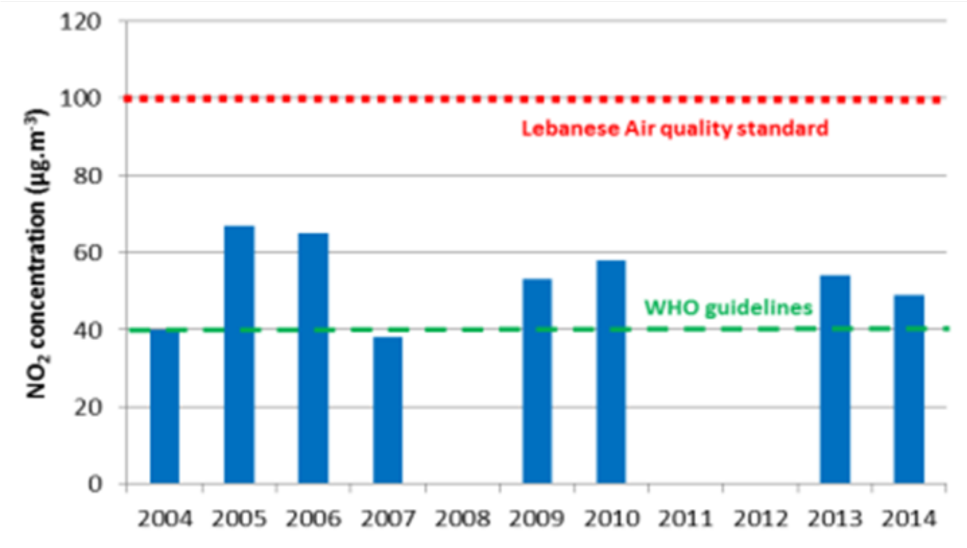


Figure 5.6: NO_2 annual values over the Greater Beirut area

Source: MoE (2017)

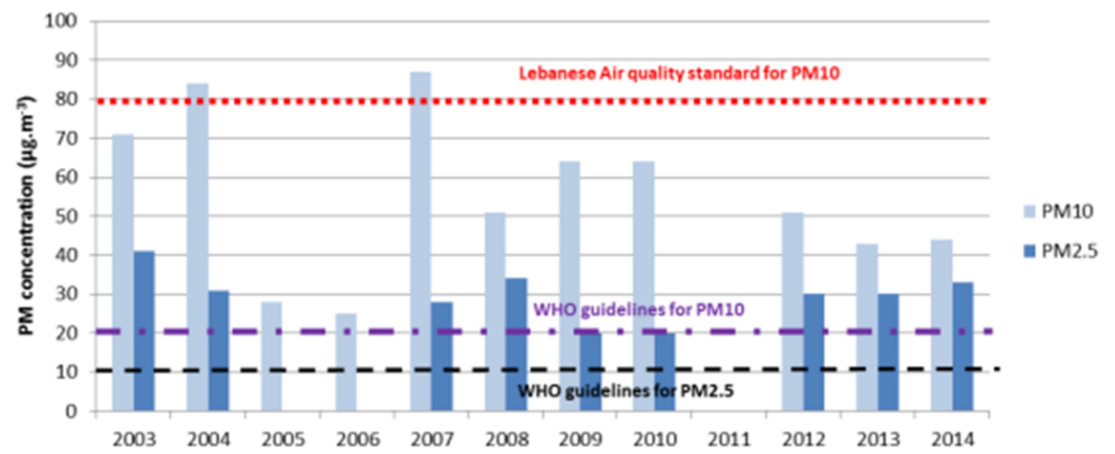


Figure 5.7: Particulate matter annual values over the Greater Beirut area

Source: MoE (2017)

It has been reported that onshore, CO and SO_2 levels in Lebanon are not of concern (MoEW, 2019). However, O_3 levels are high (MoEW, 2019), but not likely to be affected by offshore oil and gas drilling activities. PM_{10} and $PM_{2.5}$ levels also tend to be high (MoEW, 2019) and influenced by dust storms from the Sahara which contain high levels of particulate matter as discussed. As such, given the open nature of the drilling site, it is not expected that impacts to air quality would be experienced, and given this, measurements of air quality in Block 4 were not collected during the offshore baseline survey.

Air quality sensitivity

Based on the offshore nature of most of the work and the high levels of air pollution onshore of PM_{10}, $PM_{2.5}$ and O_3, the sensitivity of air quality to the project is low (2) (for definitions of sensitivity see Table 1.3 in Section 1.8.7.2). Offshore air quality is affected by long-range air pollution from various sources and is also of low sensitivity.

Climate change

The Earth acts like a greenhouse, whereby energy from the sun enters the atmosphere, some is radiated back into space and some reaches the surface but 90% is absorbed by greenhouse gases and radiated back towards the surface (NASA, 2019). If there was no greenhouse effect, most of the energy would be released from the atmosphere and the planet would be too cold to support life as we know it.

Greenhouse gases include water vapour, nitrous oxide, carbon dioxide, methane and chlorofluorocarbons (CFCs):

- Water vapour is the most abundant greenhouse gas, but causes rain as it warms, so it has a feedback mechanism.
- CFCs are industrial compounds that are regulated in their production by international agreements to protect the ozone layer.
- Nitrous oxides are powerful greenhouse gases, produced predominantly by soil cultivation practices using fertilisers and by burning biomass.
- Methane comes from natural and human sources such as livestock and is a more effective greenhouse gas but less abundant than carbon dioxide.
- Carbon dioxide has a long residual life in the atmosphere and is caused by natural and human sources but predominantly by burning fossil fuels (NASA, 2019).

Rising levels of CO_2 emissions are seen as the driving force for climate change. These originate from fossil fuel combustion and industrial processes which contributed about 78% of the total GHG emission increase from 1970 to 2010 (IPCC, 2014).

Climate change is expected to have significant impacts on Lebanon in the coming decades, costing the country an estimated $140 million in losses by 2040 (USAID, 2016). Particular risks to Lebanon are

- sea level rises along the coast where 85% of people live high temperatures reducing tourism in winter and summer
- falling agricultural yields due to higher temperatures and lower rainfall.

Greenhouse gas emissions in 2012 in Lebanon were 24.34 $MtCO_{2e}$ or 0.05% of global GHG emissions. Most of these emissions were from the electricity and heat sector (21.14 $MtCO_{2e}$) and mostly from oil power plants. The MoEW has a policy of moving towards gas power stations and reducing the use of oil (MoEW, 2010).

There is currently no major legislation in respect to climate change in Lebanon, apart from law 738/2006 relating to the ratification of the Kyoto Protocol of the United Nations Framework Convention on Climate Change. Lebanon signed the Paris Agreement in April 2016 and is in the process of ratifying it (MoE/UNDP/GEF, 2017). Lebanon submitted its Intended Nationally Determined Contributions under the Paris Agreement in 2015, with unconditional targets of reducing GHG emissions by 15% compared to the business as usual scenario by 2030 and generating 15% of the power and heat demand in 2030 through renewables, and conditional targets of reducing GHG emissions by 30% compared to the business as usual scenario by 2030 and generating 20% of the power and heat demand in 2030 through renewables (see Table 2.2).

Climate change is considered an issue for Lebanon and on a global scale, therefore sensitivity has been scored as medium (3).

5.3.1.2 Wave action and wind

The study area for wave action and wind encompasses the Lebanese coastline, with more detail provided for the area off Beirut. This study area provides context for Block 4, with no AOI specified as the project will not affect these components of the environment.

Wave action

The maximum average monthly wave height off Beirut is 1.41 m. The average significant wave height over 12 months is greatest in January and February and drops steadily until June (Figure 5.8). Most waves travel from west to east (Figure 5.9). More forceful waves are expected in windier areas, specifically in northern Lebanon, where average offshore winds were found to be strongest with speeds reaching 7 m/sec (Aoun et al., 2013).

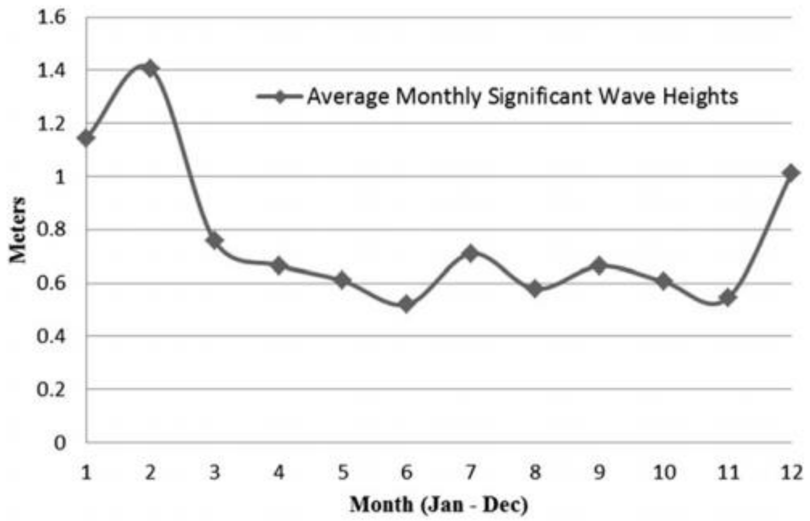


Figure 5.8: Average monthly significant wave heights offshore Beirut

Source: Aoun et al. (2013)

Based on the data recorded by the Tripoli Environment and Development Observatory (TEDO) between 2012 and 2017, the highest waves in northern Lebanon were mostly recorded during storm activity in the winter season, reaching around 1.1 m between January and March (TEDO-Tripoli Weather station).

The MeteoGroup modelled metocean conditions at a single location in Block 4 (34°02’24’’N – 035°19’48’’E) in 1510 m water depth to be representative of the conditions at the B4-1 well site (2019). Table 5.3 presents the data sources used by MeteoGroup to model the wave, wind, current, sea temperature and salinity parameters. The MG Metocean wave hindcast data set was used to derive wave extremes (MeteoGroup, 2019).

The percentage occurrence of significant wave height is presented in Table 5.4. Significant wave height ranged from 0 to 6.1 m with an average monthly significant wave height of 0.7 m, which is less than the average found off of Beirut.

The yearly average of significant wave height and direction measured at Block 4 is presented in Figure 5.10. The majority (>75%) of the waves come from the west and travel to the east, which is similar to those measured off Beirut.

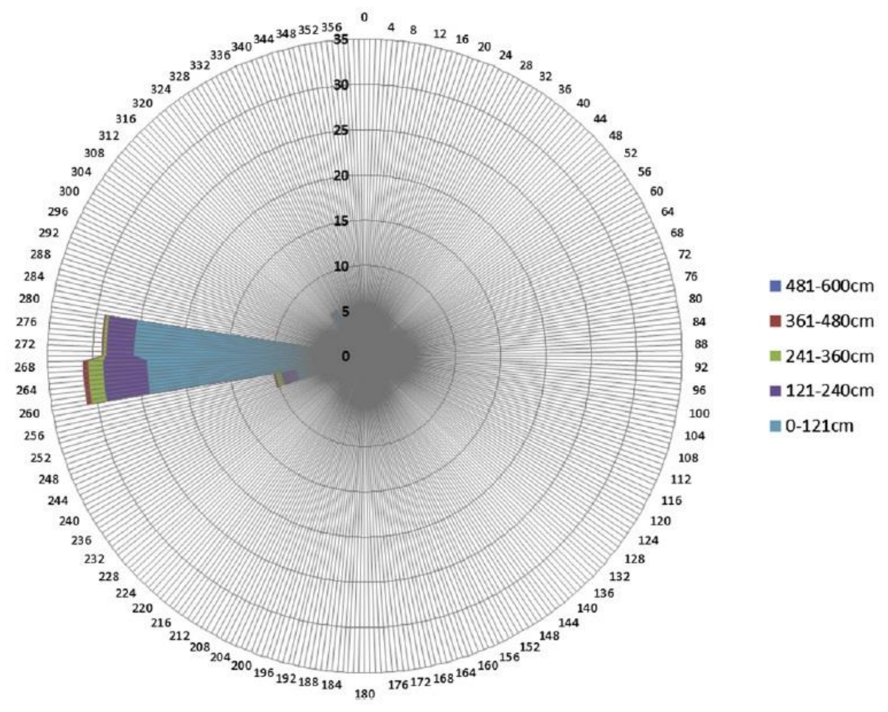


Figure 5.9: Wave rose for 2003 (significant wave height) offshore Beirut

Source: Aoun et al. (2013)

Table 5.3: Data sources used by MeteoGroup for Block 4 metocean modelling

Source of data	Parameter
CYCOFOS	7-year time series (2009–2016) of current data
CSFR from NOAA	30-year time series (1979–2017) of current and wind data
ERA-Interim from ECMWF	20-year time series (1989–2017) of wind and wave data
MG Metocean wave hindcast	26-year time series (1991–2017) of wave data
MG Metocean regional wave hindcast	26-year time series (1991–2017) of wave data
HYCOM	20-year time series (1992–2012) of current data
OSCAR	20-year time series (1992–2012) of current data
ESA	20-year time series (1992–2013) of wave and wind data
MeteoGroup historical database (GTS in-situ stations)	16-year time series (1996–2016) of wind data
Mediterranean Forecasting System from NEMO	28-year time series (1987–2015) of sea temperature and salinity

Source: MeteoGroup (2019)

Table 5.4: Percentage occurrence of significant wave height (m) measured in Block 4

Percentage occurrence of significant wave height (m)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All year
7.5 - 8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.0 - 7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.5 - 7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6.0 - 6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.5 - 6.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.0 - 5.5	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.5 - 5.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1
4.0 - 4.5	0.4	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.1
3.5 - 4.0	0.7	0.8	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.2
3.0 - 3.5	1.1	1.7	0.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.2	0.5
2.5 - 3.0	1.9	2.8	1.5	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.9	2.3	0.8
2.0 - 2.5	3.8	4.5	3.0	1.2	0.4	0.0	0.0	0.0	0.1	0.2	2.1	3.7	1.6
1.5 - 2.0	7.0	7.5	6.3	5.1	2.0	0.9	0.3	0.2	0.7	1.5	3.7	6.1	3.4
1.0 - 1.5	15.9	14.4	15.4	15.9	10.8	10.1	9.5	4.9	6.9	5.3	8.4	12.4	10.8
0.5 - 1.0	29.1	28.8	31.2	33.2	34.8	47.5	62.8	56.4	38.9	26.1	22.2	26.9	36.6
0.0 - 0.5	39.8	38.6	41.2	43.9	52.0	41.5	27.4	38.5	53.4	66.8	61.9	46.3	45.9
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100
Minimum	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
Average	0.9	0.9	0.8	0.7	0.6	0.6	0.7	0.6	0.5	0.5	0.6	0.8	0.7
Maximum	6.1	6.0	5.0	4.2	3.0	2.2	2.0	1.7	2.2	3.0	5.2	6.1	6.1
Standard deviation	0.7	0.8	0.6	0.5	0.4	0.3	0.2	0.2	0.3	0.3	0.6	0.8	0.5

Source: MeteoGroup (2019)

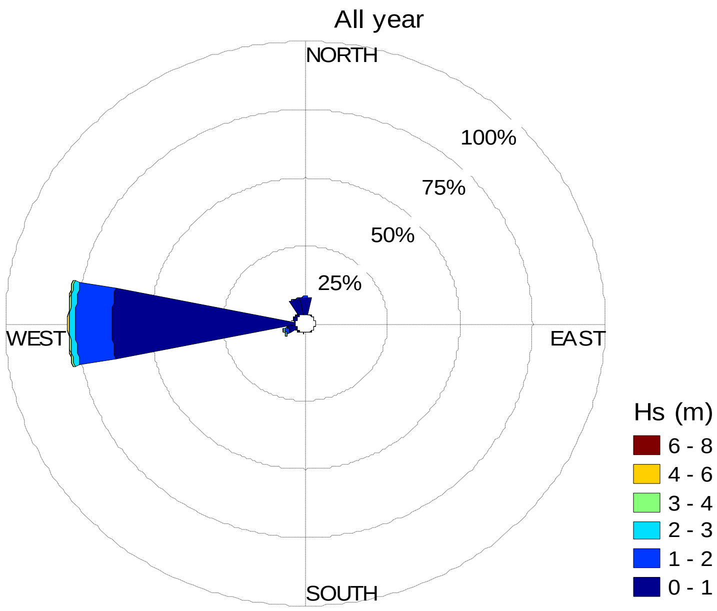


Figure 5.10: Wave rose for measured for the year in Block 4

Source: MeteoGroup (2019)

Wind

Results of wind speed and direction models (shown in Figure 5.11 to Figure 5.14) show that there is a variation in wind speed pattern and wind direction (especially at Tyre, the centre of directional change) between the north and the south of the Levantine coast of Lebanon (Safadi, 2016). This also applies to offshore areas up to 40 km off the coast, especially in the morning, but also in the evening during the summer season. No violent winds are recorded even in winter, during which the strongest recorded wind did not exceed 4 on the Beaufort scale. The generated models nevertheless show some variations in wind direction patterns. The known predominant winds during May and October are north-westerly, southerly and south-westerly. A noticeable difference in wind direction is observed between the northern and southern coast, especially at Tyre (Safadi, 2016).

Percentage occurrence of wind speed and direction were modelled for Block 4 at the single point metocean station. The CFSR dataset was used to derive wind extremes (MeteoGroup, 2019). Table 5.5 presents the results of the percent occurrence of wind speed (m/s) and Figure 5.15 shows the wind direction for the year (MeteoGroup, 2019). Wind speeds ranged from 0 to 21.0 m/s with an average of 4.4 m/s (Table 5.5). Wind direction was predominantly from the southwest (Figure 5.15).

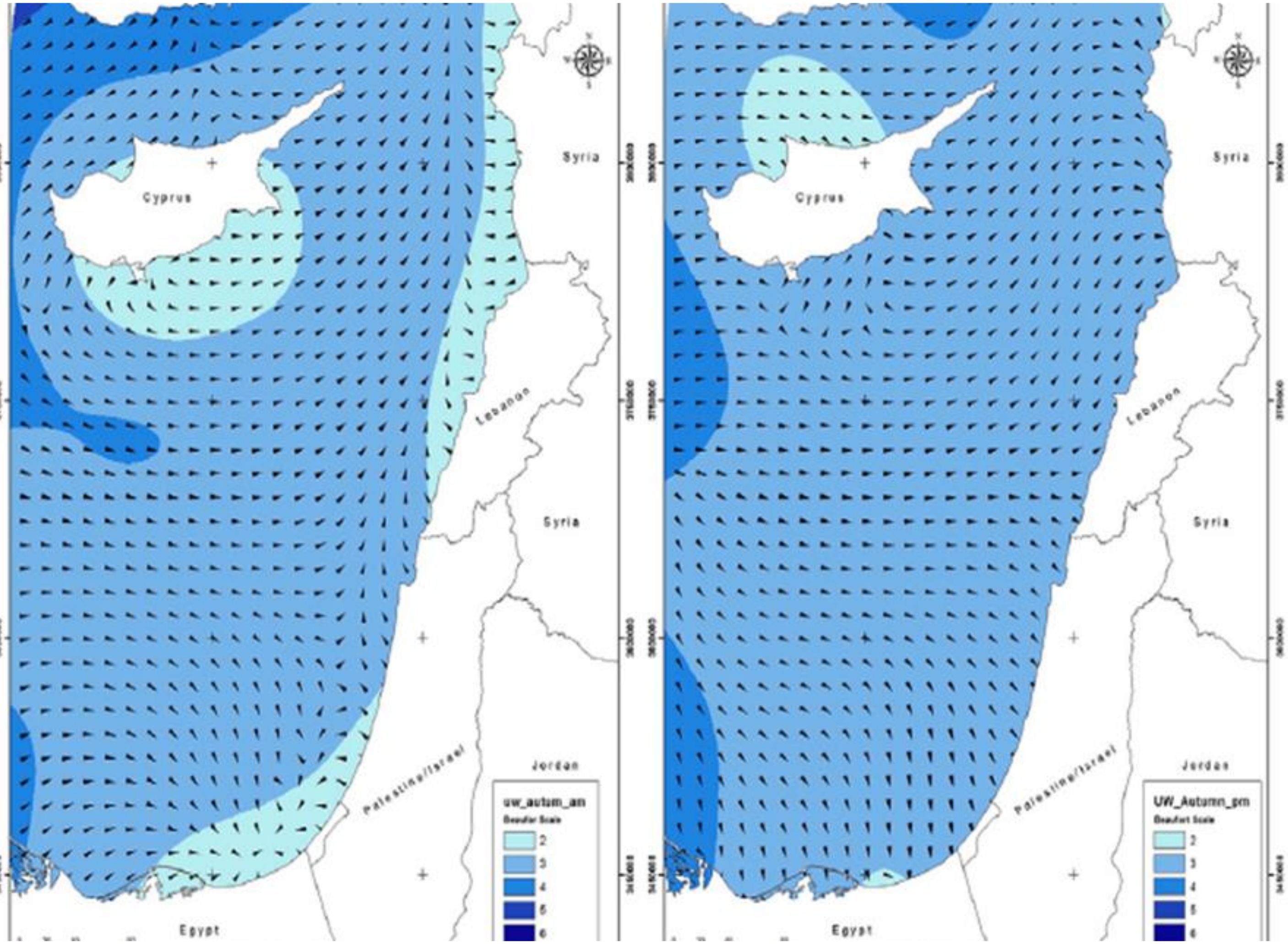


Figure 5.11: Wind speed and direction models for autumn: morning (left) and afternoon (right)

Source: Safadi (2016)

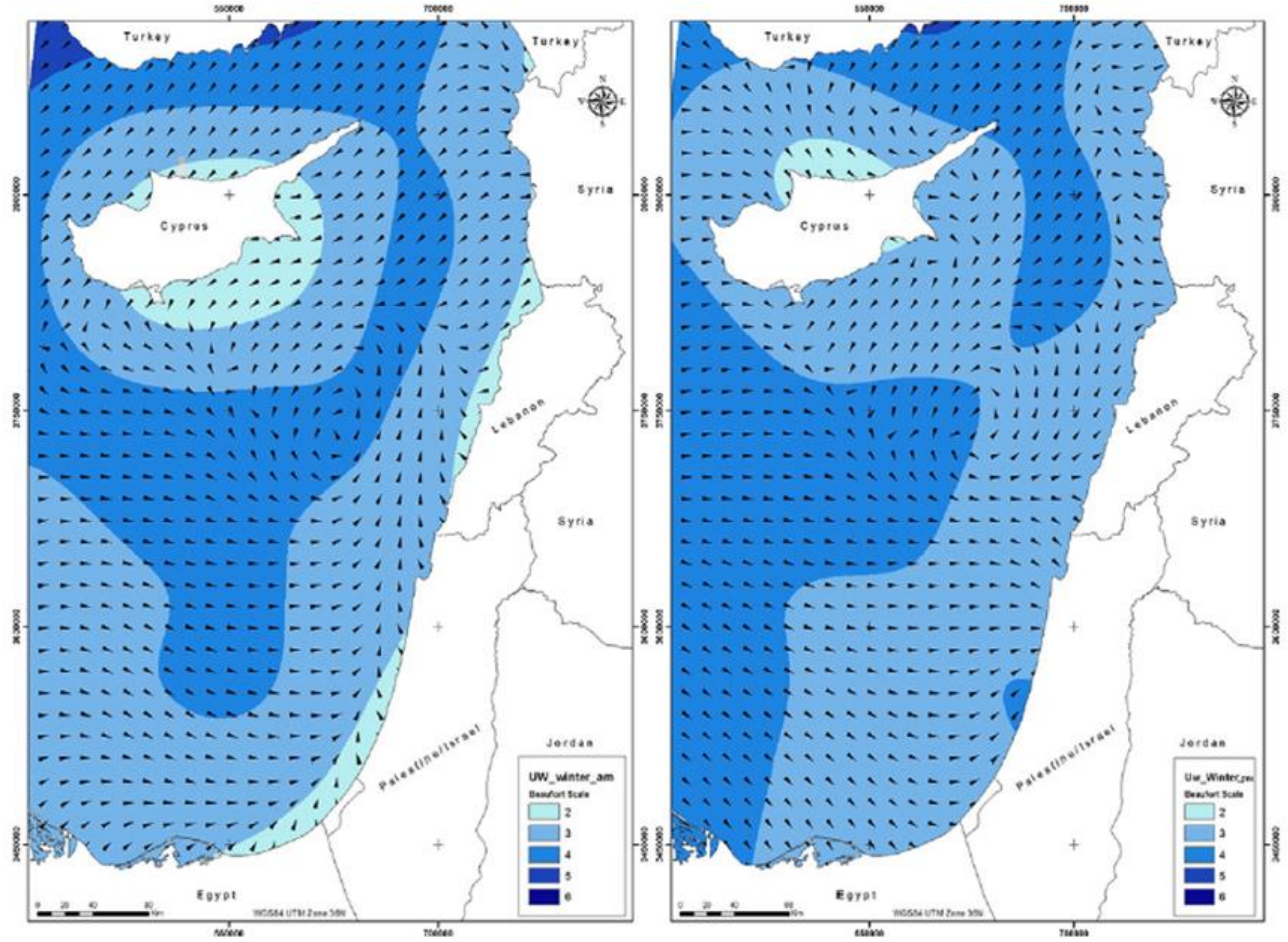


Figure 5.12: Wind speed and direction models for winter: morning (left) and afternoon (right)

Source: Safadi (2016)

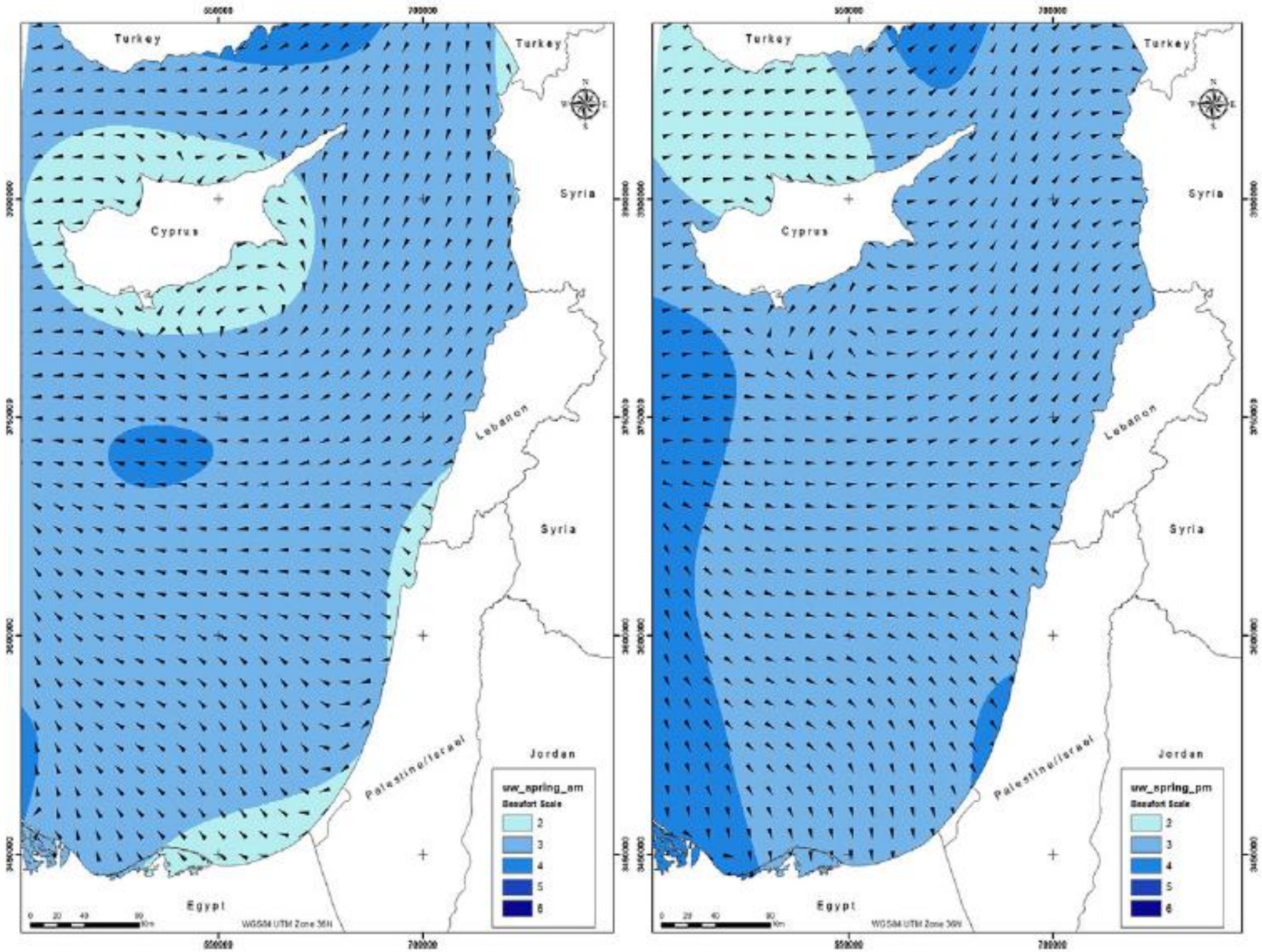


Figure 5.13: Wind speed and direction models for spring: morning (left) and afternoon (right)

Source: Safadi (2016)

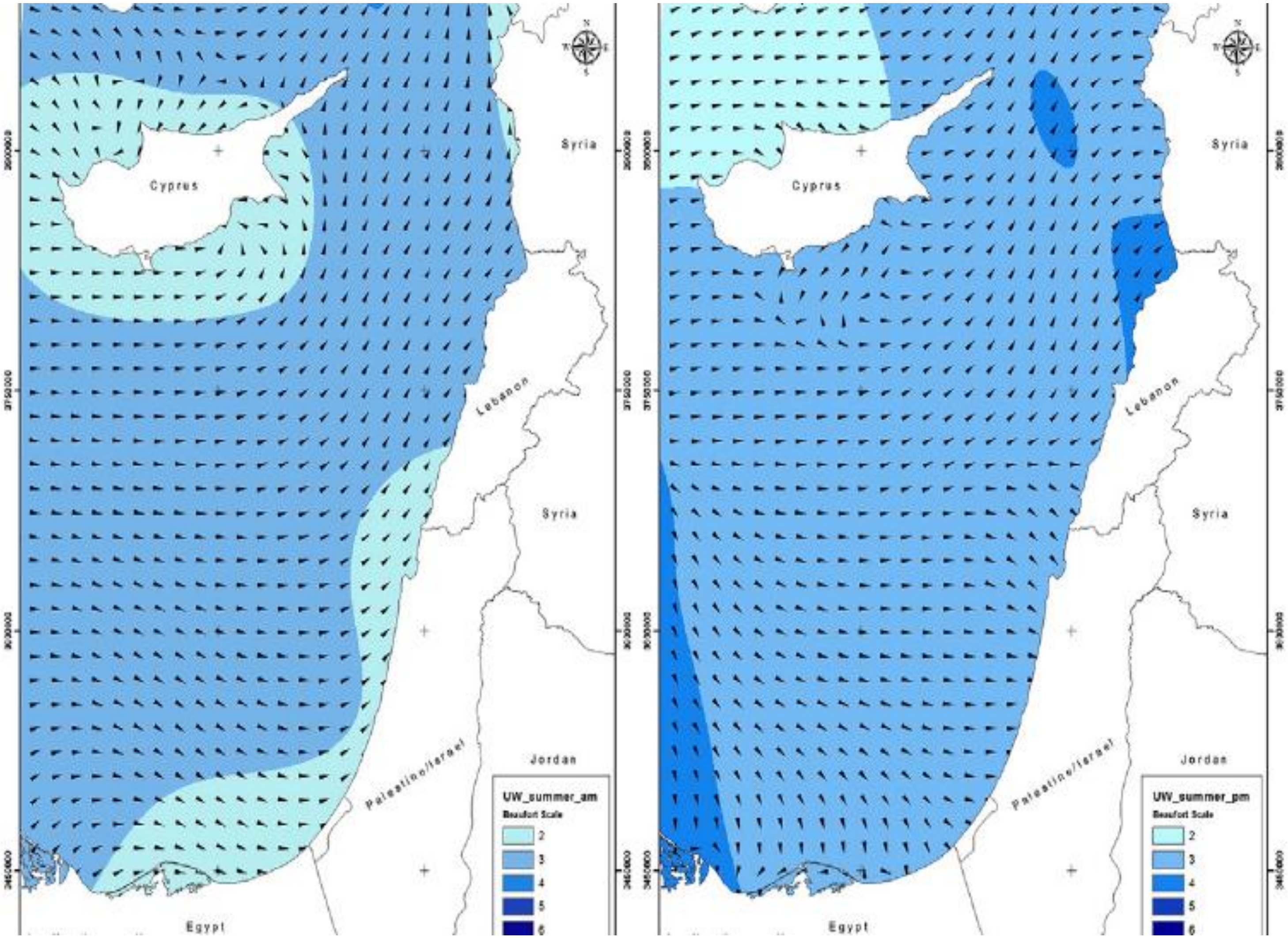


Figure 5.14: Wind speed and direction models for summer: morning (left) and afternoon (right)

Source: Safadi (2016)

Table 5.5: Percentage occurrence of wind speed measured in Block 4

Percentage occurrence of wind speed (m/s)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All year
20 - 21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19 - 20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18 - 19	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17 - 18	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16 - 17	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
15 - 16	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
14 - 15	0.3	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.1
13 - 14	0.5	0.5	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.6	0.2
12 - 13	0.9	1.0	0.7	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.5	1.0	0.4
11 - 12	1.6	1.7	1.2	0.6	0.2	0.1	0.0	0.0	0.0	0.1	0.8	1.5	0.7
10 - 11	2.0	2.6	2.0	1.2	0.6	0.3	0.0	0.0	0.1	0.3	1.1	2.3	1.0
9 - 10	3.0	3.6	3.5	2.8	1.6	0.9	0.4	0.2	0.4	0.7	1.8	3.1	1.8
8 - 9	4.1	4.4	4.5	4.6	3.1	2.4	2.2	0.8	1.5	1.4	2.4	4.1	2.9
7 - 8	6.4	5.9	7.2	7.4	5.8	6.3	6.1	3.5	4.3	3.3	3.3	5.4	5.4
6 - 7	8.1	9.2	10.0	10.5	9.8	10.1	12.6	9.6	8.3	6.0	5.5	6.4	8.8
5 - 6	10.7	11.5	13.2	15.0	14.1	14.6	20.0	18.4	14.1	11.2	9.5	8.9	13.4
4 - 5	12.7	15.3	16.5	16.5	18.2	19.9	20.4	21.6	19.1	19.0	16.3	13.2	17.4
3 - 4	17.1	16.8	16.9	16.5	17.4	18.1	16.6	17.8	18.5	20.9	20.4	17.4	17.9
2 - 3	16.0	14.0	12.5	12.6	14.8	14.0	11.6	14.9	16.9	18.5	19.6	17.8	15.3
1 - 2	11.7	9.4	8.5	8.6	10.3	10.2	7.5	9.9	12.1	13.4	13.9	13.1	10.7
0 - 1	4.2	3.2	2.9	3.3	3.8	3.2	2.5	3.2	4.6	5.0	4.5	4.7	3.8
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100
Minimum	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Average	4.7	4.9	4.9	4.7	4.3	4.3	4.5	4.1	3.9	3.7	4.0	4.5	4.4
Maximum	21.0	19.6	17.7	14.8	14.6	12.5	10.1	10.2	12.7	13.5	16.7	19.4	21.0
Standard deviation	2.9	2.9	2.6	2.3	2.1	2.0	1.8	1.7	1.9	1.9	2.4	2.9	2.4

Source: MeteoGroup (2019)

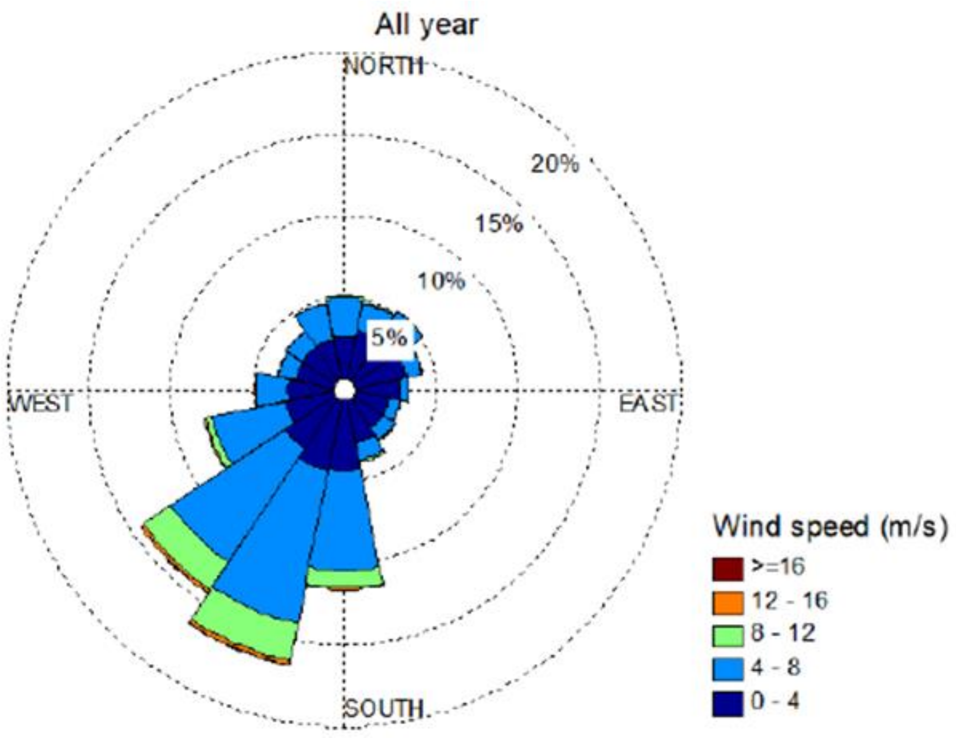


Figure 5.15: Year-round wind rose for a single location in Block 4

Source: MeteoGroup (2019)

5.3.1.3 Circulation

The study area for circulation encompasses the Mediterranean, with greater focus on the eastern Mediterranean basin. This study area provides context for Lebanese waters, with no AOI specified as the project will not affect this component of the environment.

Winter circulation through the Mediterranean is generally counter-clockwise, while in summer, the closest gyre system to Lebanese waters is the Shikmona and Mersa Matruh gyre system located just south-east of Cyprus (Würtz, 2010).

The water circulation in the deep Mediterranean is dominated by the dynamics of the regional seas, the Adriatic and the Aegean, and the transport through the Gibraltar and Sicily straits. The eastern Mediterranean deep water (EMDW) is formed by the Aegean deep water (AeDW) and Adriatic deep water (AdDW), while the western Mediterranean deep water (WMDW) is formed by the Tyrrhenian deep water (TDW) and the Gulf of Lions deep waters. The water depth in the eastern Mediterranean basin is 4000–5000 m, which is deeper than the water depths in the southern Aegean and southern Adriatic parts of the EMDW (1000–1500 m). This generates a current due to water moving to fill the deeper area in eastern Mediterranean basin (El-Geziry and Bryden, 2010). The EMDW flows into the western Mediterranean basin at the deepest point on the Tunisian side because of the Coriolis force influence. The AeDW provides a warmer, more saline and denser deep-water mass in the eastern Mediterranean (Würtz, 2010).

The average renewal time of the deep waters of the Mediterranean is 126 years, considering that the upper boundary of the deep regime is of 1200 m.

5.3.1.4 Currents and tides

The study area for currents and tides encompasses the Mediterranean Sea, with more detail provided for the Lebanese coastline. This wide study area provides context for Block 4, with no AOI defined as the project will not affect these components of the environment.

Tidal activity on the Lebanese coast is weak and ranges between 30 and 40 cm in height range. The tidal current along the coast of North Africa generally flows eastward, before turning in a north-eastern-northern direction along the coasts of Lebanon and Syria, where it becomes weak, variable and affected by winds. The speed of this north current has been recorded to exceed 1 knot during strong winds from the west.

According to the tidal movement, flood and ebb currents in the Mediterranean Sea set east and west respectively. The flood current is accelerated by winds blowing from the west and prevented by winds blowing from the east; while the inverse applies for the ebb current (NG-IA, 2017).

Percentage occurrence of current speed and direction were modelled for Block 4 at the single point metocean station. The CYCOFOS data set was used to model currents (MeteoGroup, 2019). Table 5.6 presents the results of the percent occurrence of current speed at the sea surface (m/s) and Figure 5.16 shows the year-round current rose at the sea surface (MeteoGroup, 2019). Current speeds ranged from 0 to 0.9 m/s with an average of 0.2 m/s (Table 5.6). Current direction was predominantly toward the northeast (Figure 5.17). Current data at the sea surface (5–10 m), and at the seabed (1500–1700 m) was used in the drill cuttings dispersion modelling, see Section 6.3.1.2.

Table 5.6: Percentage occurrence of current speed measured at the surface in Block 4

Percentage occurrence of current speed (m/s)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All year
0.9 - 1.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.8 - 0.9	1.0	0.0	0.0	0.0	0.0	0.0	0.6	0.1	0.0	0.0	0.0	0.5	0.2
0.7 - 0.8	0.8	0.1	0.0	0.0	0.0	0.0	1.2	0.3	0.0	0.0	0.0	0.5	0.2
0.6 - 0.7	1.3	0.5	0.3	0.1	0.2	0.0	4.8	2.9	0.4	0.0	0.0	2.8	1.1
0.5 - 0.6	5.2	2.7	0.0	1.2	0.8	1.2	10.6	7.5	2.3	1.2	0.1	5.0	3.1
0.4 - 0.5	13.0	7.1	2.4	3.6	3.2	6.8	18.2	9.7	8.9	3.6	1.2	9.4	7.2
0.3 - 0.4	13.9	15.2	16.5	8.0	10.9	21.0	22.1	15.7	13.3	10.5	4.0	13.3	13.7
0.2 - 0.3	22.8	27.2	24.9	26.2	24.3	31.9	19.9	24.2	16.5	24.5	18.2	16.9	23.1
0.1 - 0.2	30.3	29.8	34.3	38.5	39.9	29.1	15.3	24.3	26.9	35.6	41.6	28.9	31.3
0.0 - 0.1	11.5	17.4	21.5	22.5	20.6	10.1	7.3	15.3	31.7	24.7	34.8	22.8	20.0
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100
Minimum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.1	0.2	0.2
Maximum	0.9	0.7	0.7	0.6	0.6	0.6	0.9	0.8	0.6	0.6	0.6	0.9	0.9
Standard deviation	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.2	0.1

Source: MeteoGroup (2019)

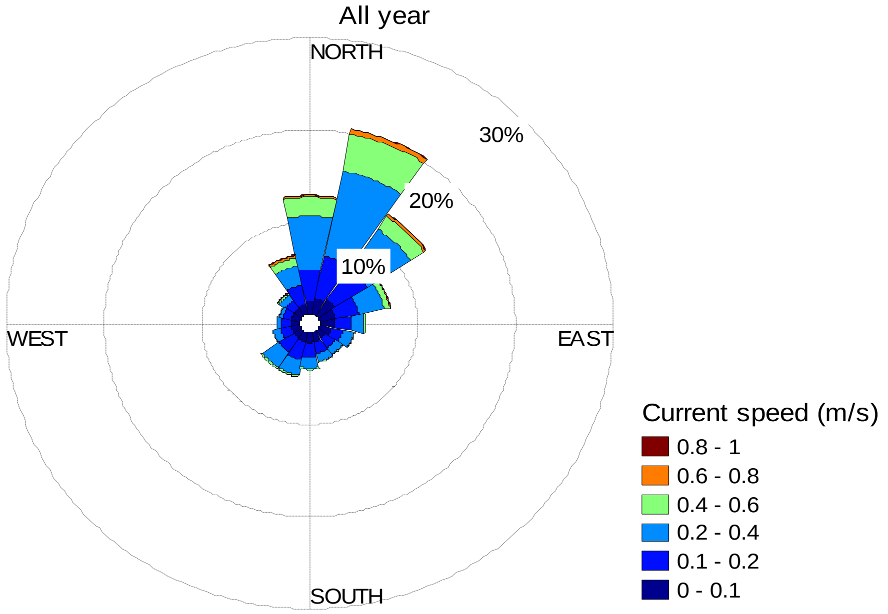


Figure 5.16: Year-round surface current rose for a single location in Block 4
Source: MeteoGroup (2019)

5.3.1.5 Surface temperature and velocity

The study area for surface temperature and velocity encompasses the eastern Mediterranean, with more detail provided for the Lebanese coastline. This wide study area provides context for Block 4, with no AOI defined as the project will not affect these components of the environment.

The data for surface water velocity and temperature in the eastern Mediterranean was provided by the Cyprus coastal ocean forecasting system (CYCOFOS). Figure 5.17 shows the data on 4 February 2016 where the surface current direction in Lebanese waters is northwards.

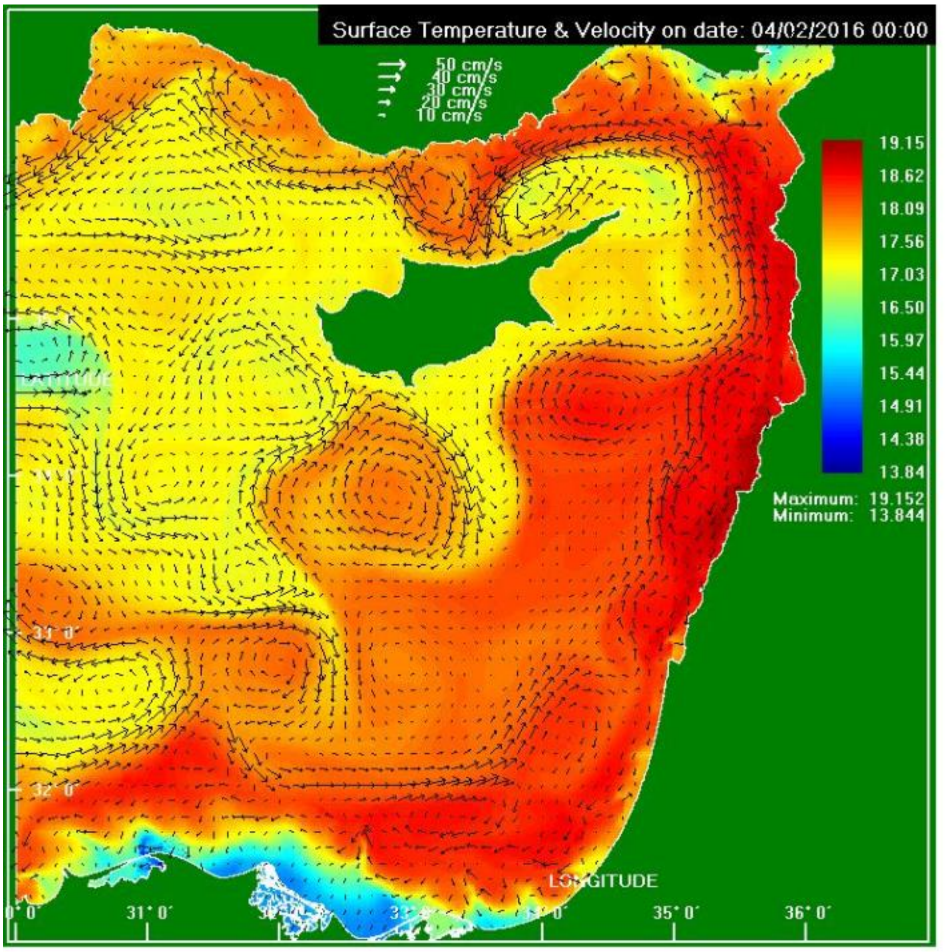


Figure 5.17: Surface temperature and velocity in the East Mediterranean on 4 February 2016

Source: Cyprus coastal ocean forecasting system (CYCOFOS)

Surface water temperatures show significant fluctuations, ranging from 17.3°C in January to 28.9°C in August. Winter is characterised by a vertical homothermy at around 17°C in the uppermost 100 m, which persists until April when a gradual warming of this layer occurs (Abboud-Abi Saab 2008a; Lakkis 2011; Lakkis et al., 2011). Table 5.7 shows the four permanent water layers that characterise the eastern Mediterranean Sea and Table 5.8 shows the water layer characteristics modelled for Block 4.

Table 5.7: Water layer characteristics in the eastern Mediterranean Sea

Water layers	Depth (m)	Temperature (°C)	Salinity (%)
Surface water	30–50	22–29	38.80–39.30
Low salinity water mass	50–75	18–23	38.60–38.80
Intermediate water	150–400	16–17	<39
Deep water	>400	14–15	About 39

Source: Abboud-Abi Saab (2008a), Lakkis (2011), Lakkis et al. (2011)

Table 5.8: Water layer characteristic in Block 4

Water layer	Average depth (m)	Average temperature (°C)	Average salinity (%)
Surface water	30–50	19.75	39.11
Low salinity water mass	50–75	19.75	39.11
Intermediate water	150–400	15.73	39
Deep water	>400	13.45	38.88

Source: MeteoGroup (2019)

During October 2016, OCEANA carried out a research cruise in Lebanese waters across five areas off the coast of the country. Oceanographic parameters were recorded among others using a conductivity, temperature and depth (CTD) instrument where conductivity, temperature, pressure, turbidity, dissolved oxygen, pH, salinity and chlorophyll-a were monitored. Although the complete monitoring results are not published, examples of temperature are shown in Figure 5.18.

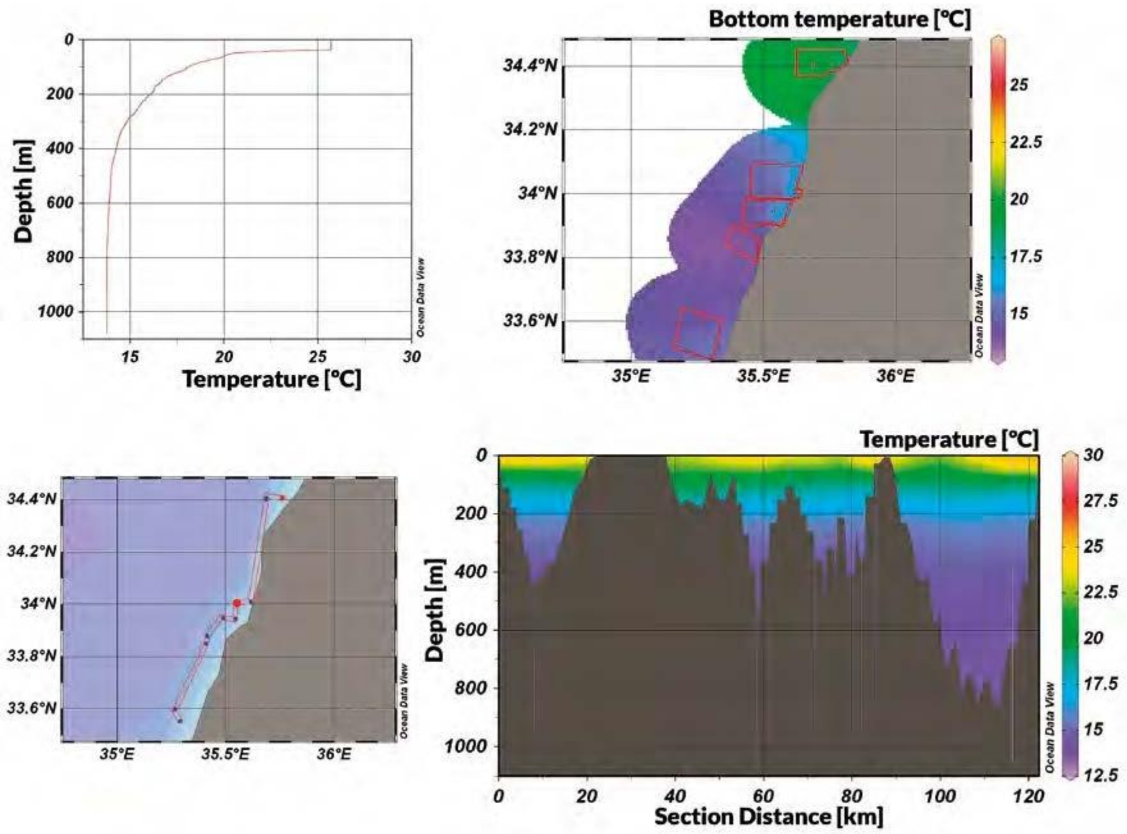


Figure 5.18: Bottom temperature gradient across the sampled areas and temperature gradient across the sampled depths

Source: Aguilar et al. (2018)

5.3.1.6 *Seawater quality*

The AOI for seawater quality is up to a radius of 25 km around the proposed well sites. Routine events near the proposed well locations and the transit corridors for the supply/support vessels will create localised effects on seawater quality, as well as within the Port of Beirut. Discussion of baseline seawater quality focuses on Block 4 presenting results from the EBS study conducted by Keran Liban/Creocean.

The study area encompasses the eastern Mediterranean to provide context for Lebanese waters. Water quality in the eastern Mediterranean, including Lebanon, is affected by many sources of pollution, ranging from river discharge, industrial effluent, coastal landfills and untreated wastewater discharge.

Existing information on seawater quality in Lebanon is based on four studies on coastal water quality by the National Centre for Marine Sciences and the National Council for Scientific Research (NCMS-CNRS) (2018), CANA-CNRS (CANA scientific research vessel) research cruises (2014), Fallah et al. (2016) and CNRS (2019). These studies concluded the following:

- biological contamination in Tripoli, Antelias and Beirut
- a strong positive correlation between high bacteriological contamination and a relatively high concentration of nitrate and phosphate at Saida and Ramlet El-Bayda public beaches, mainly due to domestic waste
- a high concentration of phosphate at Selaata and Antelias industrial sites
- a higher concentration of nitrites and nitrates at the seawater–freshwater interface between Jbeil and Nahr Brahim in 2014 when compared to the control site of Enfeh
- concentrations of metals (copper, chromium and lead) in Al Mina (Tripoli) exceeded the toxicity reference value (along with significant levels of bacteriological contamination attributed to untreated sewage dumping in coastal waters).

These results demonstrate the presence of organic waste and bacterial pollution at the two public beaches, the leakage of industrial chemical to the marine environment at the industrial site, and the effect of continental freshwater on the variability of the seawater characteristics. Table 5.9 shows cities, sampling locations and the nature of contamination recorded.

Table 5.9: Summary of seawater contamination at selected sites on the coast of Lebanon

Cities	Sampling location	Nature of contamination			
		Biological	Chemical toxicity	Eutrophication	Trace metals
Enfeh	Enfeh coastline	○	○	○	x
Tripoli (Al Mina)	Al Mina coastline	●	○	○	●
Antelias	Industrial	●	●	●	x
Beirut	Beirut coastline	●	○	○	x
Saida	Public beach	●	●	●	x

Cities	Sampling location	Nature of contamination			
		Biological	Chemical toxicity	Eutrophication	Trace metals
Ramlet El-Bayda	Public beach	●	●	●	x
Selaata	Industrial	○	●	●	x
Jbeil – Nahr Brahim	Seawater – freshwater	○	○	●	x

Notes: ● contamination recorded; x no data available; ○ contamination not recorded.
Source: CANA-CNRS (2014)

Fallah et al. (2016) conducted a study on seawater quality of the Northern Lebanese coast in 2012 in 45 locations along the Mina coastline. Sampling took place in the month of June and November. Results showed the following:

- There was a slight decrease in temperature between June and November, ranging from 24–25°C and 24–24.8°C respectively.
- pH ranged between 5.25 and 8.75 during June with a mean value of 8.1 and between 4.2 and 7.8 during November with a mean value of 7.8. The lowest pH value recorded was 4.2 at the site of a sewage discharge along the Mina city coastline.
- Levels of dissolved oxygen (DO) during June and December respectively ranged between 1.38–7.8 mg/L and 2.01–7.8 mg/L. The low levels of DO concentration were recorded at sites with sewage discharges and are linked with heavy contamination.
- Electrical conductivity was around 98.8 mS/cm in June and 107.41 mS/cm in November, while total dissolved solids (TDS) ranged between 17,355–975,000 ppm in June and 280,150–1,072,500 ppm in November. According to international standards, ionic concentrations were found in non-contaminated areas.

Trace metals were also measured with results showing that Cr (chromium), Cu (copper) and Pb (lead) exceeded the toxicity reference value (TRV). Microbial analysis for heterotrophic bacteria, total and faecal coliform, *Salmonella* sp. and *Shigella* sp. was conducted showing significant levels of pollution associated to the discharge of untreated sewage in coastal waters (Fallah et al., 2016).

Studies have shown that there are several sources of pollution that can affect water quality in the eastern Mediterranean including Lebanon, such as but not limited to river discharge, industrial effluent, coastal landfills and untreated wastewater. Reports have highlighted that over the years there has been increasing values of pollution in seawater, mainly around the major coastal cities of Lebanon, which reflect the negative impact of anthropogenic sources (discharge of untreated sewage, solid waste, port activities, etc.).

The CNRS conducts monthly sampling at 26 stations along the coast of Lebanon as part of the Coastal Seawater Monitoring Programme. The programme measures biological, chemical and physical parameters. Figure 5.19 summarises the bacterial content of faecal coliform and faecal streptococci in relation to the WHO guidelines (CNRS, 2019).

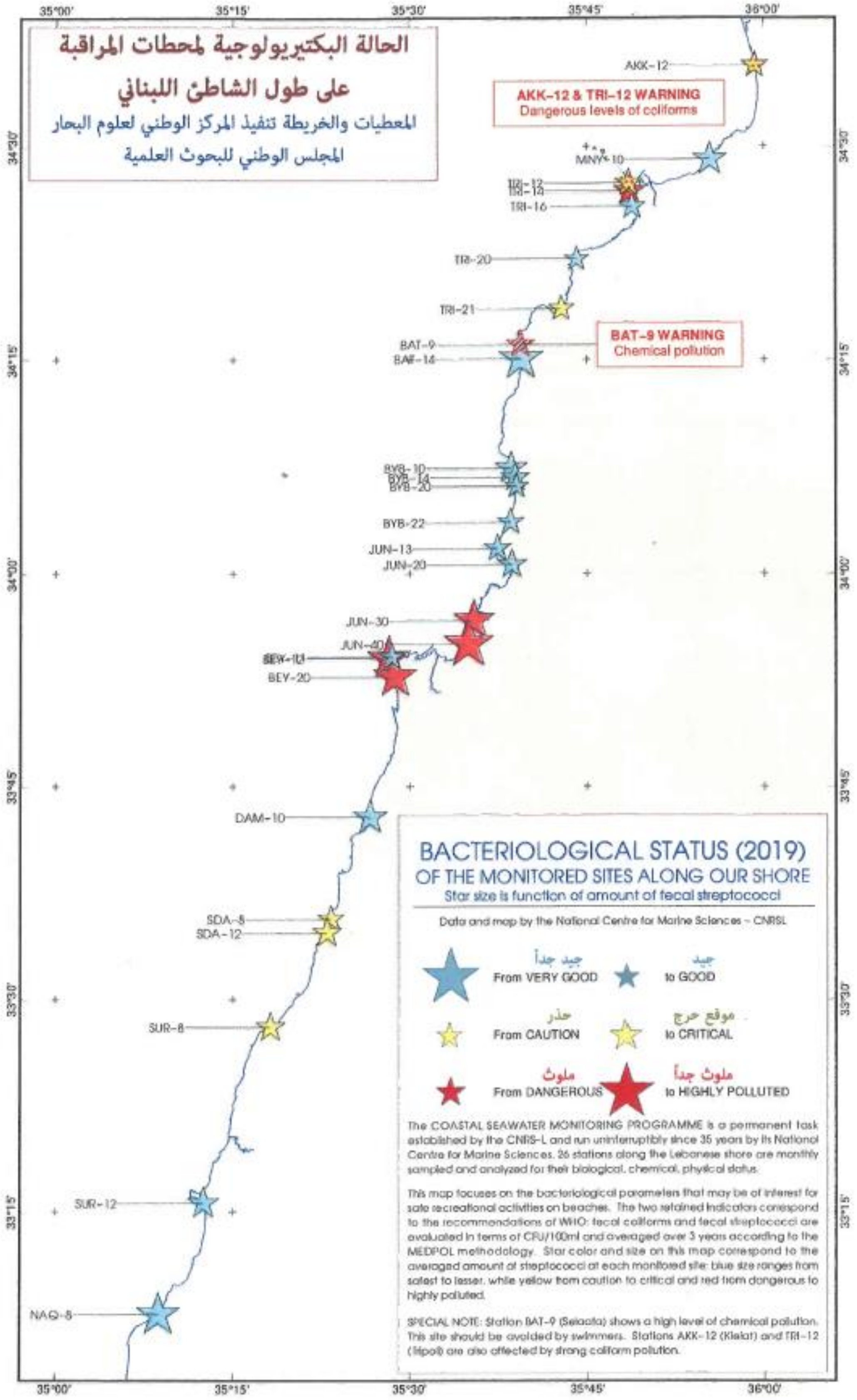


Figure 5.19: Bacteriological status

Source: CNRS (2019)

Nutrients

Nutrients such as phosphates, nitrates and silicates, among others, are known to constitute determinant and limiting factors for microalgae and as well as the whole food web (MoE/UNDP/GEF, 2016). Hydro-climatic and physical-chemical factors play a major role in the transport of nutrients along the water mass as they have the ability to impact the vertical and seasonal variations of plankton populations as well as their distribution (Abboud-Abi Saab et al., 2008a).

During the winter season (December–March), upwelling and seawater mass-mixing create conditions suitable for spring blooms which cause peaks in productivity in the spring season. During the summer hot season (June–October), stratification in the water column along with the shortage of nutrients lowers the quality and quantity of the plankton community (Lakkis, 2011a; Lakkis et al., 2011; Kouyoumjian and Hamze, 2012).

Algal blooms have been observed and will worsen and become more frequent with increasing temperatures due to climate change (Abboud-Abi Saab et al., 2006; Abboud-Abi Saab et al*.,* 2008a; Lakkis, 2011a; Lakkis et al., 2011; Nader, 2011). Algal blooms were observed near the Antelias River estuary and the El Kaleb estuary following a heat wave recorded on 8 May 2007 (Abboud-Abi Saab, 2008).

Abboud-Abi Saab et al. (2008b) conducted an environmental study describing the concentrations of the nutrients and the chlorophyll along the Lebanese coast from the north (Tripoli) to the south (Naqqoura). A total of 215 samples from 18 stations were recorded monthly over one year. Figure 5.20 shows the stations' location, while Table 5.10 summarises data obtained from the 18 stations.

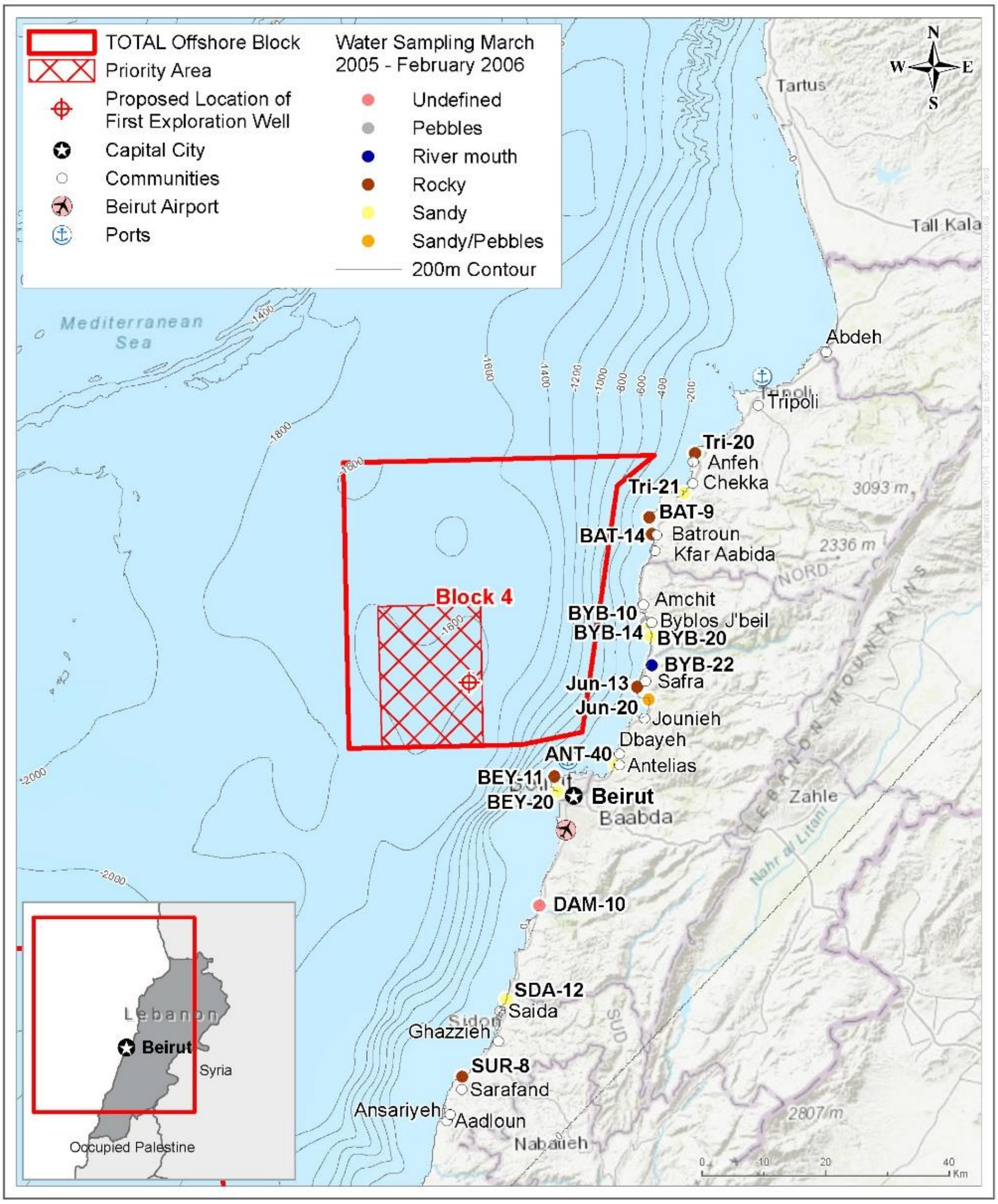


Figure 5.20: Location of water sampling locations from Abboud-Abi Saab et al. study

Source: Based on information from Abboud-Abi Saab et al. (2008b)

Table 5.10: Descriptive statistics (mean, standard deviation, minimum and maximum values) of the parameters measured at the 18 stations

	T°C	Salinity	pH	N-NO2 (μM/L)	N-NO3 (μM/L)	P-PO4 (μM/L)	Chl a (mg/m^3)
Mean	20.41	33.34	7.28	0.19	4.27	0.60	0.72
Min.	21.88	30.31	8.09	0.03	0.31	0.14	0.09
Max.	23.59	39.31	8.25	0.53	10.69	2.88	2.73

Source: Adapted from Abboud-Abi Saab et al. (2008b)

5.3.1.7 Block 4 seawater sampling campaign

Methods

In-situ and discrete seawater quality samples were collected at four stations in Block 4 for water column characterisation and physiochemical analyses. Three of the stations were within the priority area while the fourth station was to the east of this area. Figure 5.21 shows the sampling locations for the entire Block 4 survey campaign, which included seawater sampling, seabed sediment physico-chemistry, benthic communities, seabed video surveying, and marine fauna and seabird visual monitoring. Seawater sampling locations are indicated in Figure 5.21 as blue diamonds.

Laboratory analyses included nutrients, total suspended solids (TSS), heavy and trace metals, total petroleum hydrocarbons (TPH), benzene, toluene, ethylbenzene, xylenes, bacteria, total organic carbon (TOC), polyaromatic hydrocarbons and chlorophyll-a. Seawater samples for the given parameters were collected from three discrete depths: subsurface (10 m below the surface), mid depth (below thermocline, 300 m) and near bottom (25 m above the seabed). Discrete samples were collected using a rosette of 10-L Niskin water samplers.

In-situ measurements were taken throughout the water column at all four stations using a multiparameter probe that measured salinity, temperature, pH, turbidity, depth and dissolved oxygen.

The multiparameter probe was allowed to equilibrate at approximately 5 m water depth for sensor stabilisation then lowered through the water column. Once the device was recovered to the survey vessel, the data was downloaded and quality checked.

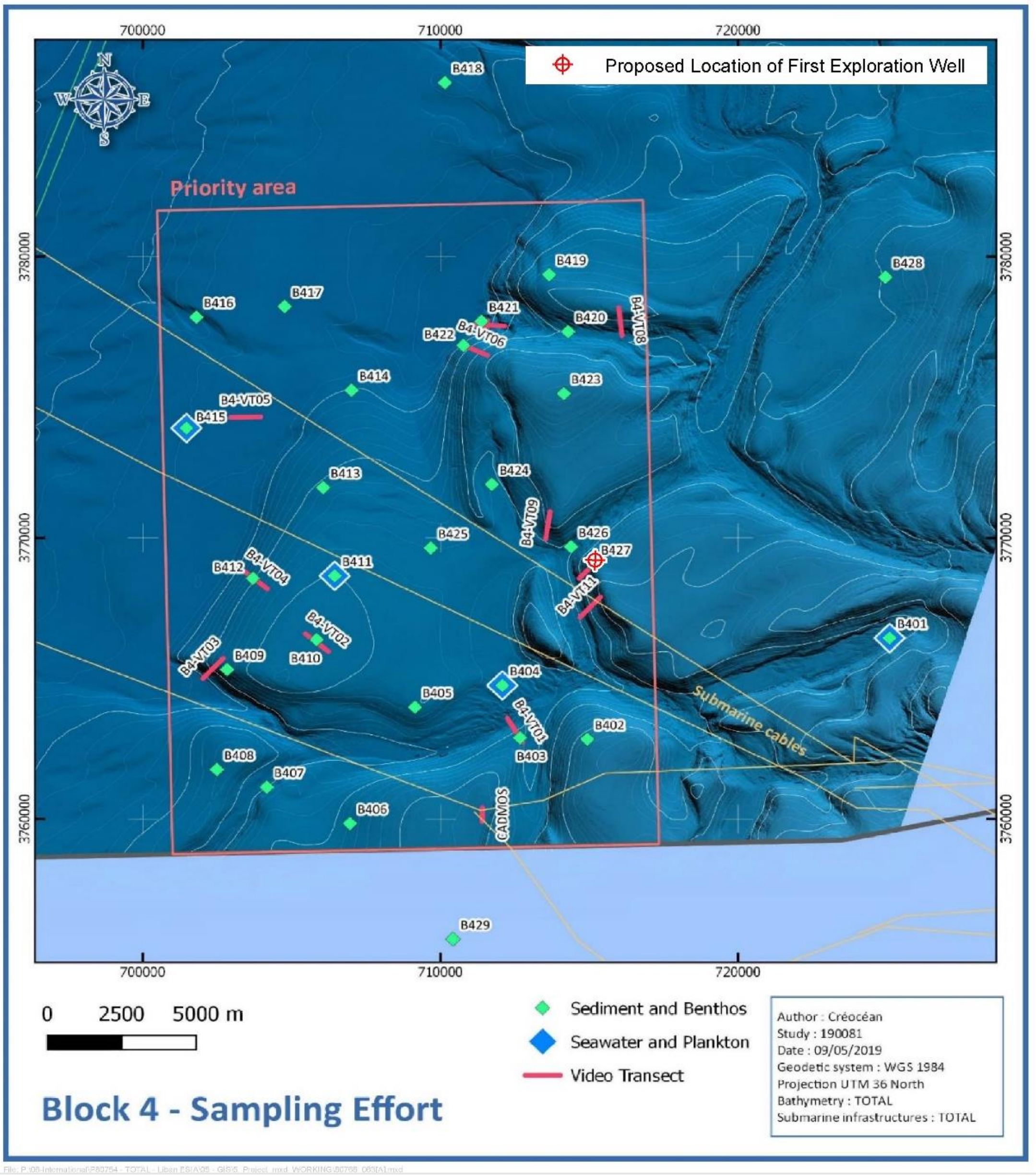


Figure 5.21: Station locations for seawater (blue diamonds), sediment and benthos (green diamonds) and video transects (red lines) sampled during the Block 4 offshore EBS

Source: Keran Liban/Creocean (2019b)

Results

Temperature

Temperatures decreased from 18°C at the surface to 17°C within a few metres. The thermocline recorded with a rapid decrease in temperature from 200–250 m depth to 400–500 m depth, reaching a stable temperature of 14°C. No further decrease in water temperatures was observed below the thermocline. Figure 5.22 presents the depth profile for temperature at all four stations.

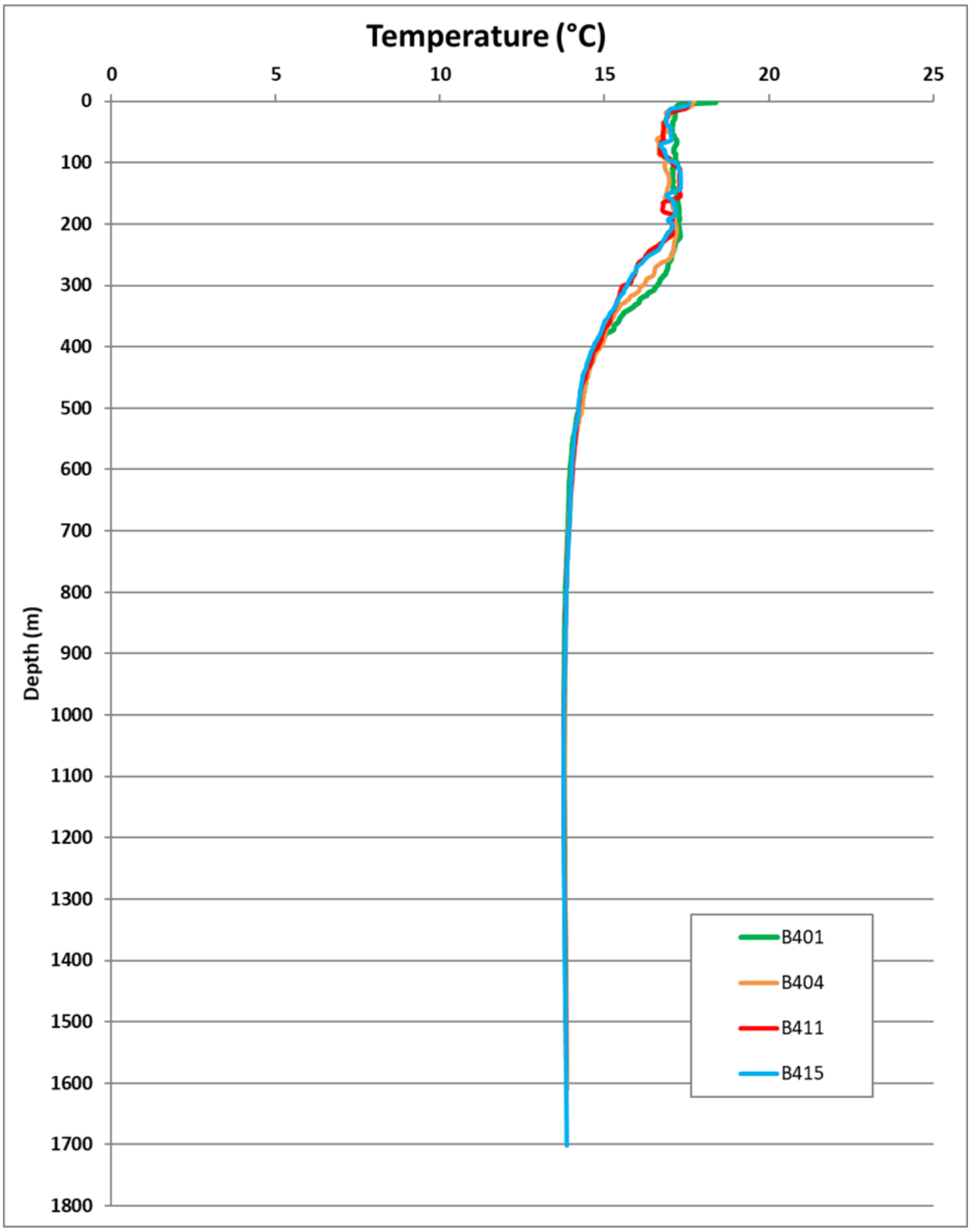


Figure 5.22: Temperature (°C) depth profiles for seawater stations sampled in Block 4
Source: Keran Liban/Creocean (2019b)

Salinity

Salinity ranged from 38.5 to 38.9 practical salinity units (PSU) throughout the water column and is presented for all stations in Figure 5.23. All stations showed a degree of variation in salinity in the upper 500 m, before showing consistent salinities down to seabed depths of between 38.5 and 39 PSU.

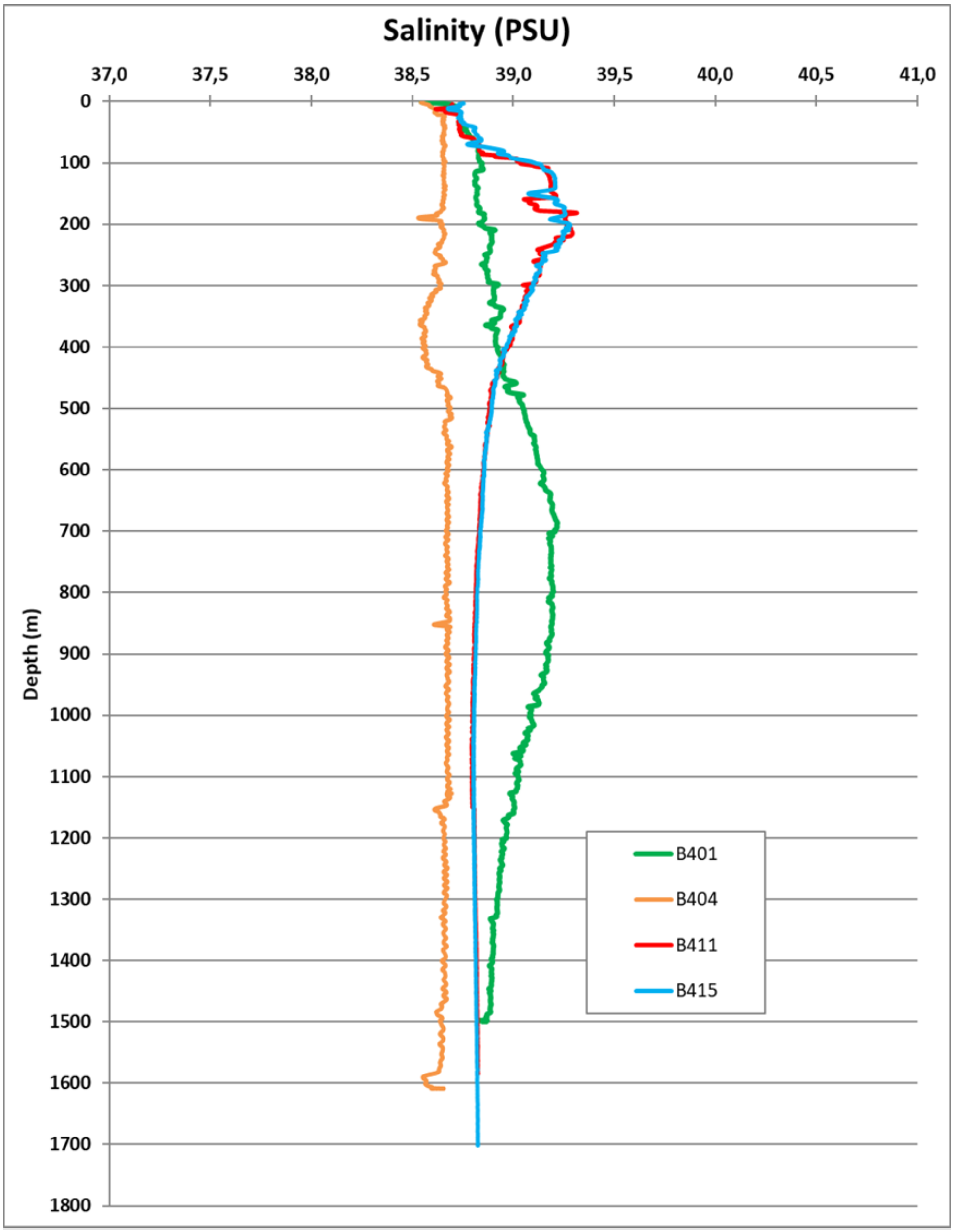


Figure 5.23: Salinity (PSU) depth profiles for seawater stations sampled in Block 4

Source: Keran Liban/Creocean (2019b)

pH

pH ranged between 7.9 to 8.2 at all sampling stations with higher concentrations at the surface than at depth. This range corresponds to typical values of alkaline Mediterranean waters. Figure 5.24 shows the depth profile for pH at the four seawater sampling stations.

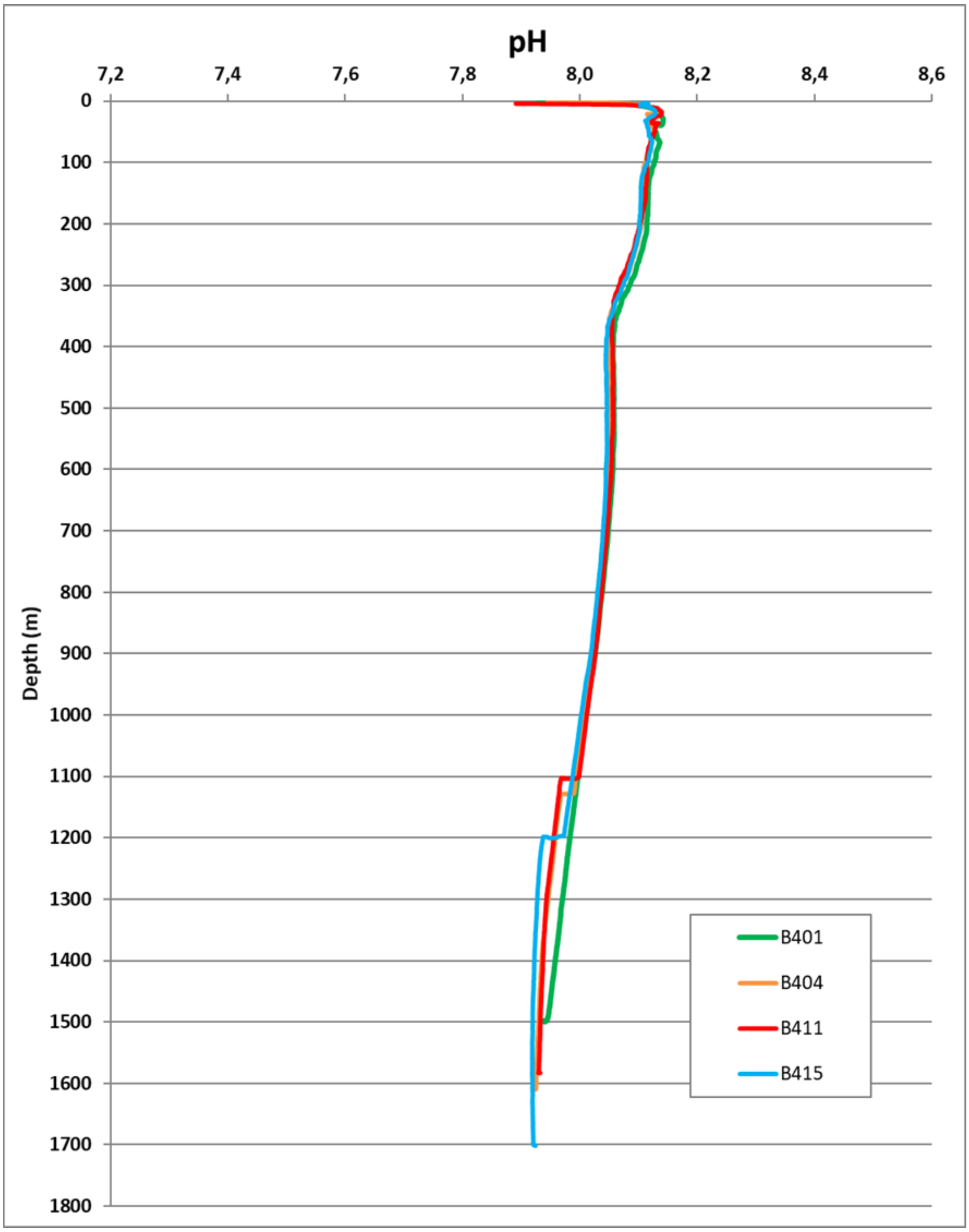


Figure 5.24: pH depth profiles for seawater stations sampled in Block 4

Source: Keran Liban/Creocean (2019b)

Turbidity

Turbidity measurements were <3 nephelometric turbidity units (NTU) at all stations sampling, indicating clear water with very low turbidity throughout the water column, which is considered typical for offshore areas of the eastern Mediterranean. Figure 5.25 shows the depth profiles of turbidity at the four seawater sampling locations.

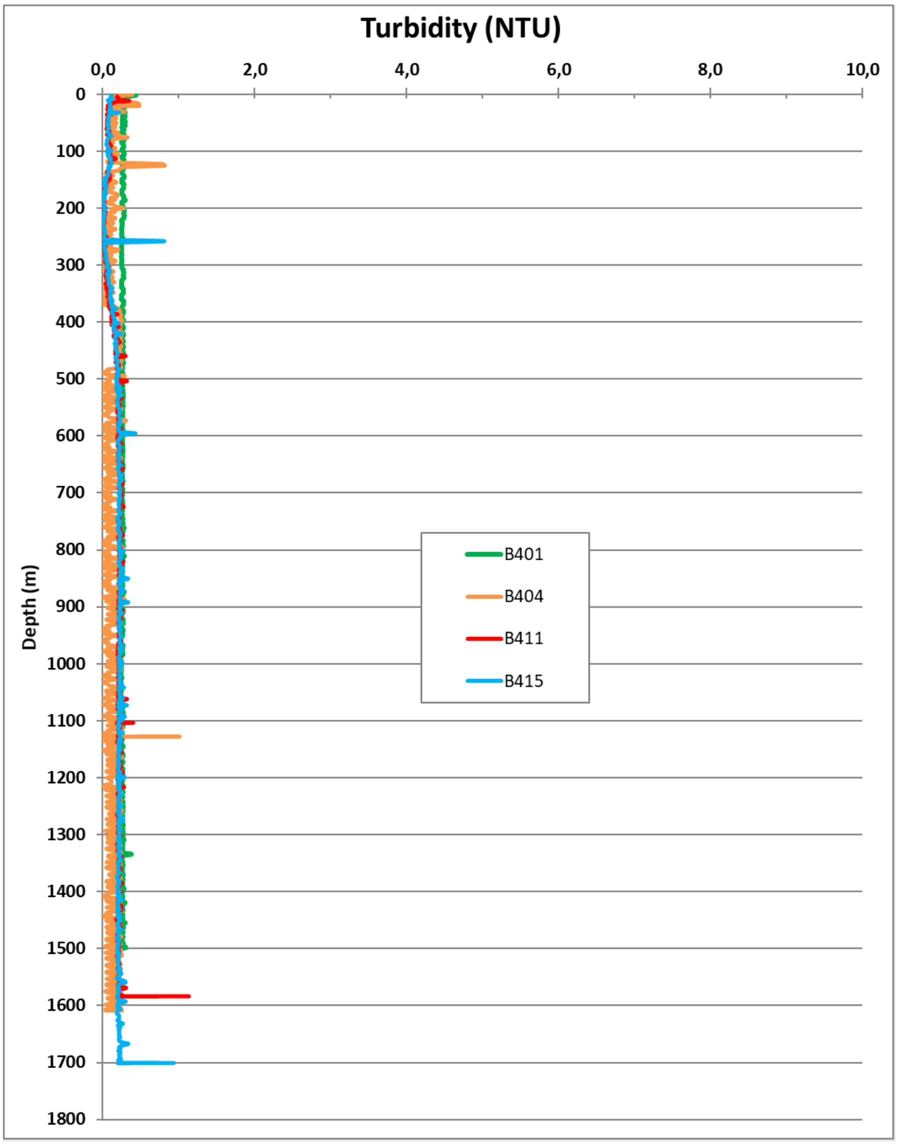


Figure 5.25: Turbidity (NTU) depth profiles for seawater stations sampled in Block 4

Source: Keran Liban/Creocean (2019b)

Total suspended solids (TSS) and total organic carbon (TOC)

Measurements for TSS ranged between <2 and 9 mg/L representing consistently low TSS throughout the water column (Figure 5.26).

TOC (total (particulate and dissolved) organic carbon) concentrations at all stations sampled ranged from 0.63 to 1.8 mg/L with highest concentrations measured in the surface waters and lowest concentrations measured at the seabed (Figure 5.26).This is likely due to the limited contributions of carbon from marine algae at depths below the euphotic zone. These measurements of TOC reflect the general oligotrophic qualities of the eastern Mediterranean waters which are characterised by low organic enrichment and correspondingly low productivity.

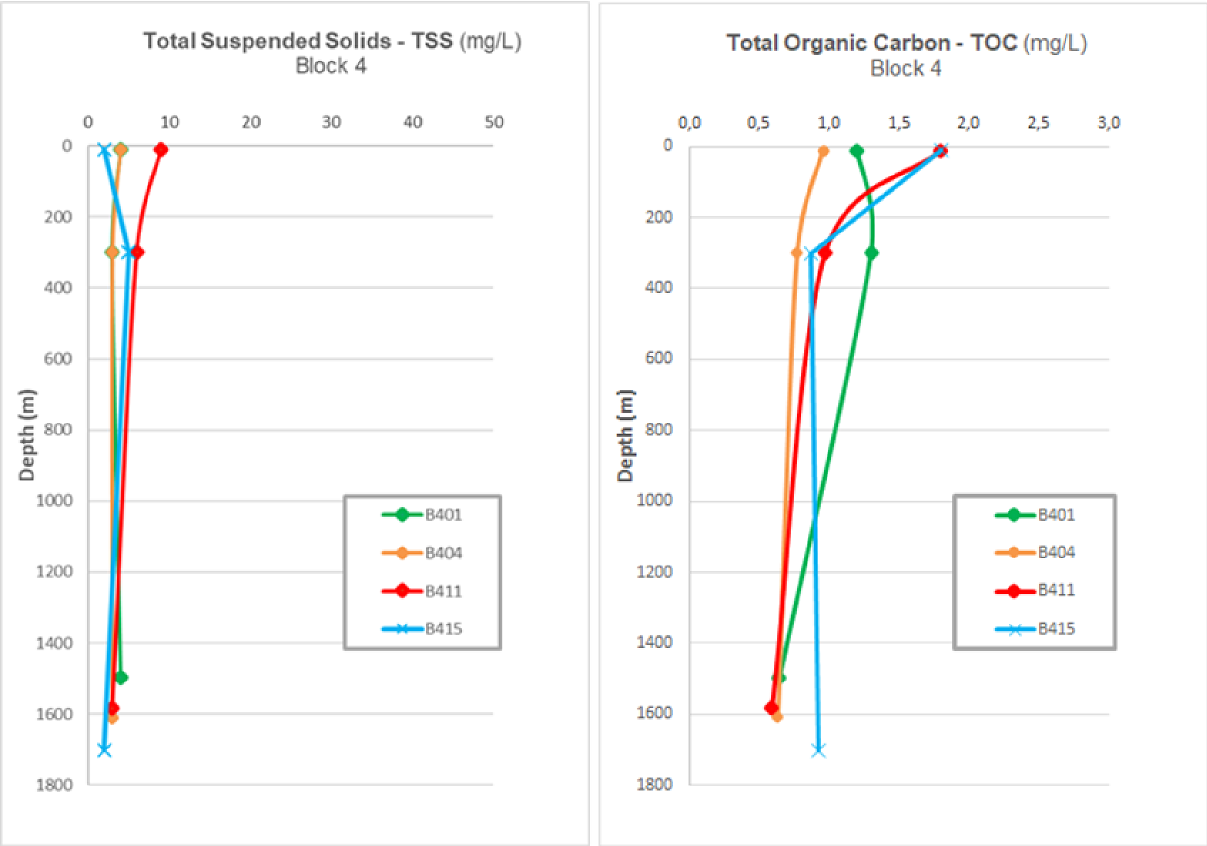


Figure 5.26: TSS (mg/L) and TOC (mg/L) depth profiles for seawater stations sampled in Block 4

Source: Keran Liban/Creocean (2019b)

Nutrients

Total nitrogen, nitrites, nitrates and organophosphates were also measured throughout the water column and presented in Figure 5.27. Most nutrient concentrations at the sea surface were close to zero and then slightly increased with increasing depth through the water column to the seabed. Orthophosphates decreased at the sea surface until the thermocline before gradually increasing or remaining constant with increased depth to the seabed. Surface waters generally contain lower concentrations of dissolved nutrients due to the uptake of nutrients from primary production. Increase in nutrient concentrations in deeper waters is from the lack of mixing of water from below the thermocline and the deposition of organic particles, primarily zooplankton faecal pellets transported from the surface.

Though recorded nutrient concentrations varied slightly, these variations were not significant as all measurements were considered low. The results compared to European Environmental Quality Standards (EQS) for nutrients in seawater (EU, 2008) indicated low nutrient enrichment, which classifies water quality as being very good or good (EQS standards: total nitrogen = ≤0.7–1.05, nitrate = ≤10–50, orthophosphate = ≤0.03[2] and nitrite = <0.3[3]).

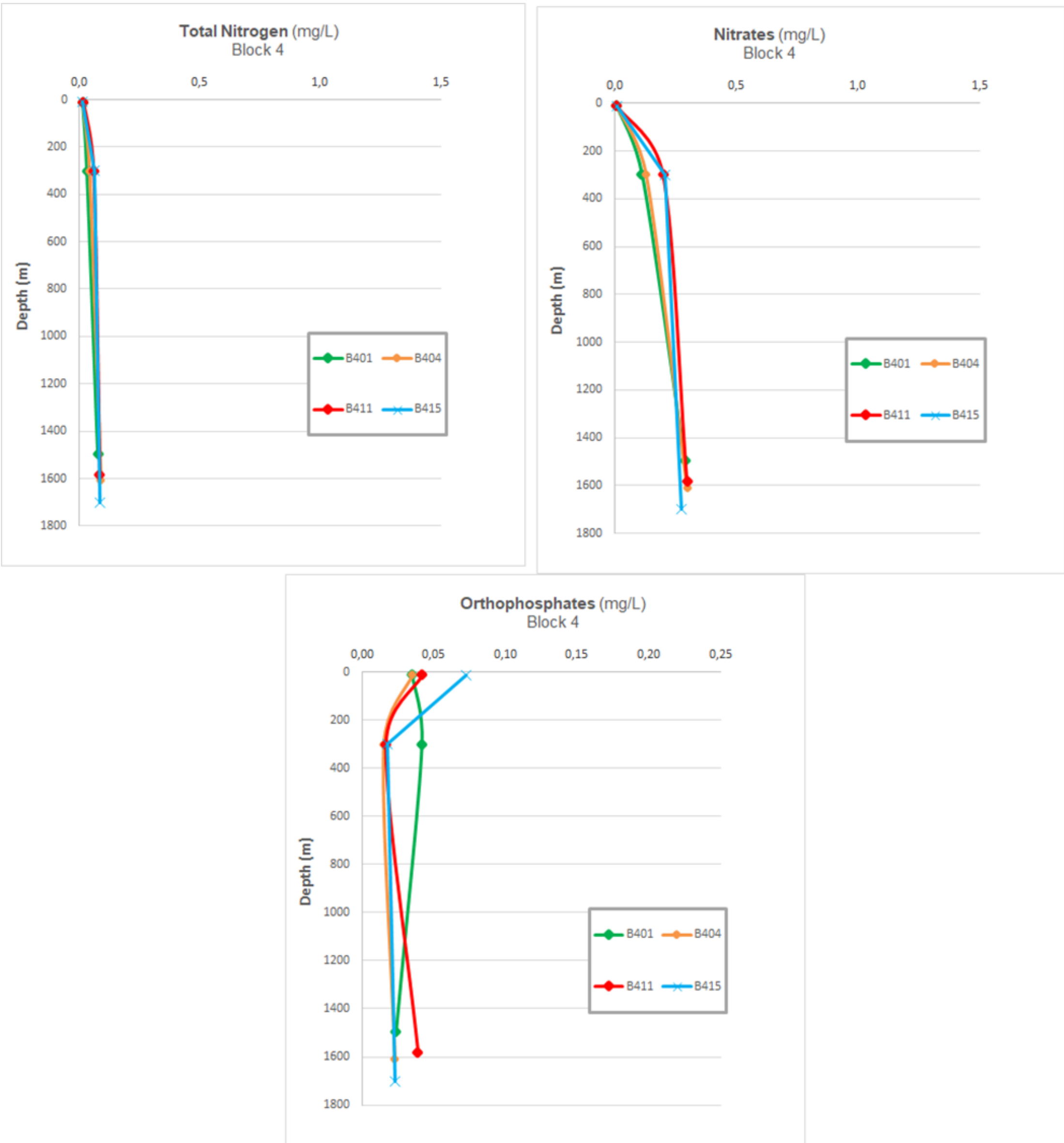


Figure 5.27: Depth profiles for total nitrogen, nitrates and orthophosphates at seawater stations sampled in Block 4

Source: Keran Liban/Creocean (2019b)

[2] WFD 2000/60/EC, Decrees of 25 January 2010 and 27 July 2015

[3] Circular of 07/05/07 defining provisional Environmental Quality Standards (pEQS)

Trace metals

Discrete water samples were analysed for 19 trace metals. The European Union Directive 2008/105/EC provides threshold levels for trace metals based on EQS (EU, 2008). Geochemical background levels (GBL) also exist for the Mediterranean as the theoretical natural background concentration of a metal in a water body (Matschullat et al., 2000, Bruland and Lohan, 2003). According to these standards, cadmium, mercury, nickel and lead are all identified as priority substances owing to the significant risk they pose to the aquatic environment. Cadmium and mercury are regarded as priority hazardous substances due to their toxicity, persistence and bio-accumulation potential. The threshold value for cadmium is less than or equal to 0.45 to 1.5 µg/L, dependent on hardness of water.

Trace metal concentrations measured were very low values for all priority substances and all were below the EQS thresholds (EU, 2008). For other trace-metals, aluminium was detectable at the sea surface at station B404 (20 µg/L) and at the mid-depth of station B401 (10 µg/L). Barium levels were detectable at the near bottom and ranged between 4 to 21 µg/L, which is the same as the GBL (4–21 µg/L) (Bruland and Lohan, 2003). Chromium was detected at all stations but was below the EU Directive threshold levels (0.16–0.26 µg/L[4]) (Keran Liban/Creocean, 2019b). Molybdenum, lithium and vanadium concentrations were detected for some depths at all stations, but again concentrations were below the EU Directive threshold values. It is noted, however, that there is currently no threshold toxicity value for lithium concentrations in seawater. Therefore, the toxicity in the samples cannot be determined.

For all other trace metals, concentrations measured at all stations were below the laboratory detection limits so are not discussed. Water quality at all stations is considered ‘good’, as no trace-metal levels exceeded threshold toxicity values (EU, 2008). These levels are considered typical for offshore areas of the eastern Mediterranean.

PAHs, PCBs, TPH biomarkers, BTEX

Poly-aromatic hydrocarbons (PAH) are identified as priority substances according to the European Union Directive 2008/105/EC (EU, 2008), owing to the significant risk they pose to aquatic environments, their toxicity, persistence and potential to bio-accumulate. Benzo(a)pyrene can be considered as a marker for other PAHs, which has an EQS limit of 0.27 µg/L. PAHs recorded in this study were well below this threshold value (< 0.001 µg/L).

Poly-chlorinated biphenyls (PCB) are classed as priority pollutants owing to their ability to bio-accumulate. Concentrations of PCBs were low in all samples (<0.013 µg/L), so it was not possible to infer contamination levels from these results as the laboratory detection limits for were higher than the EU EQS threshold levels.

Low concentrations of total petroleum hydrocarbon (TPH) were measured at all stations (< 0.01 µg/L). Benzene, toluene, ethylbenzene and xylene (BTEX) levels were below limits of detection for all stations (<1 µg/L) and below the threshold values of the Directive 2008/105/EC (modified by the Decree of 27 July 2018 (benzene) and the Circular of

[4] Circular of 07/05/07 defining provisional Environmental Quality Standards (pEQS)

07/05/07 (other BTEX) in seawater). The EU threshold limit for benzene is an annual mean of 8 µg/L for coastal and transitional waters[5].

Bacteria

Measurements were taken for hydrocarbon-degrading-bacteria and heterotrophic/aerobic bacteria in order to determine overall bacteria concentrations for the stations sampled throughout Block 4. Hydrocarbon-degrading-bacteria in surface waters ranged from 60 to 250 MPN/ml and from < 14 MPN/ml to 25 MPN/ml in near bottom waters.

Heterotrophic and autotrophic bacteria concentrations were high in all samples with the highest concentration of 25,000 MPN/ml. Despite relatively high bacterial concentrations, the ratio between hydrocarbon-degrading-bacteria and heterotrophic/autotrophic bacteria was very low (0.02–1.25%). This suggests that there is no hydrocarbon contamination in the water column of Block 4.

Phytoplankton

The pigments chlorophyll a, b and pheophytin were measured to determine primary production levels and plankton biomass. Chlorophyll concentrations in water samples at all stations were highest at the sea surface indicating the presence of phytoplankton in the surface waters above the thermocline. However, all concentrations were low and consistent with oligotrophic eastern Mediterranean waters. Chlorophyll a is used as an indicator pigment in the EU standards with 0–1.18 µg/L indicating “very good ecological status”. Figure 5.28 presents the depth profile for pigment concentrations.

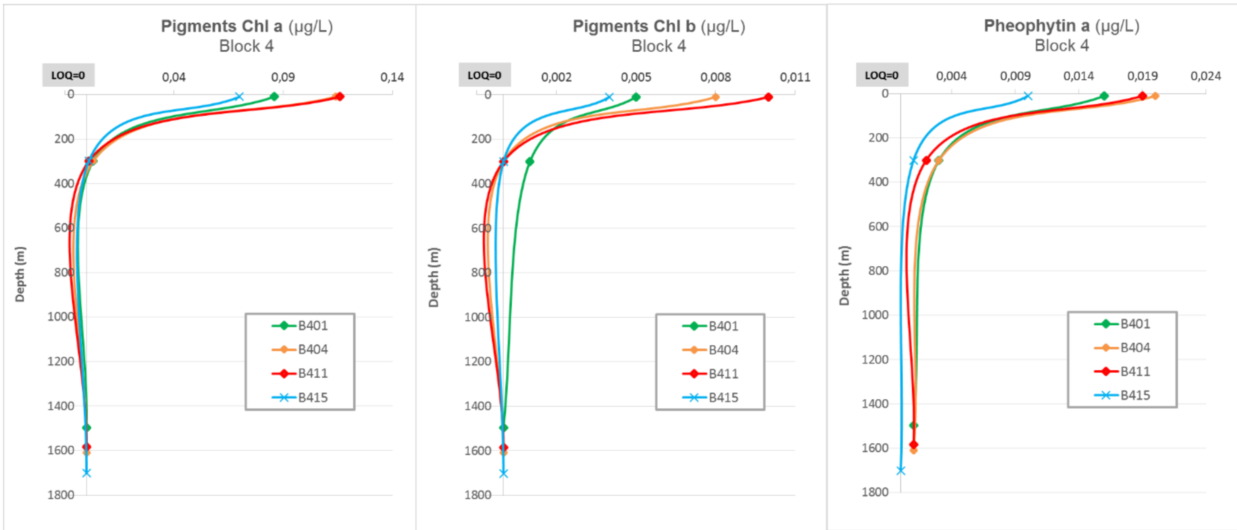


Figure 5.28: Depth profile for chlorophyll a, b and pheophytin concentrations at Block 4

Source: Keran Liban/Creocean (2019b)

[5] EC Directive dated 25 January 2010 (EU, 2010) modified by EC Directive dated 27 July 2018 (EU, 2018)

Conclusion

Overall, the results for seawater quality obtained during the Block 4 survey campaign exhibit seawater that is of low turbidity, oligotrophic in terms of nutrients and uncontaminated. The results for Block 4 are considered representative of conditions typical for offshore locations for the eastern Mediterranean.

The small degree of variation between sampling stations of organic and nutrient content as well as contaminant concentrations indicate a high degree of homogeneity of the environmental conditions throughout the study area.

5.3.1.8 Seawater sensitivity

Based on the low contamination levels offshore and general good water quality, the sensitivity of the system is identified as medium (3). It is not designated as high because the system is low in nutrients (oligotrophic) and has a low capacity to support higher levels of biodiversity. The coastal waters are highly contaminated in certain locations; therefore, the sensitivity is variable but generally considered to have a low sensitivity (2) (pre-existing pollution limits its value)

5.3.1.9 Bathymetry

The study area for bathymetry encompasses the Lebanese EEZ, which provides context for Block 4, with no AOI specified as the project will not affect this component of the environment.

A bathymetric survey of the Lebanese EEZ was conducted in 2003 by the SHALIMAR bathymetric cruise (MOPWT–DGLMT, 2017). According to the survey, the water depth off the coast increases westward to 2000 m in the deep-sea plain of the Levant basin (MOPWT–DGLMT, 2017). The mean depth of the Levant sub-basin in 1451 m (Würtz, 2010).

As defined by Law 163/2011 under the United Nations Convention on the Law of the Seas, the seabed and subsoil that extends beyond the State's territorial sea to the outer edge of the continental margin (the seabed and subsoil of the shelf, the slope and the rise) is termed the continental shelf. When the continental margin does not extend to 200 nm, the corresponding area to 200 nm is included as part of the continental shelf.

The technical definition of a continental shelf is the shallow marine water (100–200 m) on the margins of land masses that overlay an underwater extension of continental land (Figure 5.29). A continental shelf is the portion of a continent submerged under an area of relatively shallow water followed by a precipitous slope.

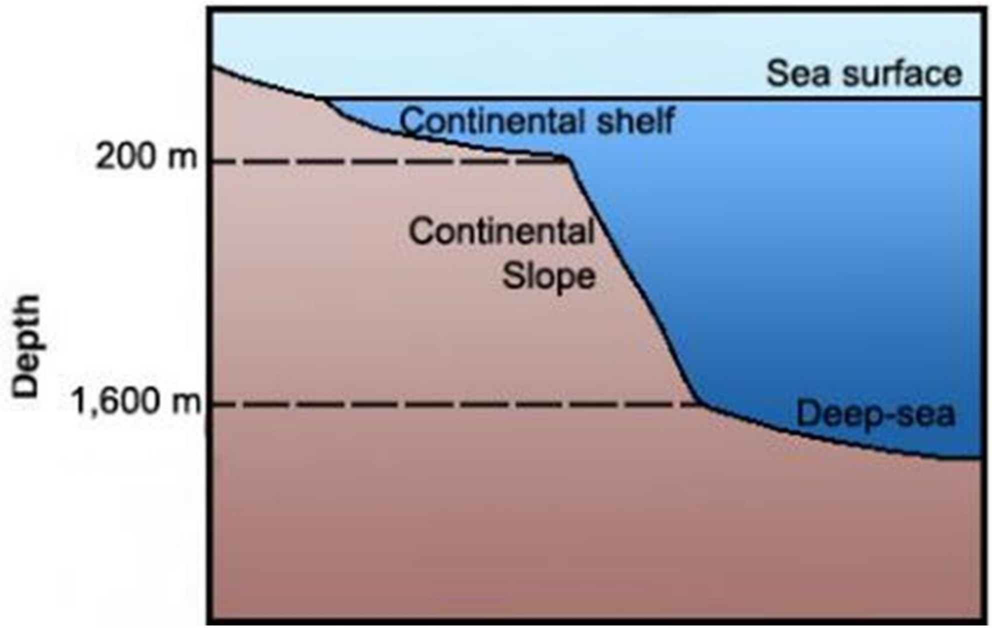


Figure 5.29: Diagrammatic cross section of key geographic features off the coast of Lebanon

Source: Nybakken (2001)

The Lebanese continental shelf itself is relatively narrow and considered the most productive part of Lebanese waters where most fishing activities are concentrated. It can be divided into three main parts:

- between Enfeh and Akkar, the widest part of the continental shelf (18 km)
- between Enfeh and Ras Beirut, the coastal plain is very narrow or almost non-existent (in this part, the continental shelf does not extend to more than 3 km)
- between Ras Beirut and Naquoura, the continental shelf widens reaching 7 km.

Between Beirut and Batroun, the shelf is extremely narrow and the margin exhibits its steepest slope, with the water depth dropping from 100 to 1500 m in less than 5 km in some areas (MOPWT–DGLMT, 2017).

The bathymetry of shallower waters (0–200 m depth) between the coast and up to 10 km seaward is currently being surveyed. Once complete this will connect the inland geomorphology with the seabed relief already mapped during the SHALIMAR bathymetric survey (MOPWT–DGLMT, 2017).

Numerous submarine canyons are found past the continental shelf within the Lebanese EEZ (Figure 5.30).

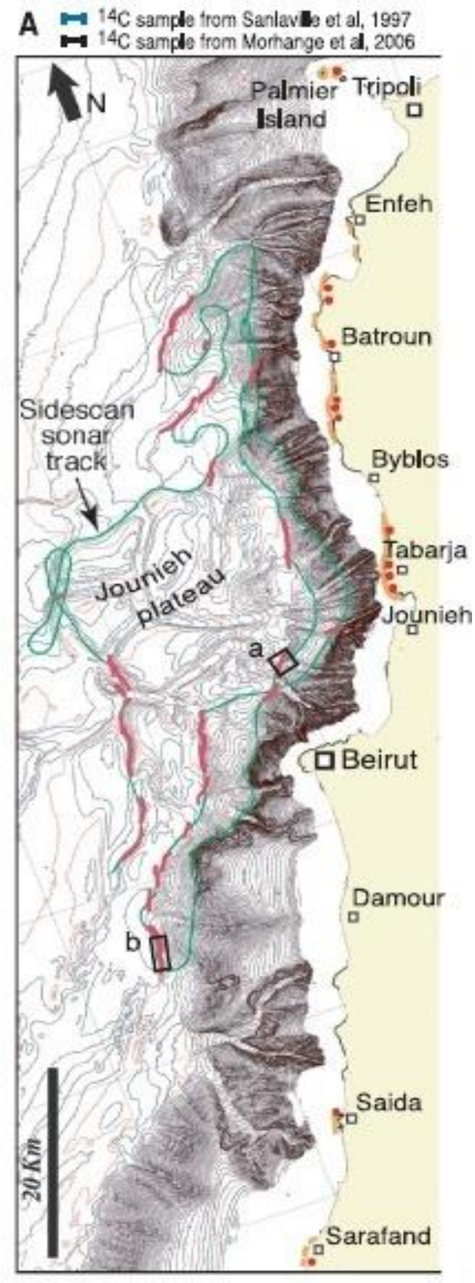


Figure 5.30: Deep sea canyons off the Lebanese coast

Source: adapted from Singh (2003)

The area encompassing these canyons has been designated as the East Levantine Canyons Area (ELCA) ecologically and biologically significant area (EBSA), owing to the deep canyons, hydrothermal vents and submarine freshwater springs that characterise the area (Elias et al., 2007; Würtz, 2012; Shaban, 2013; Bakalowicz, 2014).

Block 4 is within the ELCA EBSA and has a depth range of 320–1780 m. Bathymetry is presented in Figure 5.31 and shows the presence of isolated mounts ranging between 50 m and 200 m in height and the presence of a submarine canyon trending southeast to northwest.

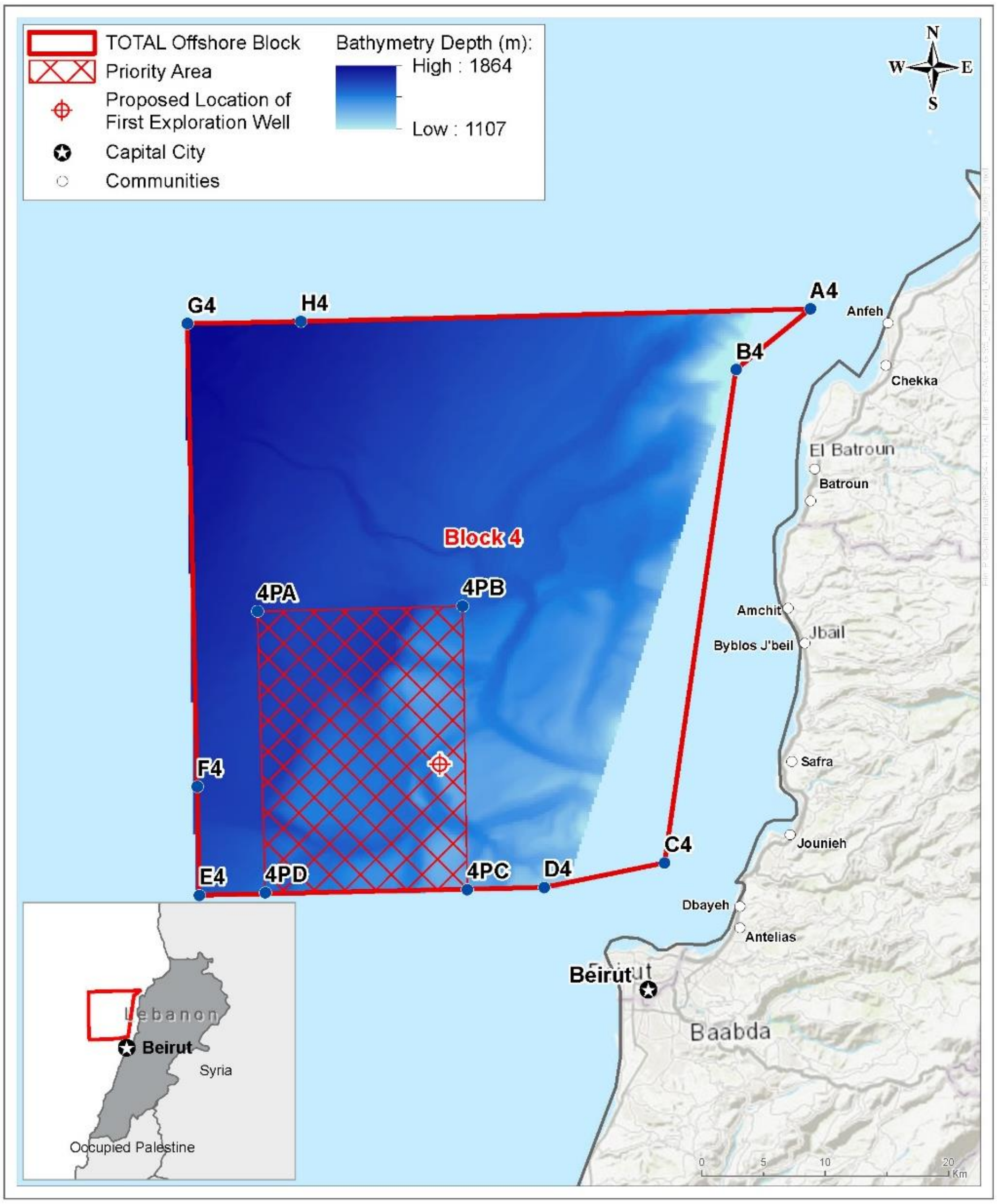


Figure 5.31: Block 4 bathymetry

Source: Keran Liban/Creocean (2019a)

5.3.1.10 Background underwater noise

The study area for background underwater noise encompasses the eastern Mediterranean, with more detail provided for Lebanese waters. This study area provides context for Block 4, with no AOI specified as underwater noise in itself is not a receptor (it serves to transmit noise from source to receptors).

Background or ambient underwater noise is generated by several natural sources, such as rain, breaking waves, wind at the surface, biological noise and thermal noise. Biological sources include marine mammals (which use sound to communicate, build up an image of their environment and detect prey and predators) as well as certain fish and shrimp. Anthropogenic sources also add to the background noise, such as fishing boats, ships, industrial noise, seismic surveys and leisure activities. Generalised ambient noise spectra attributable to various noise sources (Wenz, 1962) are presented in Figure 5.32.

The frequency and intensity of an underwater noise source affects the way sound travels in water and impacts the biological environment. Lower frequency noise, of less intensity, travels further underwater than higher frequency, more intense noise. This is due to the greater attenuation (scattering and absorption by water column) of the higher frequency noise. The degree of attenuation depends on various conditions such as water pressure, temperature and salinity (Gisiner, 1998).

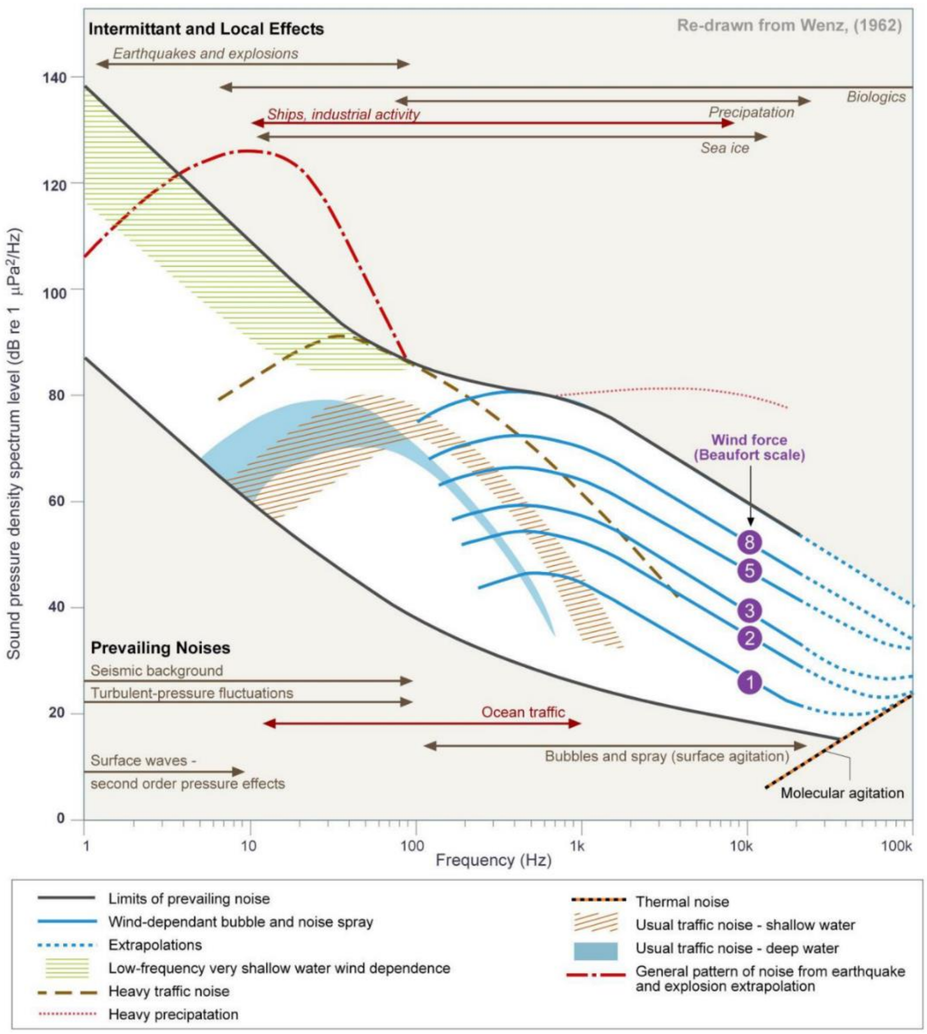


Figure 5.32: Composite of underwater noise spectra

Source: Xodus Group (2019)

There is currently no data on ambient underwater noise for Block 4. However, underwater noise has been recorded during in the wider eastern Mediterranean area close to Block 4 through a wider visual and acoustic survey (Marine Conservation Research International, 2014).

From this study, shipping was concluded to be the major source of underwater noise. Shipping generally produces a low frequency (below 1,000 Hz) and continuous noise generated from engines (Ameer and Linden, 2008). Shipping also produces additional noise types, such as higher frequency pulsing/burst type noise from propellers and thrusters, high frequency noise from rotating gears and mechanical components and much higher frequency noise from turbine engines and hydro-jets (1–2 kHz) (Ameer and Linden, 2008). Table 5.11 illustrates the frequencies (pitch), decibels (intensity) and estimated received level of expected anthropogenic noise sources from different ships that may occur in Block 4.

Table 5.11: Anthropogenic noise sources

Activity	Frequency range (kHz)	Average source level (dB re 1 µPa-m)	Estimated received level at different ranges (km) by spherical spreading[a]			
			0.1 km	1 km	10 km	100 km
Large merchant vessel	0.005–0.9	160–190	120–150	99–129	74 – 104	<29
Military vessel	-	190–203	150–163	129–142	104 – 117	29–42
Super tanker	0.02–0.1	187–232	147–192	126–171	101–146	26–71

Source: Adapted from Evans and Nice (1996); Richardson et al. (1995) in IOSEA2 (ERT/Aqua-Fact International Services, 2007)

The ports of Beirut and Tripoli are to the east of Block 4 and receive over 300,000 ships per year resulting in high levels of underwater noise due to shipping (Marine Traffic, 2019). Shipping routes in the area are shown in Figure 5.33 (Marine Traffic, 2019).

Ferries and recreational boating may also be potential underwater noise sources. Ferries generate a higher frequency noise than other vessels and are common in the Mediterranean Sea. This is due to their greater speeds requiring different propulsion systems to larger ships, which produce a noise of 10 kHz or more. Recreational boating may induce intense underwater noise bursts due to very fast speeds, but this is not currently monitored (Ameer and Linden, 2008). Figure 5.34 illustrates the speed of vessels in the area during 2013, highlighting the potential presence of ferries and recreational boats (vessels travelling at more than 30 knots). It is likely that in 2019, vessel traffic will be greater than in 2013, owing to increased industrialisation and development in the region.

Background underwater noise from shipping is present in the region. However, the sensitivity of underwater noise is not assessed in the baseline because underwater noise in itself is not a receptor. Underwater noise is dealt with in relation to marine mammals, turtles and fish in the impact assessment chapter (Section 6.3.1.13).

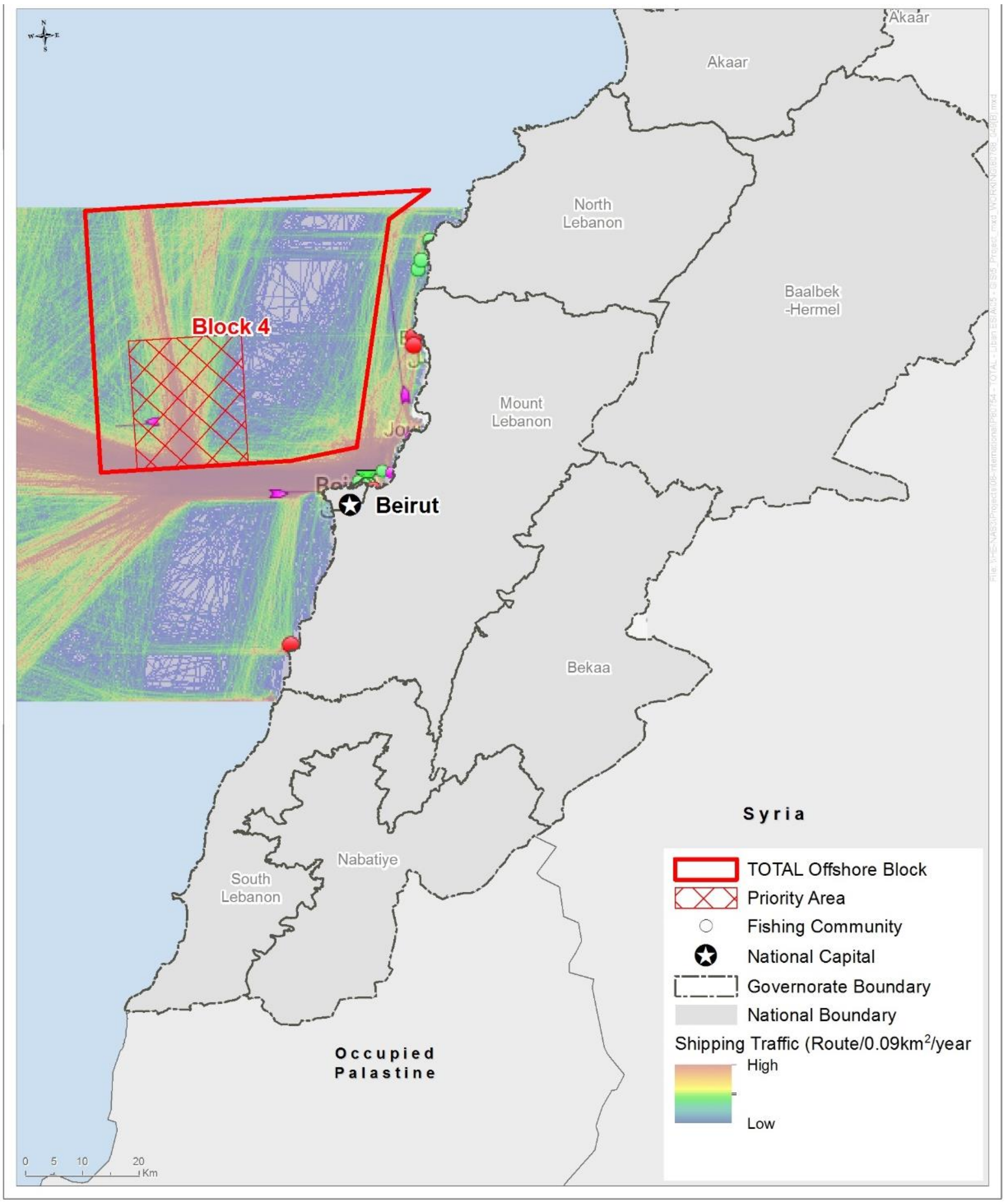


Figure 5.33: Density of shipping in the Block 4 area

Source: Marine Traffic (2019)

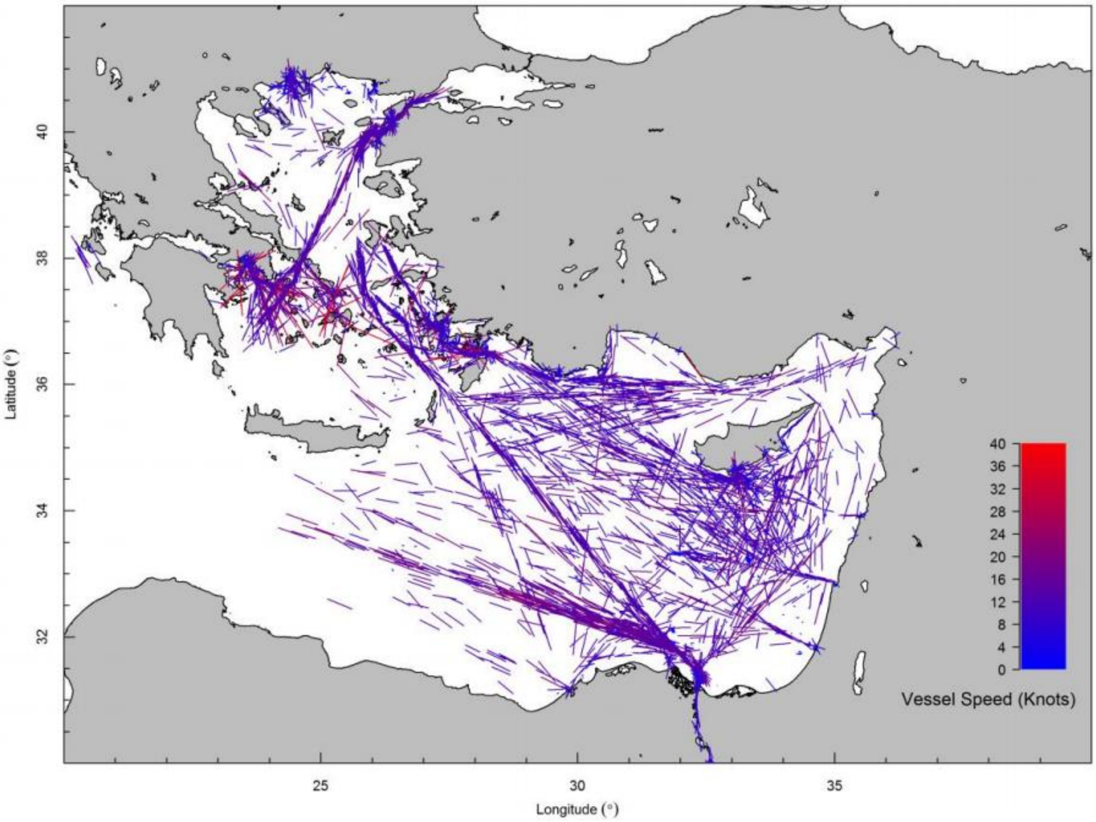


Figure 5.34: Vessel speeds in the eastern Mediterranean

Source: Marine Conservation Research International (2014)

5.3.2 Geology and geohazards

The study area for geology and geohazards encompasses the east Mediterranean region, including the whole country of Lebanon. This study area provides context for Block 4, with no AOI specified as the project will not affect these components of the environment. However, an AOI has been defined for seabed sediments (see Section 5.3.2.5).

5.3.2.1 Geological framework

The geomorphology of Lebanon consists of two mountain chains (the Lebanon and Anti-Lebanon ranges) separated by the high-altitude Beqaa Plain. Both ranges trend in a north–northeast–south–southwest direction (Figure 5.35). To the west, Mount Lebanon is limited by a narrow coastal plain and the Mediterranean with relatively steep slopes except in its northern part (near Tripoli), where the coastal plain is wider. This mountain chain has the highest altitude in northern Lebanon (around 3083 m) and it plunges under the Late Neogene Basalts and Quaternary Deposits of the Tripoli-Homs depression, which separates it from the similar structural high of Jibal As-Sahiliyeh in Syria. To the east, Mount Lebanon is limited by the Yammouneh Fault, a segment of the Dead Sea Transform Fault, which constitutes the boundary between the Arabian Plate and the Levant micro-Plate. The lithology of the deposited rocks and sediments constituting the mountain chains along with the intervening plains ranges from siliciclastic to carbonates, depending on the depositional environment and the ongoing regional and tectonic events at the time of deposition. Localised volcanic outpourings, mainly through fractures and vents are present in northern Lebanon, and these form a part of the neighbouring Homs Basalts, exposed in neighbouring Homs Province in Syria. The different geological formations along with their corresponding stratigraphic units/facies and the depositional/tectonic environments are presented/summarised in Figure 5.36.

Ghalayini et al. (2018) further subdivided Lebanon into four petroleum domains: the distal Levant Basin, the Lattakia Ridge, the Levant margin and the onshore domain (Figure 5.37).

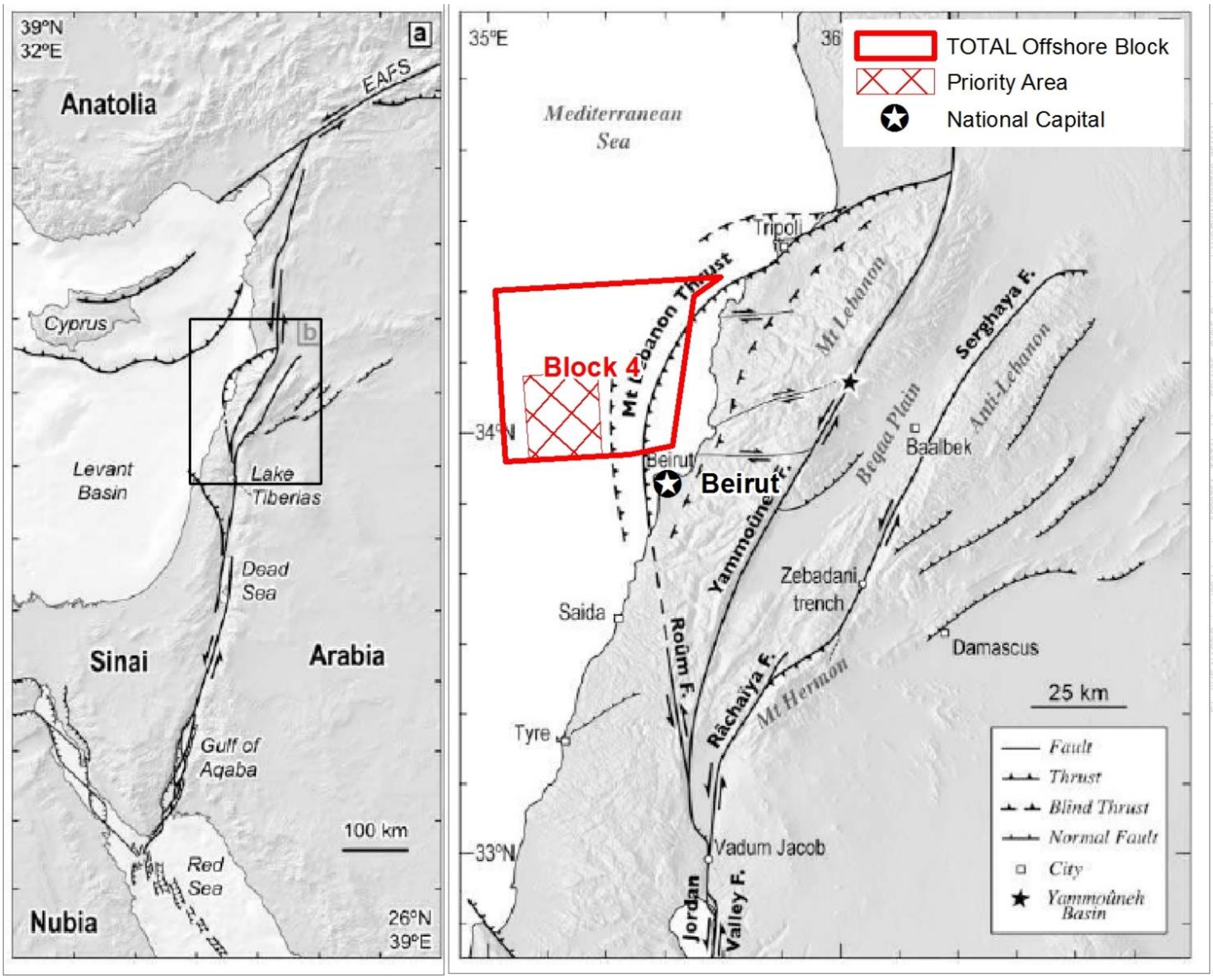


Figure 5.35: Regional tectonic framework: (a) Levant fault system; (b) active faults of the Lebanese restraining bend

Source: Adapted from Daeron et al. (2007)

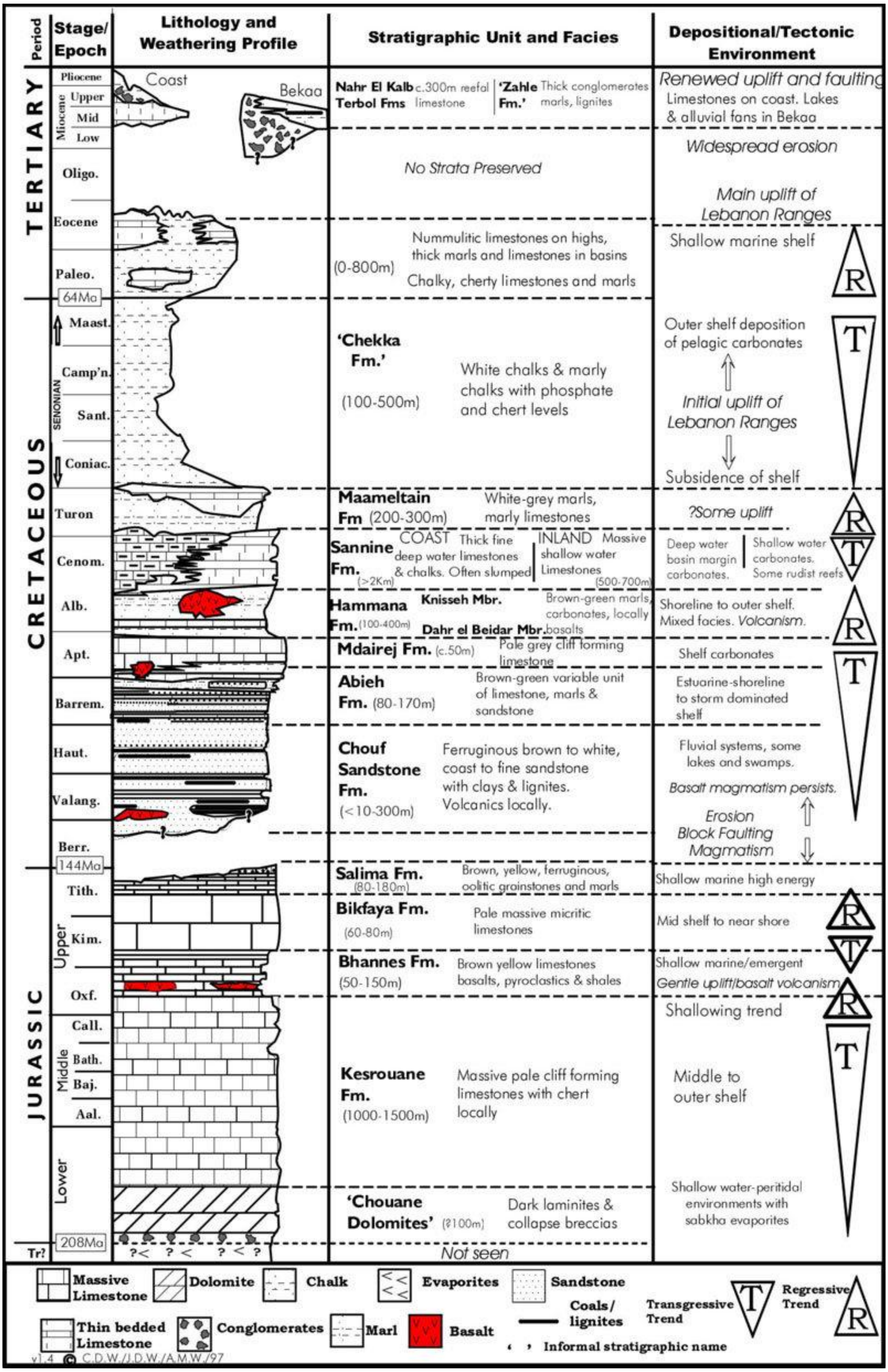


Figure 5.36: Simplified stratigraphic chart of Lebanon

Source: Adapted from Walley (1997)

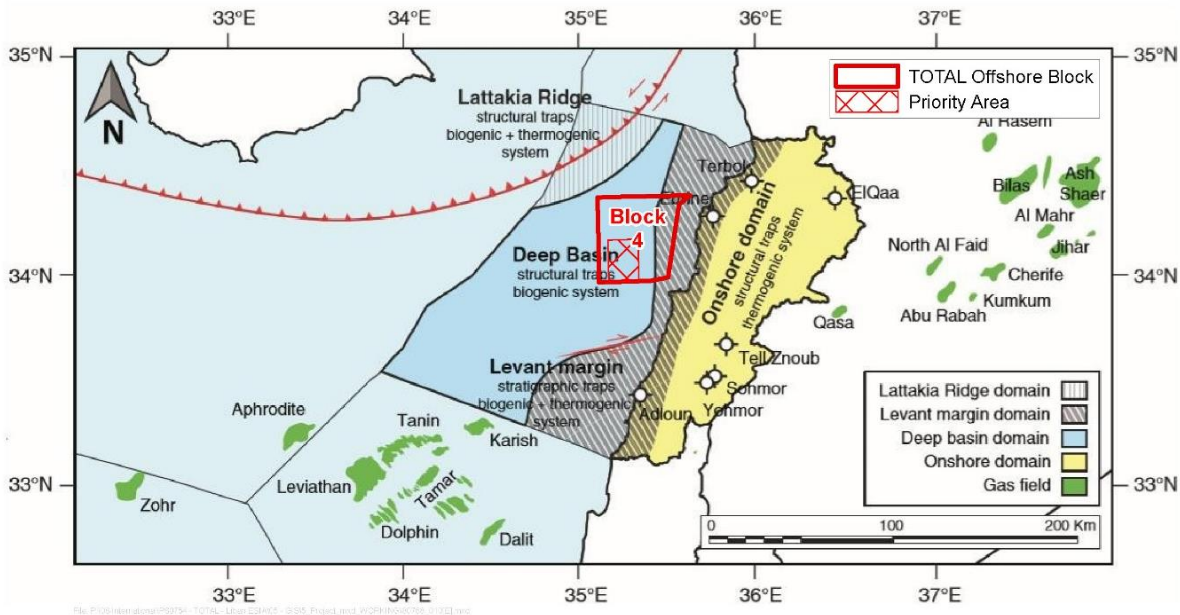


Figure 5.37: Geological/petroleum domains of Lebanon

Source: Adapted from Ghalayini et al. (2018)

5.3.2.2 Regional tectonic framework

The tectonic setting of Lebanon is intimately related to that of the eastern Mediterranean Levant Fault System as it is the result of the interaction of three major plates, the Arabian, African and Eurasia plates, in addition to the Anatolian and Sinai sub-plates. The eastern Mediterranean region is a tectonically complex system containing a variety of tectonic regimes. In the south, the Red Sea represents a divergent tectonic environment (continental rift). Strike-slip movement occurs along the Dead Sea Transform Fault (DSTF) and the East Anatolian Fault System (EAFS), while convergence/collision is taking place along the Hellenic and Cyprian Arcs (see Figure 5.35).

The DSTF is a nearly 1000-km-long strike-slip fault system that defines the plate boundary between the Arabian and African plates, and extends from the Gulf of Aqaba, to the southeast of Turkey (see Figure 5.35). It transfers most of the Arabia-Africa divergent motion in the Red Sea into the convergence motion between Eurasia and Arabia (Wdowinski et al., 2004). Some of the divergent motion in the Red Sea is also transferred to the Gulf of Suez, which forms the boundary between Africa and Sinai. Previous studies have estimated the plate motion along the DSTF to be within a range of 4-10 mm/yr (e.g., Meghraoui et al., 2003; Gomez et al., 2003; Daeron et al. 2005).

5.3.2.3 Local tectonic framework

The DSTF can be subdivided into two main sections joined by an approximately 200-km-long restraining bend running along the length of Lebanon. Within this Lebanese restraining bend, the DSTF splays into several fault branches: the Roum, Yammouneh, Serghaya and Rachaiya faults (Figure 5.35). Of these only the Yammouneh Fault crosses the whole country and is considered the main fault branch of the DSTF within Lebanon that is transferring most of the movement occurring along the DSTF (Daeron et al., 2004). Recent paleo-seismic studies (Gomez et al., 2003; Daeron et al., 2004, 2005; Nemer and

Meghraoui, 2006) and geodetic investigations (Wdowinski et al., 2004) along the different fault branches within the restraining bend have indicated that these faults are active and accordingly they are likely to influence the earthquake hazard in Lebanon.

Furthermore, during the course of the investigation and identification of active thrust faults in the Tripoli region in northern Lebanon, Tapponnier et al. (2001) referred to the existence of a large thrust fault system, the Mount Lebanon thrust (MLT), in the offshore area between the cities of Saida and Tripoli (Figure 5.35). The existence of this offshore thrust system has also been confirmed by geophysical data (Elias et al., 2007; Carton et al., 2009).

5.3.2.4 Geohazards

Several geohazards are associated with offshore exploration activities, including seismicity, gas hydrates, over-pressured zones and submarine landslides.

Seismicity (earthquakes)

The DSTF system and its associated surface expressions (Yammouneh, Roum, Rachaya and Serghaya faults) have an active seismic record. Recent research work categorised the Lebanese section of the DSTF as being a strong seismic activity zone. The active structures within and around Lebanon are shown in Figure 5.38 (Huijer et al., 2016).

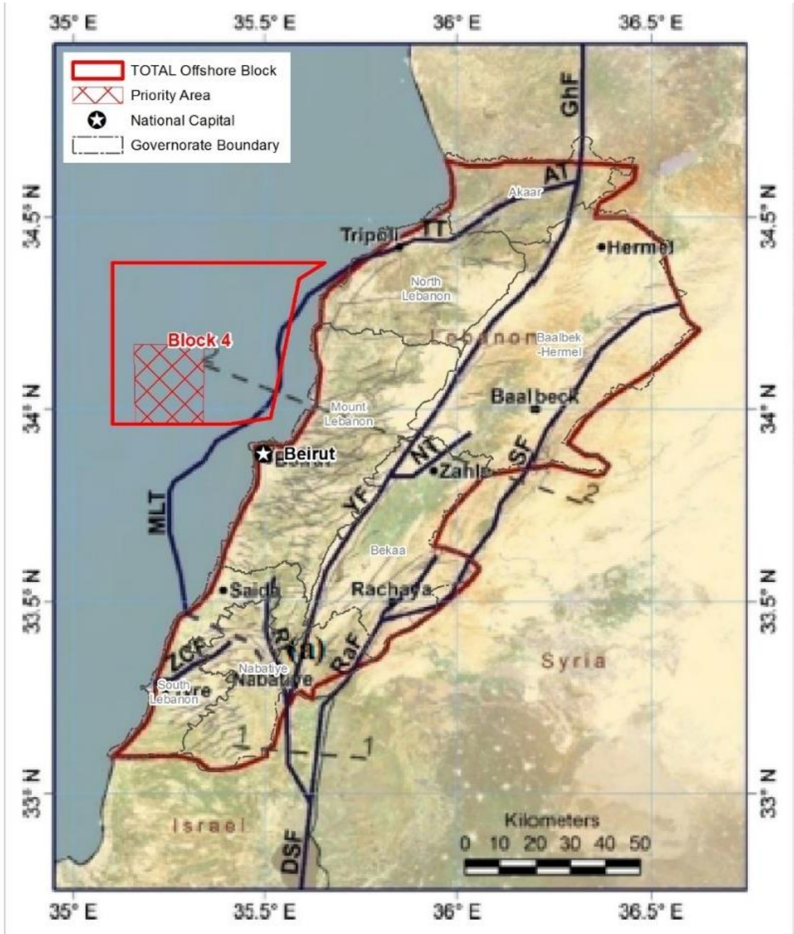


Figure 5.38: Main active structural elements of Lebanon

Source: adapted from Huijer et al. (2016)

An evaluation study on seismic hazards of Lebanon that was carried out initially by Huijer et al. (2011) concluded that Lebanon is a country of moderate to high seismic hazard. However, in the light of newly mapped active thrust fault system of the MLT, Huijer et al. (2016) undertook a re-evaluation and update of the seismic risk hazards, as the thrust fault extends right underneath and runs along the Lebanese shoreline and in respect of the established coastal cities along its extent. It is important to note that a revised and up-to-date source catalogue was used in the new study, in addition to the use of the recent and new generation attenuation relationships/parameters that are proposed for the eastern Mediterranean region. The study proposed updated and revised design recommendations for Lebanon and its outcome can be summarised as follows:

- Lebanon is a country of moderate to high seismic risk.
- The expected peak ground acceleration (PGA) with a 10% probability of exceedance in 50 years ranges mostly from 0.20 g to 0.30 g.
- The seismic zone parameter adopted for the coastal area between Tripoli and Saida should be increased from its present value of 0.20 to 0.30 g in the local design code.
- The remaining parts of the country should adopt a revised PGA of 0.25 g for seismic design.

A historical seismicity map and a seismic hazard map of Lebanon are presented in Figure 5.39 and Figure 5.40 respectively.

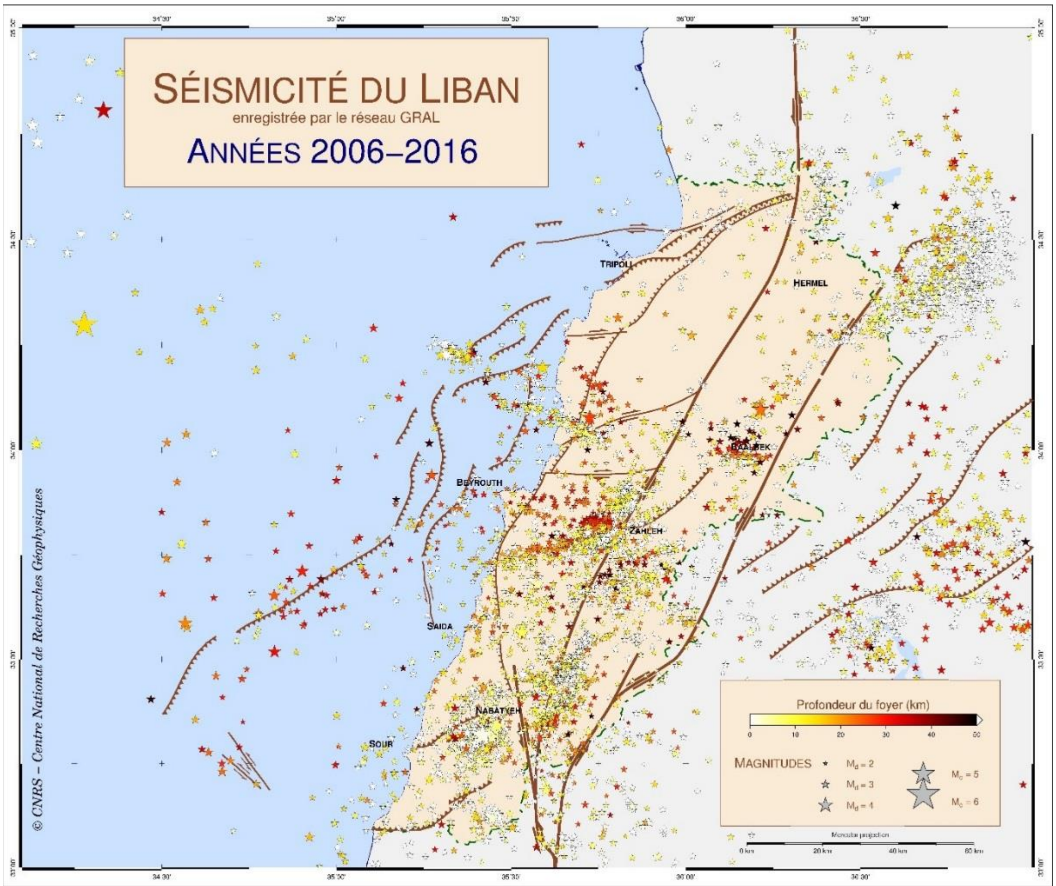


Figure 5.39: Instrumented earthquake events in and around Lebanon between 2006 and 2016

Source Adapted from CNRS (2016)

The updated study concluded that all structures that are to be constructed in the coastal area between Tripoli and Saida should be designed based on the design and reinforcement detailing requirements for concrete structures of high seismic hazard specified in the international codes of practice.

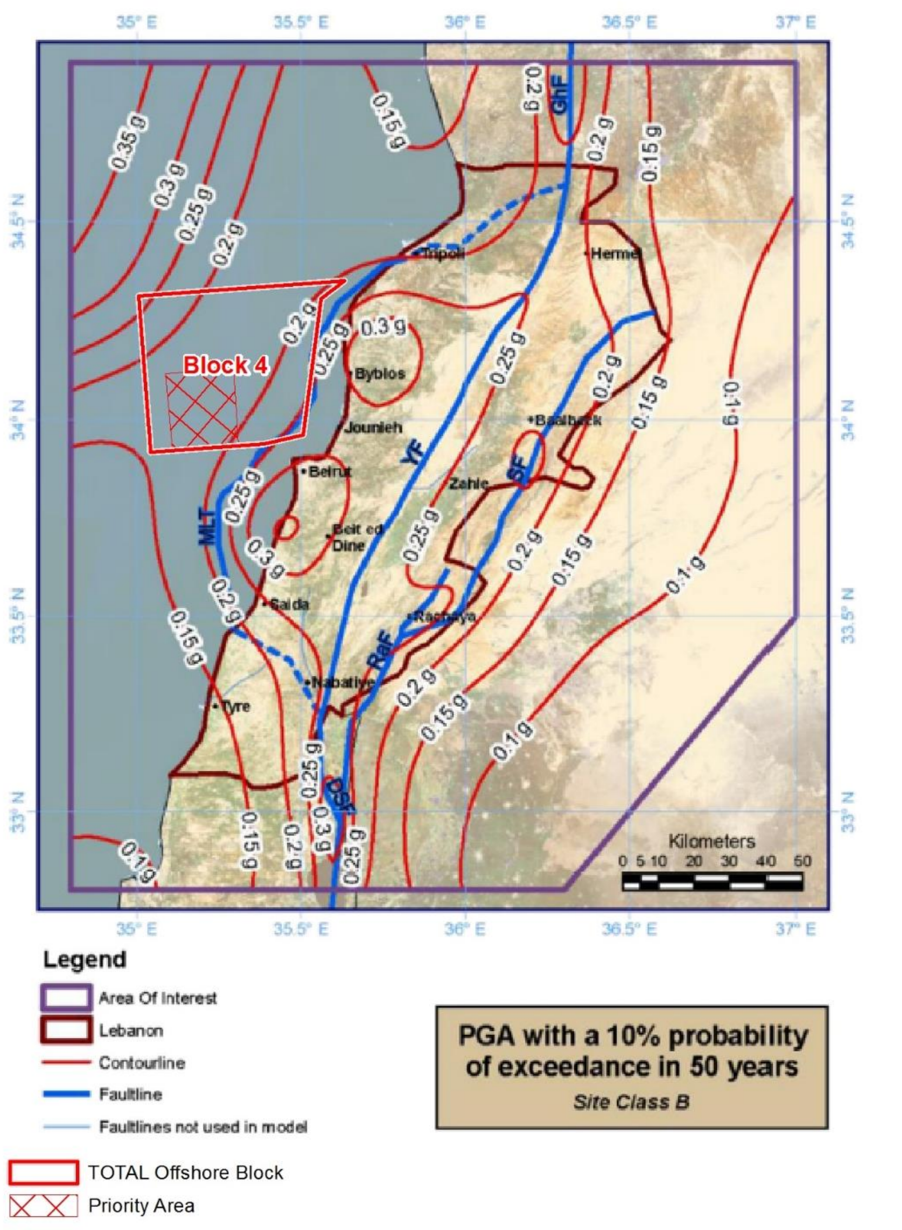


Figure 5.40: Seismic hazard map (contouring of peak ground acceleration with a 10% probability of exceedance in 50 years)

Source: Adapted from Huijer et al. (2016)

Gas hydrates

The eastern Mediterranean is known for the presence of gas hydrates, which are known in the Lebanon exploration areas. Gas hydrates form when methane and water freeze at high pressures and relatively low temperatures. These conditions occur in the shallow part of marine sedimentary sections on many continental margins (Shanmugam, 2012).

Gas hydrates are considered a potential hazard, considering the impacts they have on the safety of drilling operations. In this respect, the zone or depth at which a methane clathrate naturally exists in the marine environment in the earth's crust is known as a methane hydrate stability zone (MHSZ) (Praeg et al., 2011).

The thickness of the stable gas hydrate zone can reach up to 150–200 m offshore Lebanon (Praeg et al., 2011). It was also reported that in the southern part of the Levant Basin, the predicted existence of MHSZ in the seafloor sediments at water depths of 1.2 km can have a thickness ranging between 1 and 600 m (Praeg et al., 2011).

Gas hydrates have been proven by coring at one site in the eastern Mediterranean, but their wider extent remains uncertain (Praeg et al., 2011). Comparing the MHSZ with known or potential zones of gas flux to seabed may indicate prospective areas for hydrate occurrence, mainly in the eastern basin. One such place is the Nile fan, where evidence of the first bottom-simulating reflector, a reflection event closely associated with identifying hydrates in seismic cross-section, confirms the potential for additional hydrate discoveries in this portion of the Mediterranean Sea (Praeg et al., 2011).

Over-pressured zones

Over-pressured zones are rock formations containing fluids with abnormally high pressures. These reservoirs are normally localised/isolated environments, where the fluid flow out of the reservoirs is restricted, and the total overburden load is partially supported by the pore fluids (Serebryakov et al., 2002). The formation of over-pressured zones has been associated with diagenetic reactions, rapid sediment disposition, and gas charging and melting of gas hydrates (Garziglia et al., 2008). Drilling into over-pressured strata can be risky and hazardous as the over-pressured fluids will rapidly escape the confinement imposed on them.

The Messinian evaporitic layer present in the eastern Mediterranean is an example of a sealing rock that can hinder the escape of fluids (Figure 5.41). Other features that present evidence of over-pressured zones are gas chimneys and mud volcanoes.

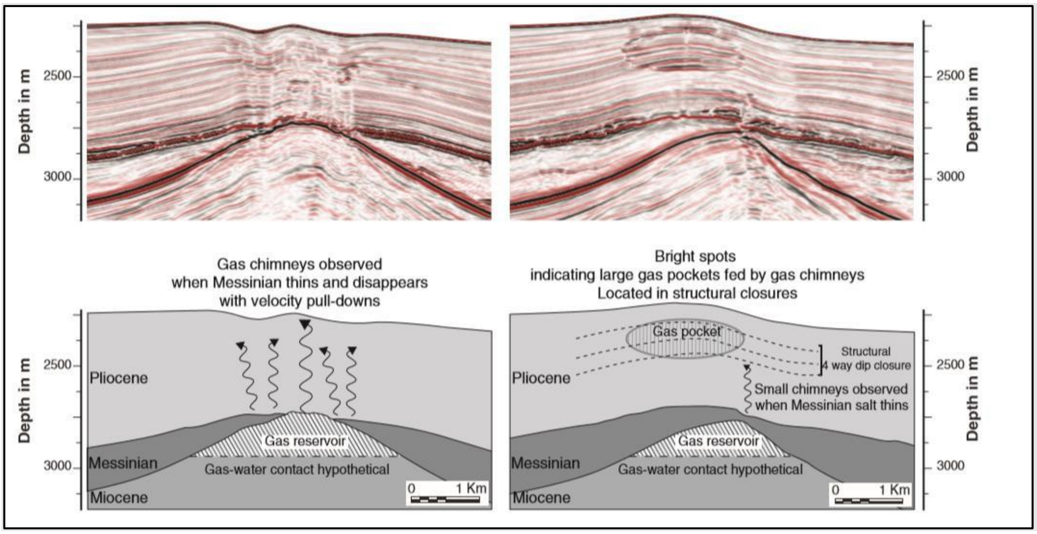


Figure 5.41: Seismic cross-section showing gas chimneys on top of a Miocene anticline in the Lattakia Ridge domain

Source: Ghalayini et al. (2018)

Gas chimneys and gas pockets

Similar to over-pressured zones, mud volcanoes and pockmarks are another potential hazard. Mud volcanoes are planar to conical features with a relief of up to 500 m on land, and a base diameter ranging from less than 1 to over 3 km. Their formation is commonly associated with over-pressured zones that usually develop by processes such as compaction disequilibrium, hydrocarbon generation and liquefaction.

Pockmarks take the form of circular erosional depressions that typically form by fluid expulsion from over-pressured zones via low-permeability pathways and are commonly associated either with strongly destabilised sedimentary masses or with gas chimneys. These may be a drilling hazard if not taken into consideration.

The eastern basins of the Mediterranean are where mud volcanoes and related fluid expulsion features are the most abundant. In the southern part of the Levant Basin, the Nile deep-sea turbid system displays many fluid-releasing structures on the seabed, namely mud volcanoes in the form of small cones (100–900 m in diameter), mud pies (5 km in diameter) and pockmarks. These features delineate a belt of apparently very active gas chimneys along the upper continental slope.

Submarine landslides and coastal slope failures

Submarine slope instability covers a variety of down-slope movements of the material composing slope (Yin-can, 2017). The major risks relating to submarine landslides include the destruction of seabed infrastructure, the collapse of coastal areas into the sea and landslide-generated tsunamis. The submarine landslides mapped in the Mediterranean basins were compiled from multiple sources and are presented in Figure 5.42. The common occurrence of slumping processes along the southern continental margin was described and attributed to a combination of seismic activity, presence of gas within the sediments, and relatively steep and precipitous slopes (MoEW, 2019).

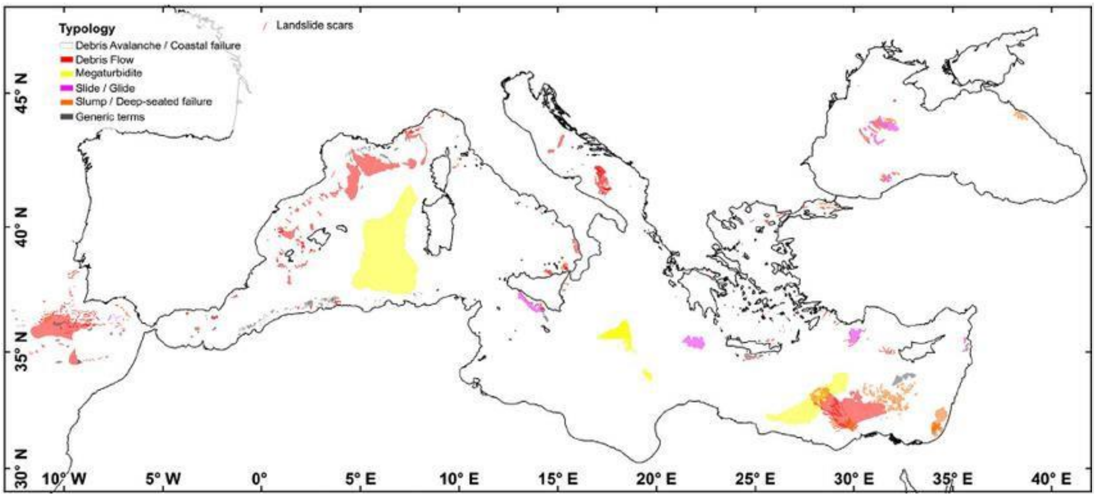


Figure 5.42: Mapped submarine landslides within the Mediterranean Sea

Source: Papadopoulos et al. (2014; modified from Urgeles and Camerlenghi, 2013)

5.3.2.5 Seabed sediments

The AOI for seabed sediments is a 1.5-km radius around the proposed well site and encompasses the precautionary distance from the wells to the distance which drilling discharge impacts and anchoring impacts (if conventional moored semi-submersibles are used) on seabed sediments could extend.

The study area is wider, with a focus on the Block 4 priority area, broadening out to include Block 4 as a whole, and including coastal sediments, to provide context for the sensitivity of the sediment quality in the AOI.

Several studies covering the coastal areas of Lebanon were conducted by the CNRS between 2011 and 2014, as part of the CANA-CNRS programme (CANA-CNRS, 2019), to analyse the sediment subject to the impact of various anthropogenic sources of pollution such as chemical industries, treated and untreated sewage effluents and the urban development expansion. The CNRS studies focused on 11 coastal areas and the results are as summarised in MoEW (2019), with a study by Merhaby et al. (2015) focusing on Tripoli harbour. All coastal areas studied exhibited elevated levels of contaminants compared with what would be expected in the deep sea, such as Block 4. The exception being Tyre, which was adopted as a coastal reference location:

- Selaata marine area seems to be the most contaminated among the studied regions owing to the presence of a phosphate fertiliser plant.
- The sediment quality of the fishing port of Tripoli varies between moderately and highly polluted. Studies on their mobility show that an extremely small percentage of copper is in ion exchange form thus representing the highest risk to the water column and to living organisms.
- The sediments of the port of Tripoli were found to be mostly contaminated with high molecular weight 5–6-ring aromatic hydrocarbons, which are highly toxic and carcinogenic.
- The sediments of the wider Tripoli harbour area were contaminated by 4-6 chlorinated polychlorinated biphenyl congeners and 4–5-ring polycyclic aromatic hydrocarbons (Merhaby et al., 2015).
- The marine region of Nahr Antelias might be occasionally considered as a contaminated area especially in its deep sector, where high values of organic matter, total phosphate and trace metals were recorded.
- The marine region of Nahr-el-Kalb is proved to be clear of any severe contamination as the sediment exhibited the lowest values of potential contaminants.
- The sediment of the Ghadir marine region is shown to be contaminated mainly at the deepest sampling points close to the outlet of the main pipe from Ghadir treatment plant.
- The coastal region of Beirut River is an area of accumulation for a range of contaminants. The sediment at all depths showed high values of contaminants, indicating that this region clearly receives the discharges from multiple sources of contamination including the waters of the river charged with agricultural, industrial and domestic wastewaters.
- The coastal area of Jounieh Bay represents a meso-oligotrophic system. The geomorphology of the bay in association with the prevailing hydrodynamic factors has caused the deepest points to behave as a sink for the fine fraction which are usually adsorbed by the organic and mineral contaminants.
- The area of Dora (Beirut) sediments were found heavily polluted with lead and cadmium.
- Raouchy is considered a potentially contaminated area and represents a zone of accumulation of mainly domestic pollutants owing to its geomorphology.

- Ramlet el-Bayda, despite the presence of two sewage outfalls, shows less signs of pollution and may be considered a non-contaminated marine area. This is because of its morphology and the strong hydrodynamism to which it is subjected.
- Tyre is a clean marine area, exempt of any type of contaminants, and may be adopted as a reference zone.
- Tyre port sediments were found to be mostly contaminated with moderate molecular weight polyaromatic hydrocarbon (3–4 rings), and with polychlorinated biphenyl concentrations extremely high mainly related to agricultural activities in the region.

Figure 5.43, Figure 5.44, Figure 5.45 and Figure 5.46 show the grain size composition, the total phosphate concentrations, the percentage of organic matter, and levels of three trace metals (cadmium (Cd), lead (Pb) and copper (Cu)) in the sediment of four Lebanese marine coastal areas (Tyre, Ramlet-el-Bayda, Raouchy and Selaata) (CANA-CNRS, 2014).

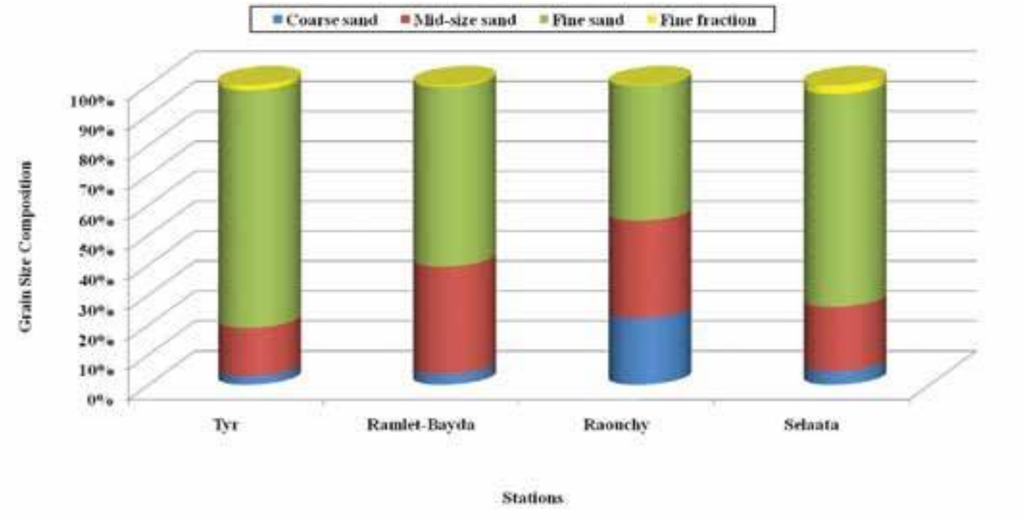


Figure 5.43: Grain size composition of the sediment of four coastal marine areas (Tyre, Ramlet-el-Bayda, Raouchy and Selaata)

Source: CANA-CNRS (2014)

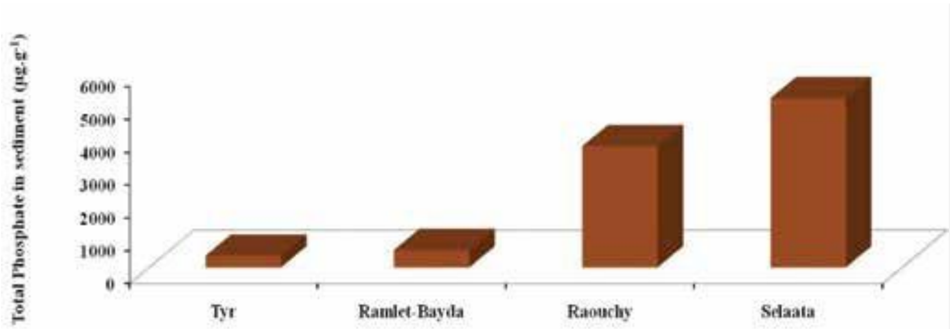


Figure 5.44: Total phosphate concentrations (µg.g^{-1}) in the sediment of four coastal marine areas (Tyre, Ramlet-el-Bayda, Raouchy and Selaata)

Source: CANA-CNRS (2014)

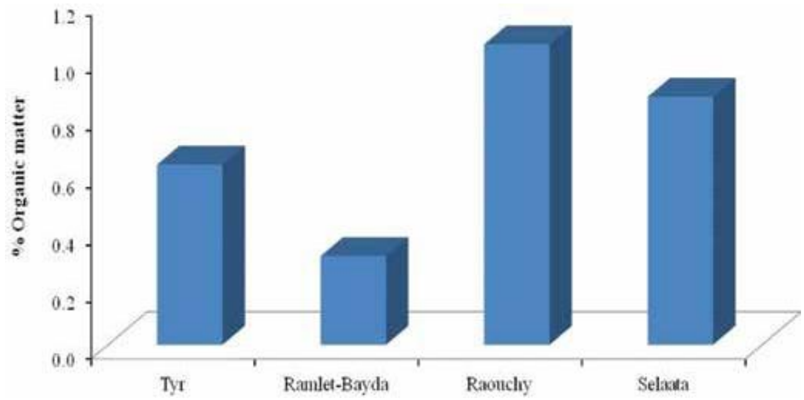


Figure 5.45: Percentage of organic matter in the sediment of four coastal marine areas (Tyre, Ramlet-el-Bayda, Raouchy and Selaata)

Source: CANA-CNRS (2014)

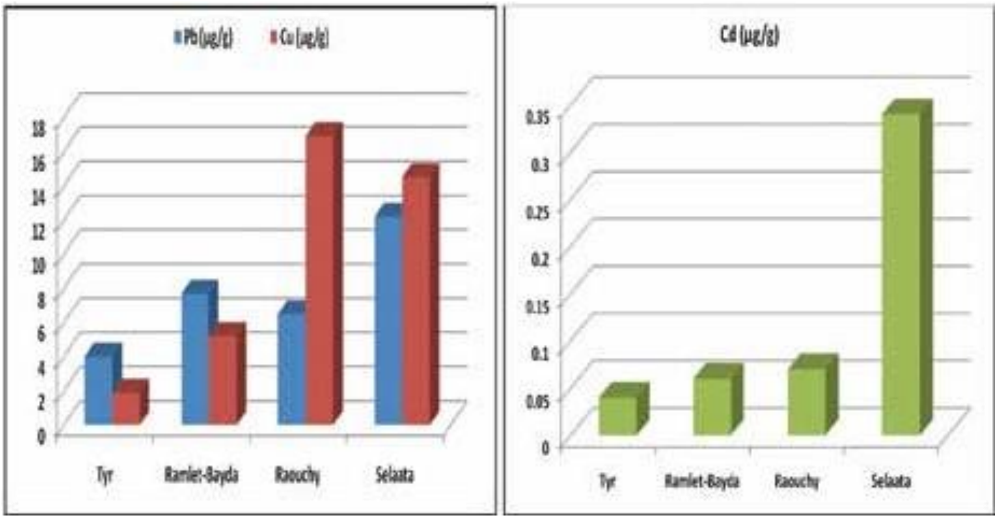


Figure 5.46: Levels of 3 trace metals (Cd, Pb and Cu) in the sediment of four Lebanese marine coastal areas (Tyre, Ramlet-el-Bayda, Raouchy and Selaata)

Source: CANA-CNRS (2014)

A study by Abi-Ghanem et al. (2016) determined the levels of the same trace metals (Cd, Pb, and Cu) in marine sediments in Tripoli fishing port and Beirut military port. In Tripoli fishing port, the marine sediment samples were taken from 11 different points with depth ranging between 2 and 5 m, while in Beirut military port, samples were taken from 12 points with depth ranging between 5 and 10 m.

The results obtained from the samples at Tripoli fishing port are shown below:

- Concentrations of Cd ranged from 0.237 to 0.644 µg/g with an average value of 0.328 µg/g.
- Concentrations of Pb ranged from 40.2 to 92.8 µg/g with an average value of 60.12 µg/g.
- Concentrations of Cu ranged from 55.7 to 524.5 µg/g with an average value of 152.592 µg/g.

The results obtained from the samples at Beirut Military port are shown below:

- Concentrations of Cd ranged from 0.26 to 6.7 µg/g with an average value of 2.25 µg/g.
- Concentrations of Pb ranged from 19.2 to 518.9 µg/g with an average value of 240.19 µg/g.
- Concentrations of Cu ranged from 27.5 to 246.8 µg/g with an average value of 143.64 µg/g.

The levels of heavy and trace metals in the seabed sediments in Tripoli fishing port above are higher than those that would typically be associated with the deep-sea seabed owing to the shallower depth and proximity to sources of contaminants from the coastline and the various anthropogenic inputs owing to the nature of the location as a commercial port.

Except for Tyre, all the studied locations on Lebanon's coast were considered representative of coastal locations for the region that were within proximity to anthropogenic or other sources of elevated concentrations of metals, hydrocarbons and nutrients, which would be expected in coastal waters.

5.3.2.6 Block 4 sediment sampling campaign

Methods

Seabed sediments were collected from 29 stations throughout Block 4, of which 25 stations were within the priority area, as shown in Figure 5.21 in Section 5.3.1.7 (Block 4 seawater sampling campaign). Figure 5.21 shows all surveyed stations for the Block 4 survey campaign. The priority sampling area comprised areas of deep-sea canyons as well as more open areas of seabed bathyal plains (bathyal – describing areas of seawater depth between 1000 and 4000 m).

Sediment was sampled using a 0.25-m^2 Grey-O'Hara steel box core deployed twice at each sampling station to collect sufficient material for sampling and analysis. The box core was deployed directly from the survey vessel.

Several in-situ observations were made of the sediment in the cores, including visual appearance, colour and redox potential. In addition, recovered samples were photographed. The box core was then subsampled for a range of physico-chemical and biological laboratory analyses.

Results

Visual description

Appearance (colour and odour) of sediments, stratification, possible disturbance (e.g. incomplete degradation of organic matter/chemical pollution) were identified during sampling.

Block 4 sediment characteristics are summarised below:

- Sediments are brown mud.
- A superficial silty mud with very fine light fractions layer is typically present at the sediment surface.
- This superficial layer overlies a more compact grey clay layer.
- Sediments had no odour and no trace of reduction but light stratification.

Grain size

Sediment grain size-distribution determines sediment fluidity and compactness and in turn the ability to host benthic infauna and/or accumulate contaminants. Table 5.12 demonstrates average grain size distribution.

Table 5.12: Average grain size distribution in sediment (Block 4)

Clay (<2 µm)	Silt (2–63 µm)	Fine sand (63–200 µm)	Coarse sand (200 µm-2 mm)
23.1%	75.3%	1.5%	0.1%

Source: Keran Liban/Creocean (2019b)

Following Bellair and Pomerol (1977) grain class standards, sediments were categorised as silts with little sand (<2%). According to grain size distribution across stations, the silt fraction was the most dominant and is presented in Figure 5.47.

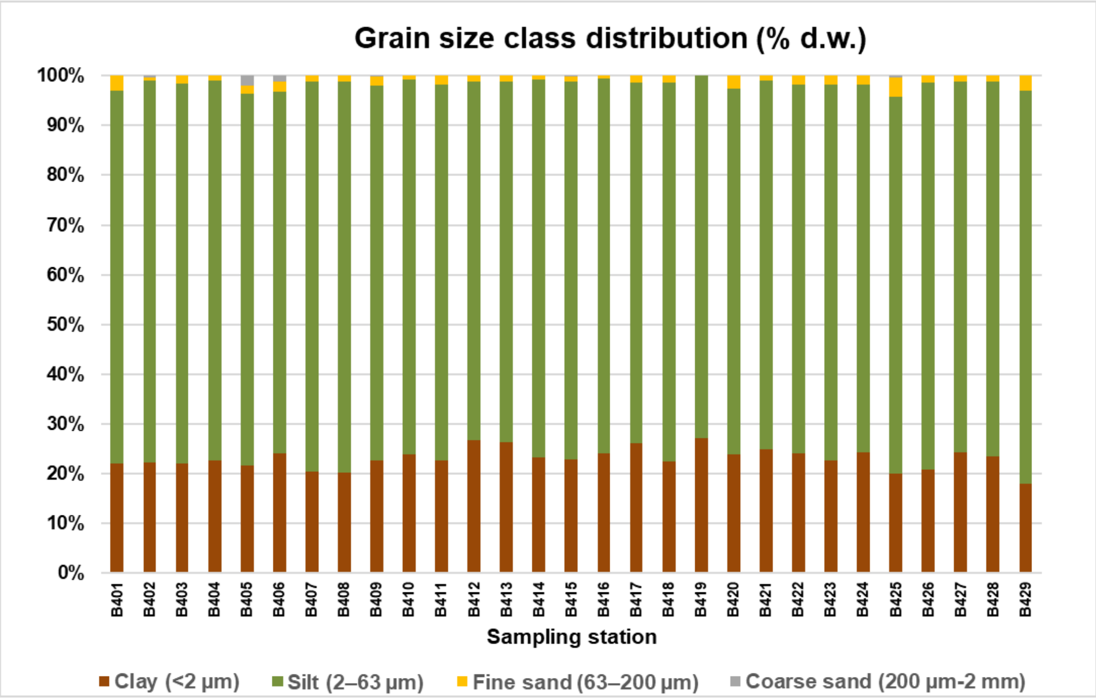


Figure 5.47: Particles size distribution in sediments between stations (Block 4) (d.w. = dry weight)

Source: Keran Liban/Creocean (2019b)

Dry weight varied between stations ranging from 2 to 73% with an average of 48%. This variation occurred due to larger rocks and elements in disturbed sediments such as bases of seamounts and entrances/seafloor of canyons. However, no correlation was identified between percentage fraction of coarse sand and distribution of coarser elements.

Water content

Water content of sediments is related to grain size with finer sediments containing more water than coarser sediments. Block 4 sampling results (shown in Figure 5.48) indicated high water content for all stations which is consistent with the grain size results.

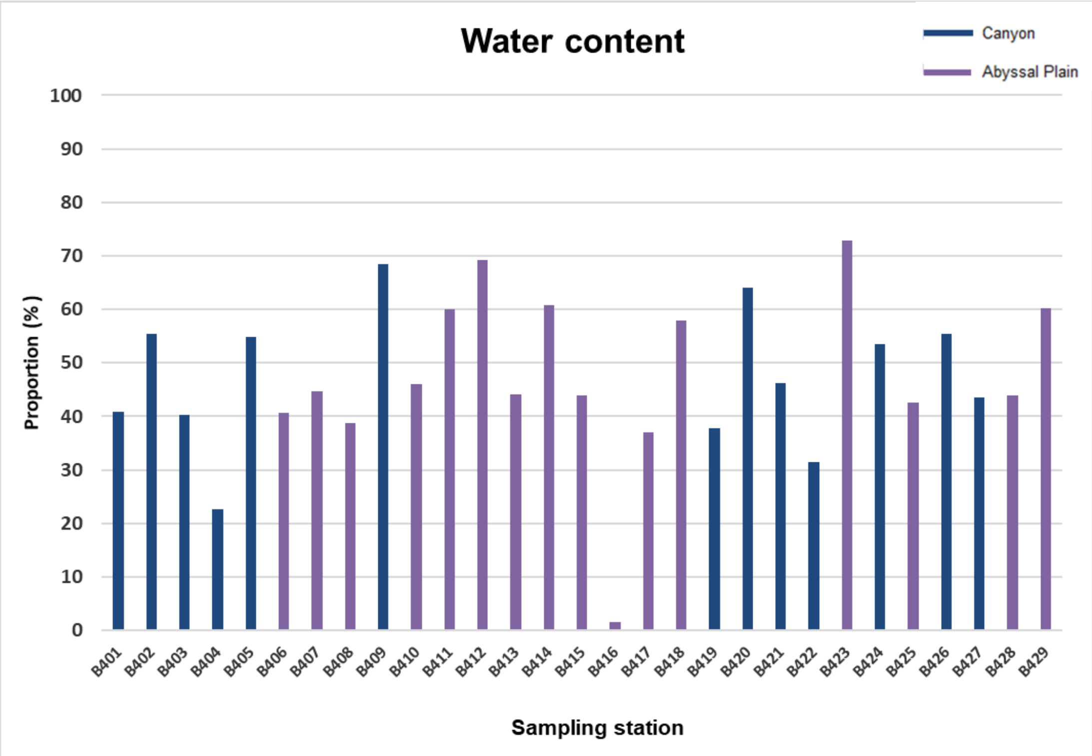
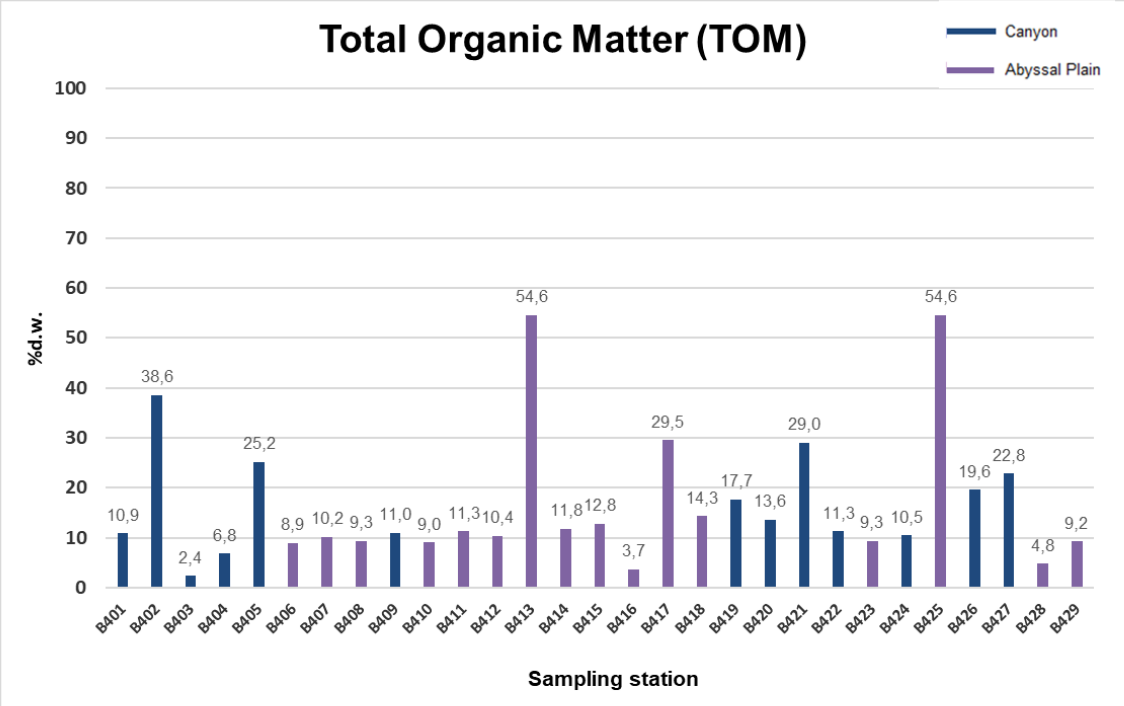


Figure 5.48: Water content distribution in sediments (Block 4)

Source: Keran Liban/Creocean (2019b)

Organic and nutrient enrichment

Total organic matter (TOM) and total organic carbon (TOC) of sediments were analysed. TOM varied widely from 2.4% to 54.6% (mean of 16.7%) with highest concentrations identified for stations located on open areas of bathyal plain seabed. Conversely, TOC concentrations showed little variation (between 6.2 and 9 g/kg). TOM and TOC results indicate a low organic content, despite the sediment containing a fairly high clay fraction. Results for TOM and TOC are shown in Figure 5.49.



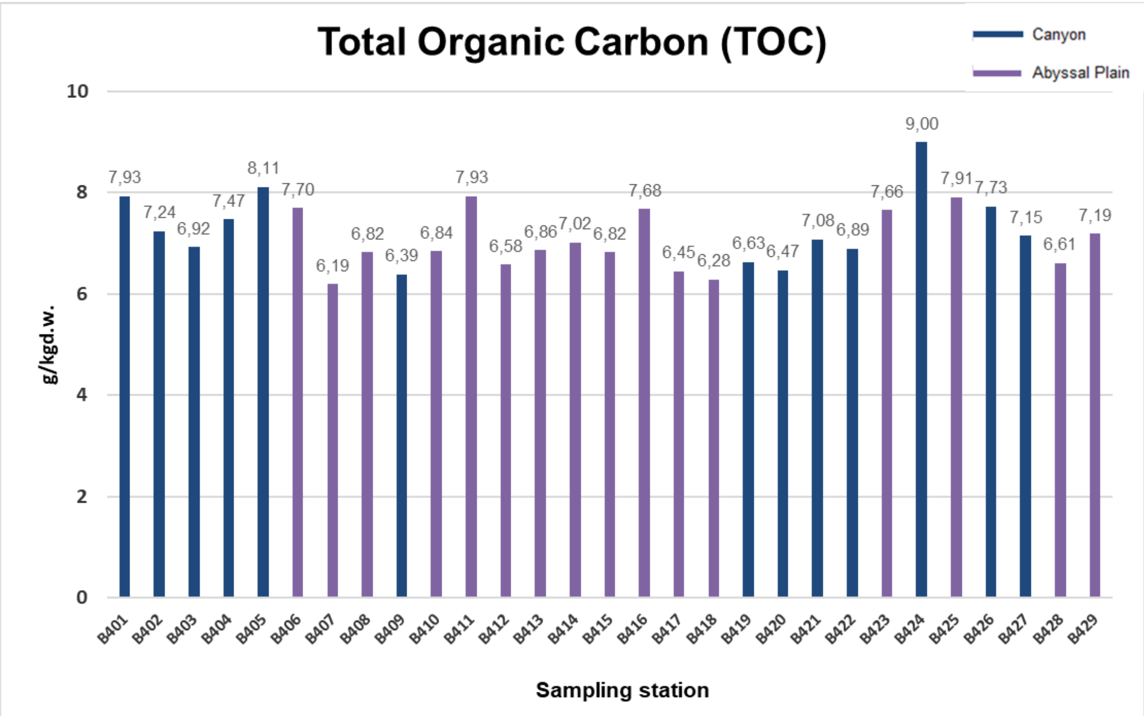


Figure 5.49: TOM and TOC distribution in Block 4 sediments

Source: Keran Liban/Creocean (2019b)

Nutrient analysis results showed total nitrogen concentrations were low (analysed using the total Kjeldahl nitrogen (TKN) method) and homogeneous between stations (between 0.5 and 0.8 g/kg dry weight (average 0.6 g/kg). Nitrite concentrations were not identified as levels were below the limit of quantification (20 mg/kg dry weight). Phosphorous (P) concentrations were also low and homogenous (ranging between 0.5 and 0.8 mg/kg dry weight and an average of 0.7 g/kg). Table 5.13 presents average results of TOC, TOM, TKN and P measured in Block 4 sediment along with the organic enrichment index (Alzieu index) for each parameter. Total index was 3, which indicates low organic enrichment.

Table 5.13: Average concentrations of organic contents and nutrients in sediments

	TOC	TOM	TKN	P
	%	%	g/kg d.w.	mg/kg d.w.
Average whole area	0.72	16.7	0.61	687
Organic enrichment index	1	-	1	1

Source: Keran Liban/Creocean (2019b)

Redox potential

The measure of oxidation-reduction (redox) potential of sediments reflects biological activity of the sediment bacteriological component. Higher organic enrichment is linked to lower redox potential, whereas lower organic enrichment is linked to higher redox potential. Block 4 stations predominantly showed positive redox potentials and are shown in Figure 5.50. This was consistent with low organic enrichment of station samples. However, some stations (those located inside or at the entrance of submarine canyons) demonstrated negative redox potential.

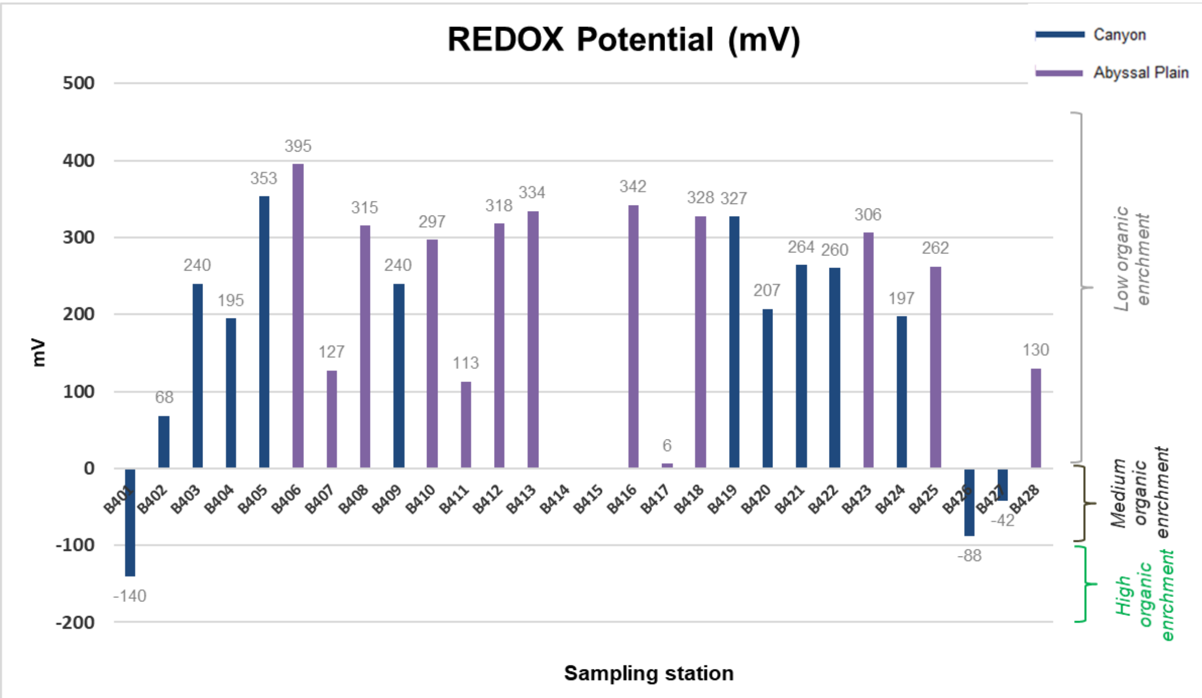


Figure 5.50: Redox potential measured in the sediments in Block 4
Source: Keran Liban/Creocean (2019b)

Metals

Metal concentrations in sediments were analysed. Aluminium and iron are of interest as these are considered indicators of anthropogenic pollution. Aluminium and iron concentrations were consistent across stations with aluminium ranging between 27.3 and

41.4 g/kg dry weight and iron between 40.6 and 56.6 g/kg dry weight. Lowest aluminium concentrations were measured at stations located on the open bathyal plain (southern section Block 4), with highest concentrations in a canyon in the northern area of the block.

Nickel and copper concentrations were above regulatory thresholds (the OSPAR and US Environmental Protection Agency (EPA) levels). Arsenic concentrations also exceeded OSPAR thresholds. Mercury levels exceeded geochemical background levels (GBL) recorded for the Mediterranean (GBL = 0.00004-0.03 µg/L (Bruland and Lohan, 2003), yet were below regulatory thresholds. Zinc and lead concentrations were low and below GBL levels, consistent with naturally occurring ocean concentrations. Some metals were not detected as levels were below limits of quantification. Table 5.14 shows average metal concentrations in Block 4 sediments.

Table 5.14: Average metal concentrations in sediments and regulatory thresholds

Metals (mg/kg dry matter)	Block 4			Regulatory threshold	Geochemical background levels (GBL)
	Mean	Min.	Max.	ERL OSPAR US EPA	
Aluminium (Al)	35,176	27,300	41,400		
Antimony (Sb)	1.2	1.0	2.62		
Silver (Ag)	<5	<5	<5		
Arsenic (As)	15.2	9.47	20.3	8.2	
Barium (Ba)	48.9	35.1	73.8		
Beryllium (Be)	<1	<1	<1		
Cadmium (Cd)	<0.4	<0.4	<0.4	1.2	0.15
Chromium (Cr)	55.7	44.0	66.3	81	
Cobalt (Co)	25.0	19.5	28.9		
Copper (Cu)	48.0	37.6	57.5	34	15
Mercury (Hg)	0.11	0.10	0.17	0.15	0.05
Iron (Fe)	50986	40600	56600		
Lithium (Li)	29.2	21.7	36.8		
Manganese (Mn)	2753	790	4960		
Molybdenum (Mo)	1.4	1.0	2.26		
Nickel (Ni)	49.1	40.2	55.2	20.9	
Lead (Pb)	17.2	11.3	23.6	46.7	25
Selenium (Se)	<5.00	<5.00	<5.00	-	-

Metals (mg/kg dry matter)	Block 4			Regulatory threshold	Geochemical background levels (GBL)
	Mean	Min.	Max.	ERL OSPAR US EPA	
Tin (Sn)	<5.00	<5.00	<5.00		
Thallium (Tl)	<1.00	<1.00	<1.00		
Vanadium (V)	84.4	66.9	94.0	-	-
Zinc (Zn)	62.8	47.0	81.8	150	90

Colours in the table indicate concentrations that exceeded a threshold. Values in blue means concentration under the threshold. ERL OSPAR US EPA = Effects Range Low provided by the OSPAR Commission and the US Environmental Protection Agency (EPA). Geochemical background levels measured in oceans, global databases (based on the literature of Bruland and Lohan, 2003). Source: Keran Liban/Creocean (2019b)

Hydrocarbons

Hydrocarbon analysis of Block 4 sediments identified PAHs, aliphatic and aromatic hydrocarbons, BTEX and PCBs. PAH concentrations ranged between 0.016 and 0.510 µg/kg dry weight (dw) with a mean of 0.093 µg/kg dw. Levels were below OSPAR and EU EPA thresholds for all stations, though fluoranthene levels were slightly higher than GBL. Overall, no significant PAH contamination was identified. Table 5.15 below presents a summary of the results, regulatory thresholds and GBLs.

Table 5.15: Average PAH concentrations in sediments and regulatory thresholds

PAH (µg/kg dry matter)	Concentration in the whole area			Regulatory threshold	Geochemical background levels
	Mean	Min.	Max.	ERL OSPAR (US EPA)	
Naphthalene	6.2	4.0	20.0	160	-
Acenaphtylene	-	<2.4	2,4	-	-
Acenaphtene	-	<2.4	5,3	-	-
Fluorene	3.4	2.0	8.6	-	-
Phenanthrene	11.5	5.6	45.0	85	-
Anthracene	3.7	2.0	13.0	240	-
Fluoranthene	10.4	2.0	53.0	600	40
Pyrene	7.6	2.0	37.0	665	-
Benzo (a) anthracene	6.4	2.0	48.0	261	-
Chrysene	7.6	2.0	51.0	384	-
Benzo (b) fluoranthene	11.7	2.8	72.0	-	200
Benzo (k) fluoranthene	4.7	2.0	24.0	-	100

PAH (µg/kg dry matter)	Concentration in the whole area			Regulatory threshold	Geochemical background levels
	Mean	Min.	Max.	ERL OSPAR (US EPA)	
Benzo (a) pyrene	7.1	2.0	47.0	430	100
Dibenzo (a,h) anthracene	3.9	2.0	28.0	-	-
Benzo (g,h,i) perylene	6.3	2.0	34.0	85	100
Indeno (1,2,3-cd) pyrene	6.7	2.0	41.0	240	100

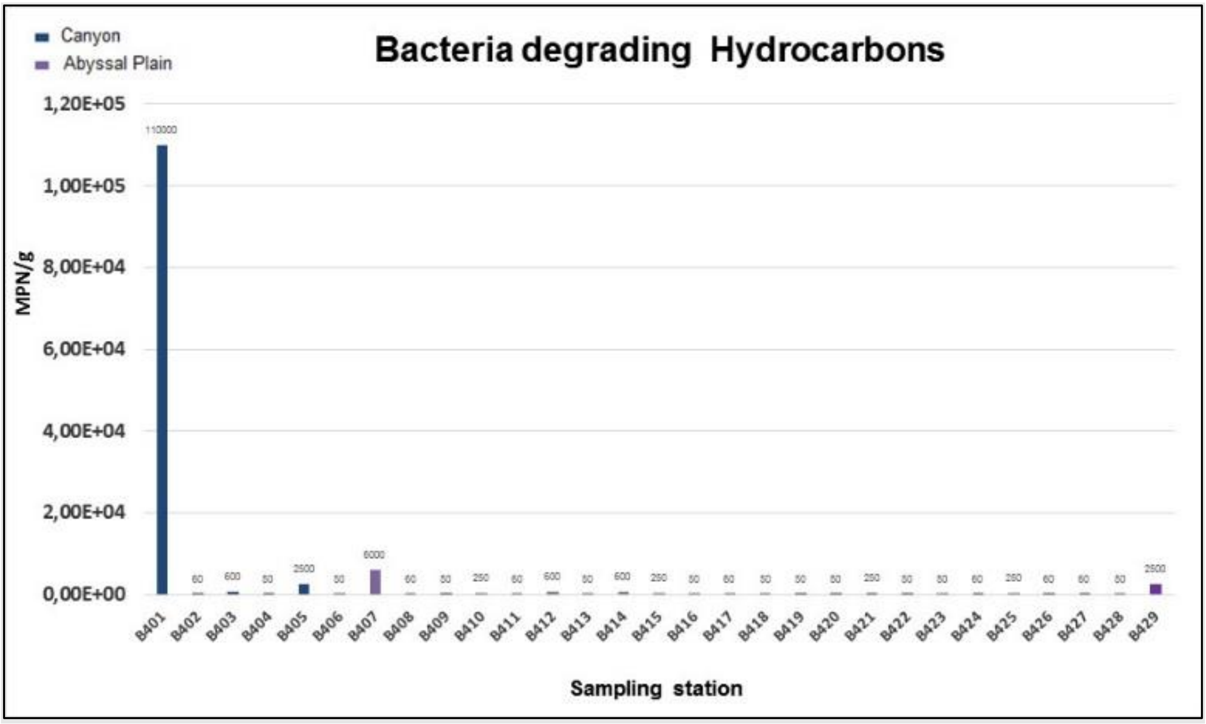
Colours in the table indicate concentrations that exceeded a threshold. Values in blue means concentration under the threshold. ERL OSPAR US EPA = Effects Range Low provided by the OSPAR Commission and the US Environmental Protection Agency (EPA). Geochemical background levels measured in oceans, global databases (based on the literature of Bruland and Lohan, 2003). Source: Keran Liban/Creocean (2019b)

No aliphatic or aromatic hydrocarbons were identified at any stations in Block 4, whereas BTEX concentrations were below limits of quantification (<0.10 mg/kg or 0.20 mg/kg of dry matter). PCB levels were also below limits of quantification (<0.001 mg/kg of dry matter).

Bacteria degrading hydrocarbons

Bacteria degrading hydrocarbons were detected in low levels at all stations except B401 (< 2,00E +04 – Most Probable Number (MPN)/g). Station B401 demonstrated far higher number at around 1.10E+05 MPN/g. Heterotrophic aerobic bacteria concentrations showed far greater variation in levels (from close to 0 MPN/g to 7,00E+06 MPN/g). Highest levels were recorded at station B406 on the open bathyal plain.

Figure 5.51 demonstrations variation in bacterial concentrations between stations.



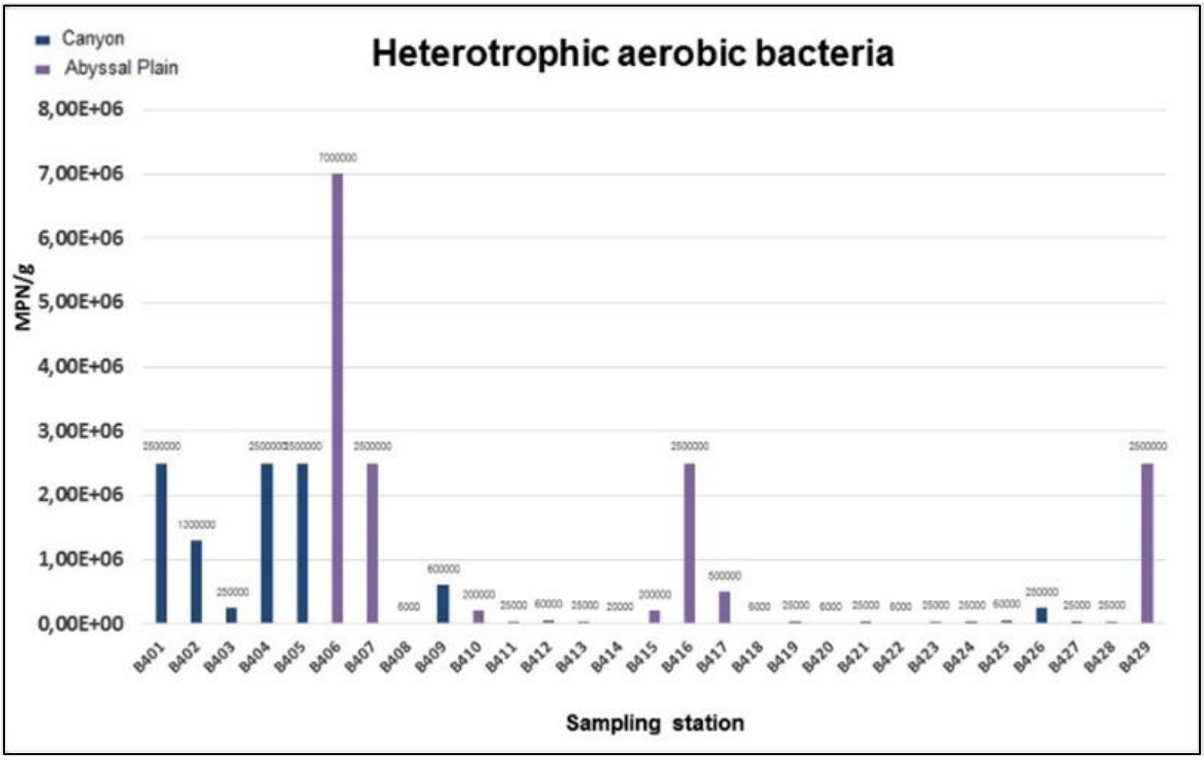


Figure 5.51: Variations of sediment bacterial concentrations between stations (Block 4)

MPN = most probable number. Source: Keran Liban/Creocean (2019b)

Conclusion

The results of the analysis of sediment samples collected during the Block 4 sampling campaign indicate that the sediments of Block 4 are comprised brownish mud dominated by fine particle size fractions.

Despite this important fine fraction, sediments exhibit a low organic and nutrient enrichment, except for TOM, which presents large spatial variations and at certain stations was very high. These results are similar to those found in Leviathan field (to the south of Block 4, within Lebanon's offshore waters) where seafloor sediments were classified as silty clay. TOC concentrations were considered similar to those at Leviathan field, which is expected given the highly oligotrophic nature of the entire eastern Mediterranean region.

In spite of a high percentage of fine fractions liable to trap metallic pollution, the overall results show the absence of metallic contamination that would present toxicity to marine organisms throughout Block 4. However arsenic, copper, nickel and, to a lesser degree, mercury present higher concentrations. Arsenic, copper, and nickel are known to be present in high concentrations throughout the Levantine Basin (CSA, 2116). These results are consistent with those found in Leviathan field to the south, where no metal contamination was noticed except for arsenic, copper and nickel. In Leviathan Field, contamination of antimony, barium, cadmium and lead were also reported but restricted in the proximity to Leviathan exploration wells themselves, and these elevated concentrations are considered the result of previous drilling activity.

Most sediments in Block 4 display hydrocarbon concentrations below the reference values proposed by different regulations, regarding toxicity for the marine organisms. PAHs were in low concentrations throughout the whole of Block 4, two stations.

Aliphatic and aromatic hydrocarbons, BTEX and PCBs were not detected.

This absence of contamination is consistent with results found in Leviathan field where no contamination of PAHs, TPH and PCBs was noted.

When detected, bacteria degrading hydrocarbons were in low concentration compared to heterotrophic aerobic bacteria: the mean ratio was 0.5% indicating no sign of hydrocarbons contamination, which is consistent with previous results of PAHs analysis.

The results are considered typical of the deep-sea sediments in the eastern Mediterranean and contrast with the much higher concentrations observed in sediments in Lebanon's coastal waters and port areas, as reported above.

5.3.2.7 Seabed sediment sensitivity

Coastal sediments off Lebanon have high contamination levels. Offshore sediments have high levels of some heavy metal contamination, but low levels of other contaminants. Therefore, the overall sediment sensitivity is considered as low (2).

5.3.3 Seascape

There is limited available information describing the seascape of Lebanon. The study area focused on the coastal landscape along the length of Lebanon. No AOI is specified as seascape is not a receptor (the receptors are tourists and other viewers).

The present and proposed land use/landscape of the Lebanese territory, including the coastline, is determined by the National Physical Master Plan of the Lebanese Territory (NPMPLT). The entire country has been mapped with respect to land use (see Figure 5.52). Coastal areas have special significance and are protected by law. The main areas include the

- Aarqa River estuary (MoE, Decision no. 188/1998)
- terraces and beach of southern Tripoli towards Qalamoun (Decree No. 3362/1972)
- El Jawz River estuary (MoE, Decision no. 22/1998)
- Batroun National Marine Hima at the National Centre for Marine Sciences (MOA, Decision no. 129 of 1991)
- Nahr Ibrahim River estuary and archaeological sites (MoE, Decision no. 34/1997)
- coastal front rocks and terraces of Wata Slim (Tabarja) (MoE, Decision no. 200/1997)
- El Kelb River estuary and historical site (MoE, Decision no. 97/1998)
- Beirut River estuary (MoE, Decision no. 130/1998)
- Awali River estuary (MoE, Decision no. 131/1998; MoEW, 2019).

Nahr Ibrahim River estuary and archaeological sites is the closest protected coastal site to Block 4 (9.1 km from Block 4 and 29.2 km from the proposed well site; Figure 5.53).

The sensitivity of the project for landscape is considered negligible and considered in the impact assessment only within the tourism receptor (Section 5.5.3.5). The drilling site is 20 km offshore and only visible from sea level along the coast, though it is noted that subsequent wells could be closer.

There is no relevant or specific information regarding seascape in Block 4.

5.3.4 Summary of key physical sensitivities

The key physical sensitivities within the study area are

- air quality: The eastern Mediterranean is affected by various sources of air pollution, including long-range airborne pollutants and particulate matter (PM_{10} and $PM_{2.5}$) from dust storms. The Lebanese coastline also has high ozone concentrations, while onshore contaminants such as such as NO_2, PM and O_3 exceed the standards as a result of air pollution in Lebanon, predominantly from the industrial and transport sector and from electricity generation and are highest in the main coastal cities.
- seawater quality: Offshore, seawater has low turbidity, is oligotrophic in terms of nutrients and uncontaminated and is considered representative of conditions typical for offshore locations for the eastern Mediterranean. The seawater quality within the priority area of Block 4 has a high degree of homogeneity. The coastal seawater is highly contaminated with anthropogenic pollution, such as untreated sewage discharge, solid waste and port activities, around major coastal cities such as Beirut, and algal blooms have been recorded near the Antelias River estuary and the El Kaleb estuary.
- seabed sediment quality: The offshore sediments comprise brownish mud dominated by fine particles and are considered typical of the deep-sea sediments in the eastern Mediterranean, with low contamination from most heavy metals and other contaminants such as hydrocarbons, BTEX and PCBs, except for arsenic, copper and nickel. The characteristics have been identified as

homogeneous throughout the priority area of Block 4, which suggests that the environmental conditions of the habitats are stable, and the area is of oligotrophic nature, with low organic and nutrient enrichment. Higher concentrations of heavy metals, hydrocarbons and nutrients are observed in sediments in Lebanon's coastal waters and port areas, but this coastal contamination has not affected the offshore deep seafloor.

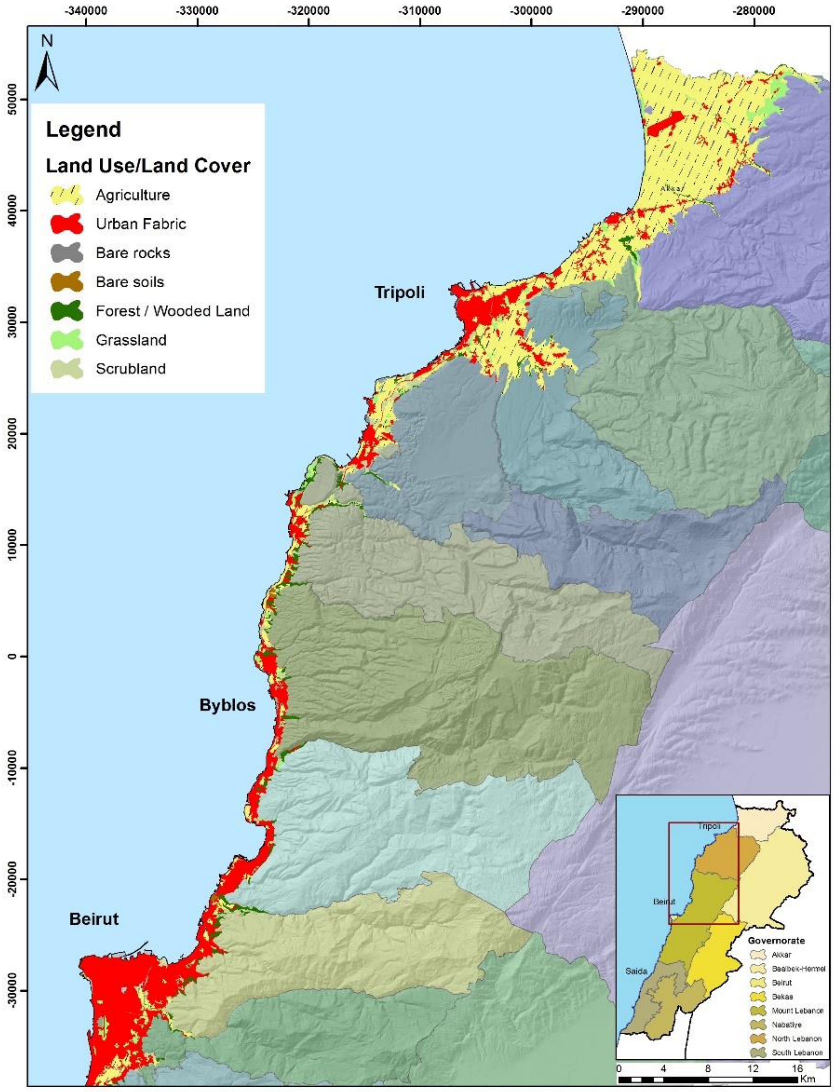


Figure 5.52: Existing and proposed land use/landscape of the Lebanese coastline (based on the NPMPLT)

Source: MoEW (2019)

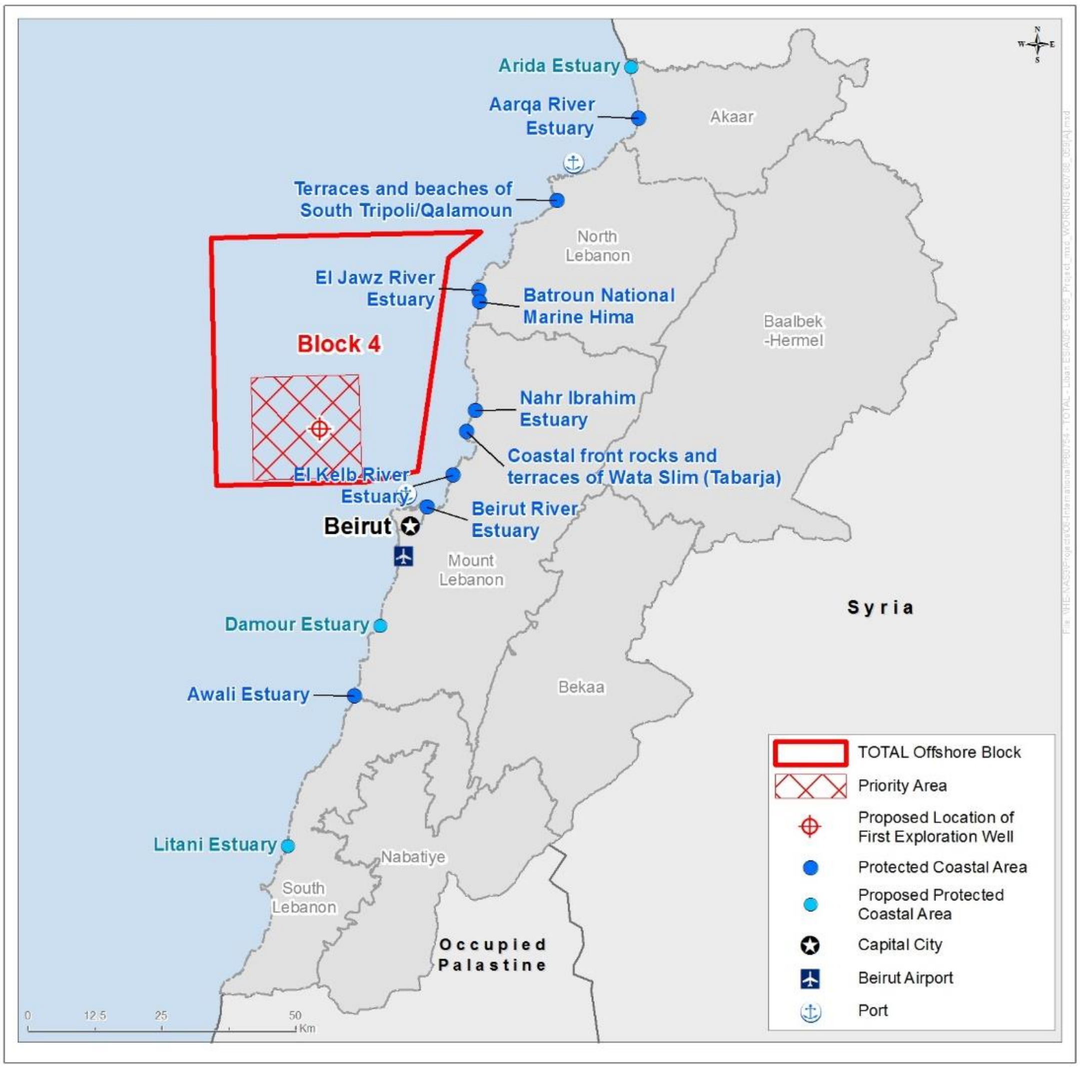


Figure 5.53: Protected and proposed coastal sites

Source: MoE/IUCN (2012), MoEW (2019)

5.4 Biological environment

The Mediterranean Sea holds more than 10,000 species of macroscopic marine organisms, which corresponds to 4–18% of global marine biodiversity (Bianchi and Morri, 2000; Boudouresque, 2004; Bariche, 2012). Cartilaginous and bony fishes, for instance, are represented in the Mediterranean by respectively 9.5 and 4.1% of the total number of species of these groups worldwide. Similarly, 18.4% of the world's marine mammals, 8.6% of marine reptiles, 5.6% of marine invertebrates and 16.9% of seaweeds and marine plants are also found in the Mediterranean. The Mediterranean is therefore considered a marine biodiversity hotspot.

Biodiversity is high as a result of its geological history, paleogeography (particularly the last 5 million years) and the variety of climatic and hydrological conditions that support temperate and subtropical biota (Bianchi and Morri, 2000; Boudouresque, 2004).

Species diversity and abundance decrease in the Mediterranean from west to east. This is because the eastern Mediterranean basin is characterised by a semi-arid climate with limited precipitation and reduced inflow of fresh water and nutrients. This is also because nutrient-rich Atlantic waters are depleted when they reach the eastern Mediterranean basin. These nutrients are essential to marine life (Quignard and Tomasini, 2000; Bariche, 2012).

Biodiversity also decreases in the Mediterranean with depth and major faunal transitions occur at 200 m, 500 m and 1000 m water depths (Tselepides et al., 2000). In addition, the relatively narrow continental shelf results in the majority of the Mediterranean basin being deep (Bariche, 2012). Prominent thermal stratification exists within the surface waters, while below a depth of about 400 m a permanent homothermia (12 to 13°C) is present between this depth and the seabed. This temperature is considered “too warm” for potential colonisers from the deep Atlantic. The situation is similar for potential deep tropical colonising species from the deep Red Sea and Indo-Pacific geographical area, through the Suez Canal (Quignard and Tomasini, 2000; Bariche, 2012). It should be noted however that a number of more moderate depth Indo-Pacific species have become established particularly in the eastern Mediterranean via the Suez Canal. Deep-sea depressions or trenches in which organic matter accumulates over time may represent isolated benthic biodiversity hotspots (Boetius et al., 1996).

Marine biodiversity reported for Lebanon’s waters includes over 230 species of seaweeds (macroalgae) and seagrasses (flowering plants) and at least 12 groups of marine invertebrates, including several hundred species of molluscs, polychaetes, crustaceans, sponges and cnidarians (e.g., Khouzami et al., 1996; Bitar and Zibrowius, 1997; Bitar and Kouli-Bitar, 1998; Bariche and Trilles, 2005; Abboud-Abi Saab, 2012; Crocetta et al., 2013a,b; 2014; Khalaf and Fakhri, 2017).

5.4.1 Benthic communities

The AOI for benthic communities is a 1.5 km radius around the proposed well site and encompasses the precautionary distance from the wells to the distance which drilling discharge impacts and anchoring impacts (if conventional moored semi-submersibles are used) on offshore benthic communities could extend.

The study area is wider, with a focus on the Block 4 priority area, and broadening out to include Block 4 as a whole. The study area also encompasses territorial Lebanese waters inshore of Block 4 to give context to the low sensitivity of the benthic communities within the AOI and to include coastal benthic communities.

5.4.1.1 Offshore benthic communities

The offshore deep-water benthic communities in Lebanese waters have rarely been studied and as such only very scarce information is available. A recent study which used a remotely operated underwater vehicle (ROV) provided some information on the biodiversity of the deep sea macrobenthos (OCEANA, 2016). Six main habitat types have been documented at depths ranging between 36 m and 1050 m. These habitats are: coralligenous habitats and rodolith/maerl beds; rocky bottom areas; muddy and sandy-muddy bottoms; sandy bottoms; canyon heads; and bathyal muds. The depths of habitat types were not delineated by the authors (Aguilar et al., 2018). The findings identified 619 benthic taxa, which included most taxonomic groups (Figure 5.54). The most significant being molluscs (178 taxa), fishes (152 taxa), cnidarians (147 taxa) and sponges (57 taxa) (Figure 5.54).

5.4.1.2 *Block 4 benthic community EBS*

Methods

As part of the Block 4 specific EBS conducted in spring 2019, benthic communities were characterised from seabed samples taken throughout Block 4. The sampling of seabed macrobenthos (invertebrates living in the seabed sediment) used the same box core that was used to collect sediment for physico-chemical analyses. Macrobenthos was sampled at a total of 29 stations throughout Block 4, of which 25 stations were sampled within the priority area (Figure 5.21) that had been identified as the focus of the exploration drilling campaign, as the seismic surveys had indicated that this area avoided to a large extent areas of potential shallow geohazard. As noted previously, two deployments of the box core were carried out at each sampling station. Half of the volume from the first deployment and all the second deployment of the box core at each sampling station were retained to provide samples covering a total seabed area of 0.3 m^2 for subsequent taxonomic analysis. This resulted in three replicate samples at each sampled station.

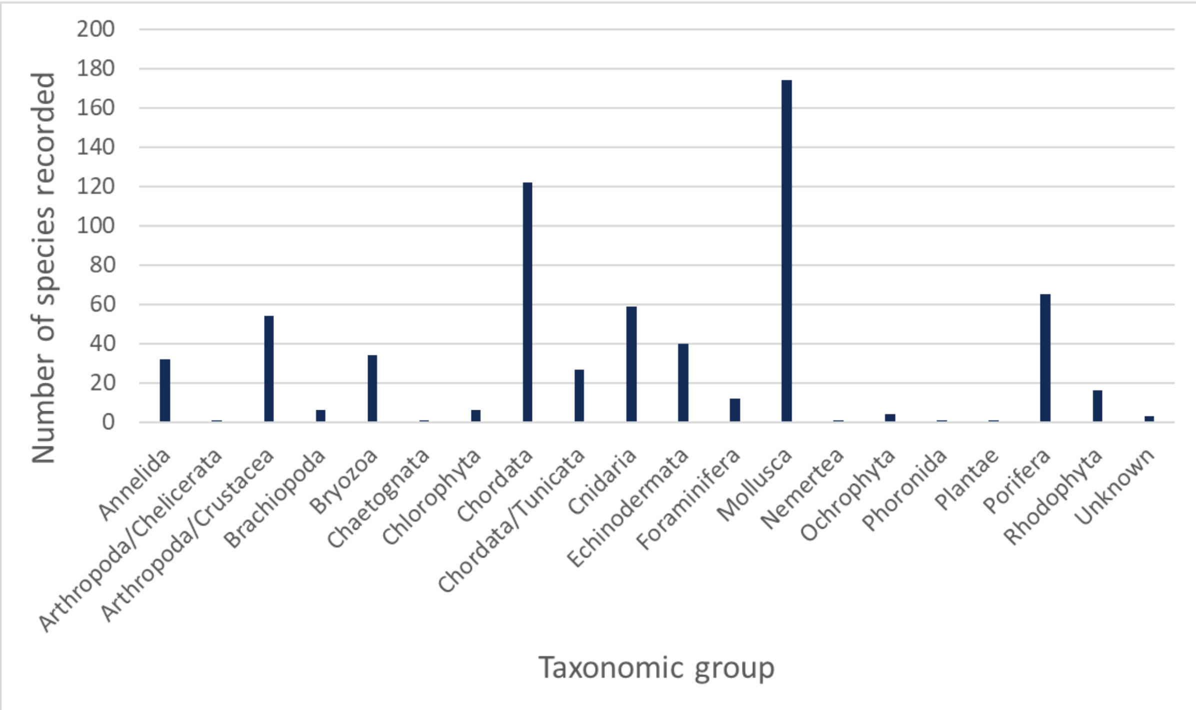


Figure 5.54: Number of species recorded during the OCEANA expedition
Source: Aguilar et al. (2018)

Samples were processed using a 500-µm-mesh sieve. All retained infaunal samples were transferred from the sieve into labelled plastic containers and preserved with buffered formalin and rose bengal. Samples were then transferred to the laboratory for subsequent analysis.

In addition to sediment collection, visual monitoring of the seabed was undertaken using a video mounted on an ROV. The ROV surveyed 14 transects throughout the block, all of which were undertaken within the priority area.

The ROV was equipped with a range of cameras and an obstacle avoidance sonar. Transects were surveyed at an approximate speed of 0.2–0.5 knots for a distance of 500–1300 m.

The imagery provided visual evidence of the seabed conditions, focusing particularly on the epifaunal communities (living on top of the seabed) in Block 4.

In addition to the video transects, drop-down video footage was captured at the same sites from which sediment was collected. A camera was deployed attached to the box core and slightly inclined to capture a general view of the seabed close to where the seabed was sampled. Videos were checked following each deployment and a screenshot of the seabed taken from the video at each sampling location.

Results

Benthic community description

The analysis of benthic samples in Block 4 identified 330 individuals of macrobenthic organisms from 20 different taxonomic groups. Samples were sorted, counted and identified to the lowest taxonomic level possible. A mean density of 38 individuals/m^2 and a mean biomass of 0.135 mg/m^2, which is considered low, for a deep-sea environment. In particular, the measurements of biomass are very low owing to the occurrence of animals of small body size.

The species richness, average density and biomass, and the measure of diversity (using the Shannon Weaver diversity Index) and evenness were all calculated on the basis of the list of identified species in combination with their density and biomass per station. Species richness was calculated per sampled area (0.3 m^2) while all other descriptors were scaled over an area of 1 m^2.

Average species richness was 8 species per station and ranged from 4 species per station within the priority area to 15 species per station to the north of the priority area.

Average density recorded was very low with an average of 38 individuals/m^2 and a range between 13 and 70 individuals/m^2 within the priority area.

Biomass measured was low with an average biomass at all stations of 0.066 mg/m^2. This biomass is indicative of communities composed of very small infaunal organisms and is typical for deep sea environments.

The calculated Shannon Weaver diversity index was intermediate with an average of 2.86. Most stations showed diversities higher than 2, except station B409, while diversities higher than 3 occurred at 13 stations. This is indicative of differences in the structure of the communities.

Species evenness indicates how evenly distributed the species are in a designated community. The average evenness was 0.94 with a range between 0.88 and 1.

Overall, the benthic infauna seems more abundant in Leviathan field to the south off the Lebanese coast with a mean density reaching 107.3 individuals/m^2 (CSA, 2016). However, the specific richness is of the same order and Shannon Weaver diversity index is lower in Leviathan field. These comparative results suggest that the offshore seafloor of the eastern coasts of the Levantine Basin is a low-productive area and supports an impoverished infaunal community, which is consistent with the low organic and nutrient enrichment found in the sediment.

Benthic community composition

Sixty-six taxa were identified in the benthic samples. The most representative species were polychaetes (23), followed by bivalves (eight), amphipods (seven) and cumaceans (five). All remaining groups have 5 or less species and 12 include a single taxon (actiniarians, copepods, decapods, mysidaceans, dipters[6], caudofoveatids, scaphopods, echinoids, holothuroids, ophiuroids, nematodes and nemerteans).

Polychaetes were present in all 29 stations and bivalves occurred in 27, while amphipods and copepods occurred in less than half of the stations. Actiniarians, decapods, mysidaceans, dipters and holothuroid echinoderms were present at single stations.

Figure 5.55 shows the averaged percentage species richness, density, biomass and frequency of the main benthic infaunal taxonomic groups collected in the Block 4 samples.

6 There is no existing insect species colonisation in seawater, so the presence of dipters must be due to sample contamination when the box corer was on the deck of the vessel in the open air.

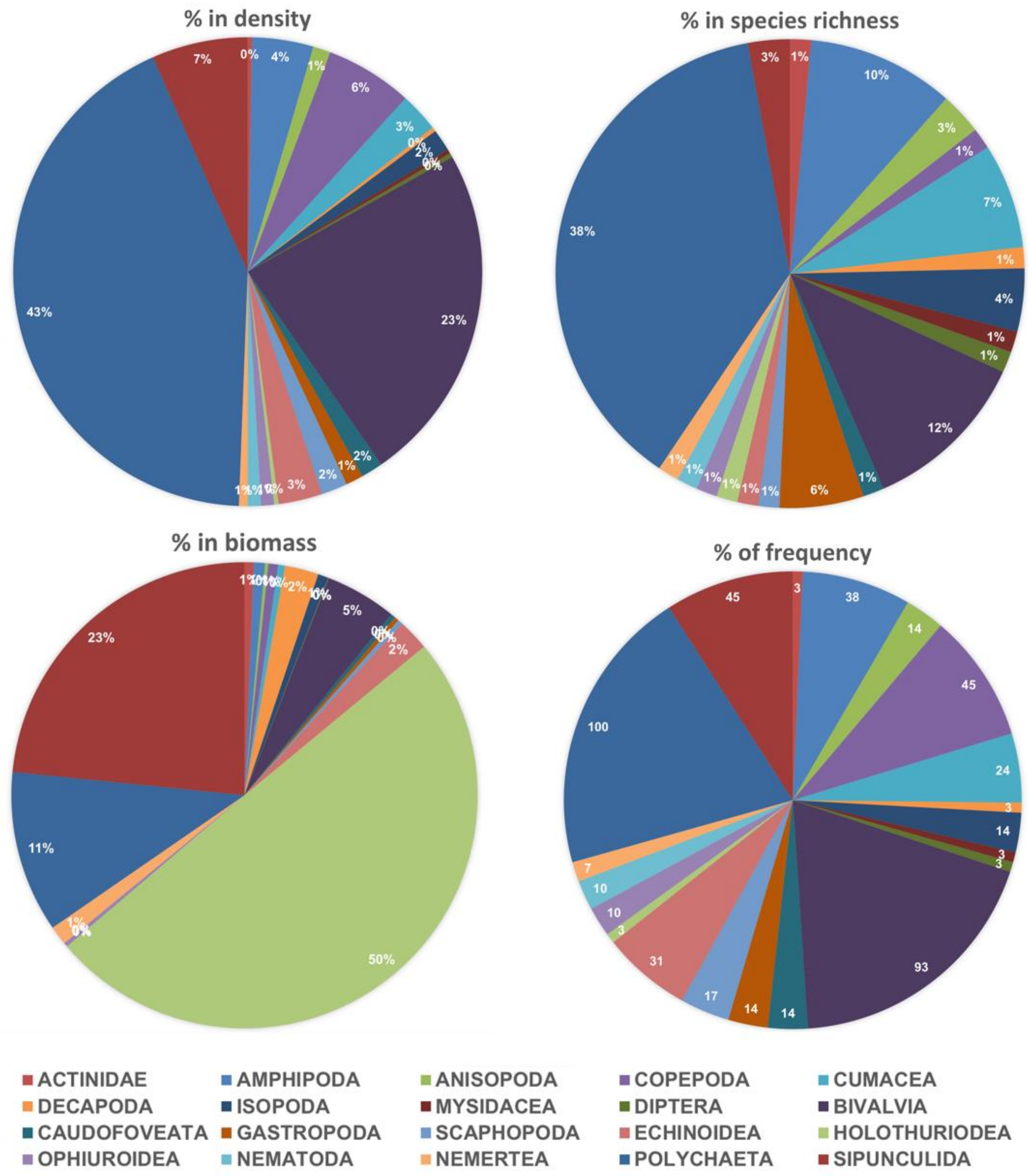


Figure 5.55: Percentage species richness, density, biomass and frequency of the main benthic infaunal taxonomic groups collected in Block 4 samples

Source: Keran Liban/Creocean (2019b)

Density was largely dominated by polychaetes which represented 42.8% of the total density (Figure 5.55). Bivalve molluscs and copepod crustaceans represent 23.5% and 6% of the total density, respectively, while the remaining taxonomical groups made up less than 5%.

Biomass of the benthic community consisted of holothuroid echinoderms, which represent almost 50% of the total. Sipunculids and polychaetes contributed to the total biomass with 23% and 10% respectively, bivalves with 5% and decapods and echinoids with 2%. All other groups make up less than 2% of the total biomass. However, it must be noted that these data did not reflect the actual distribution of biomass in Block 4 samples, as the holothuroids were represented by a single specimen (a sea cucumber) in one of the replicates at station B423. Therefore, the other taxonomic groups (namely sipunculids and polychaetes) have a higher representative biomass than that shown in the percentages shown in Figure 5.55.

The following figures (Figure 5.56 and Figure 5.57) illustrate several abundant or common species that were identified within samples collected throughout Block 4.

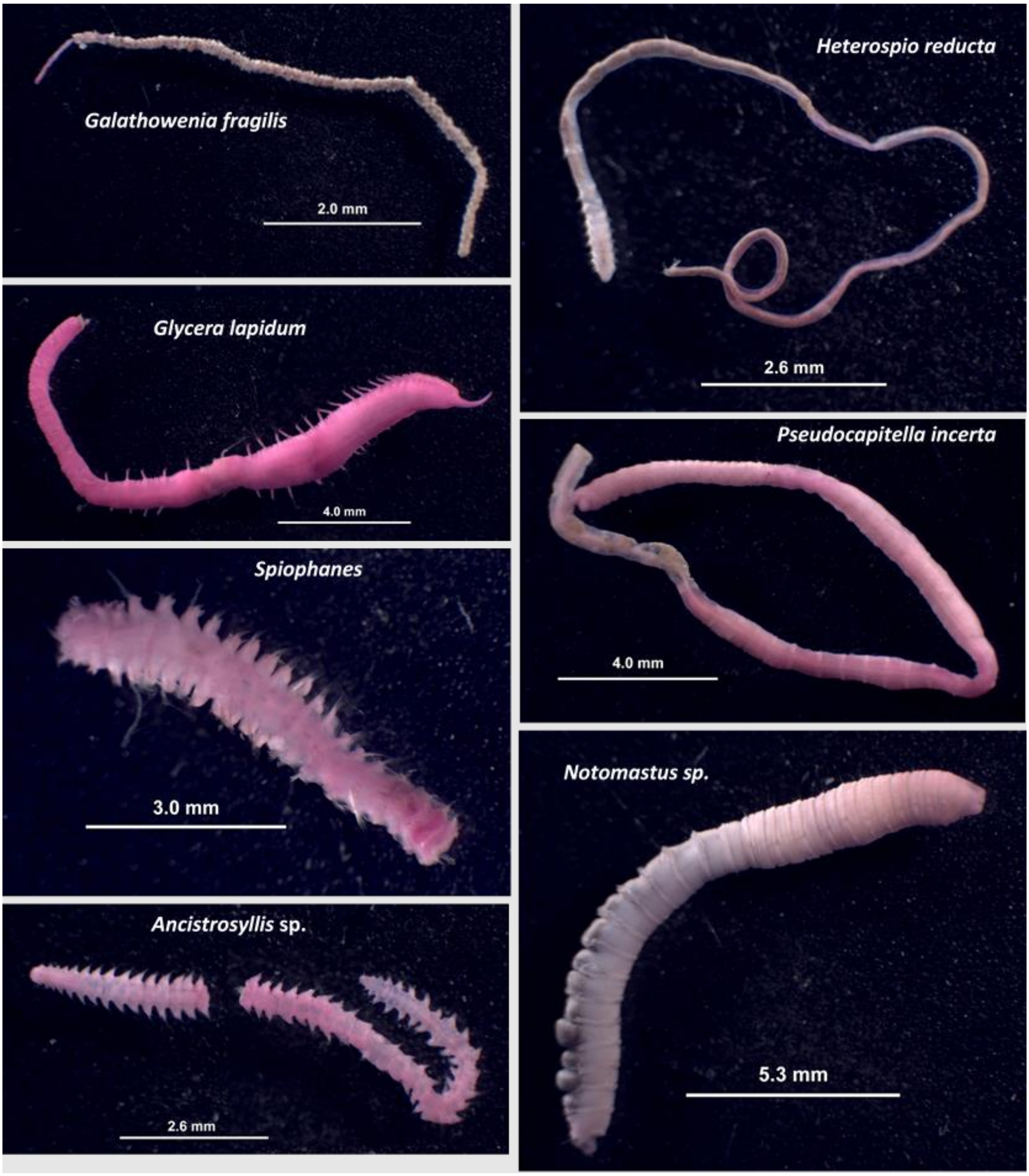


Figure 5.56: Common or abundant species sampled in Block 4 (annelids)

Source: Keran Liban/Creocean (2019b)

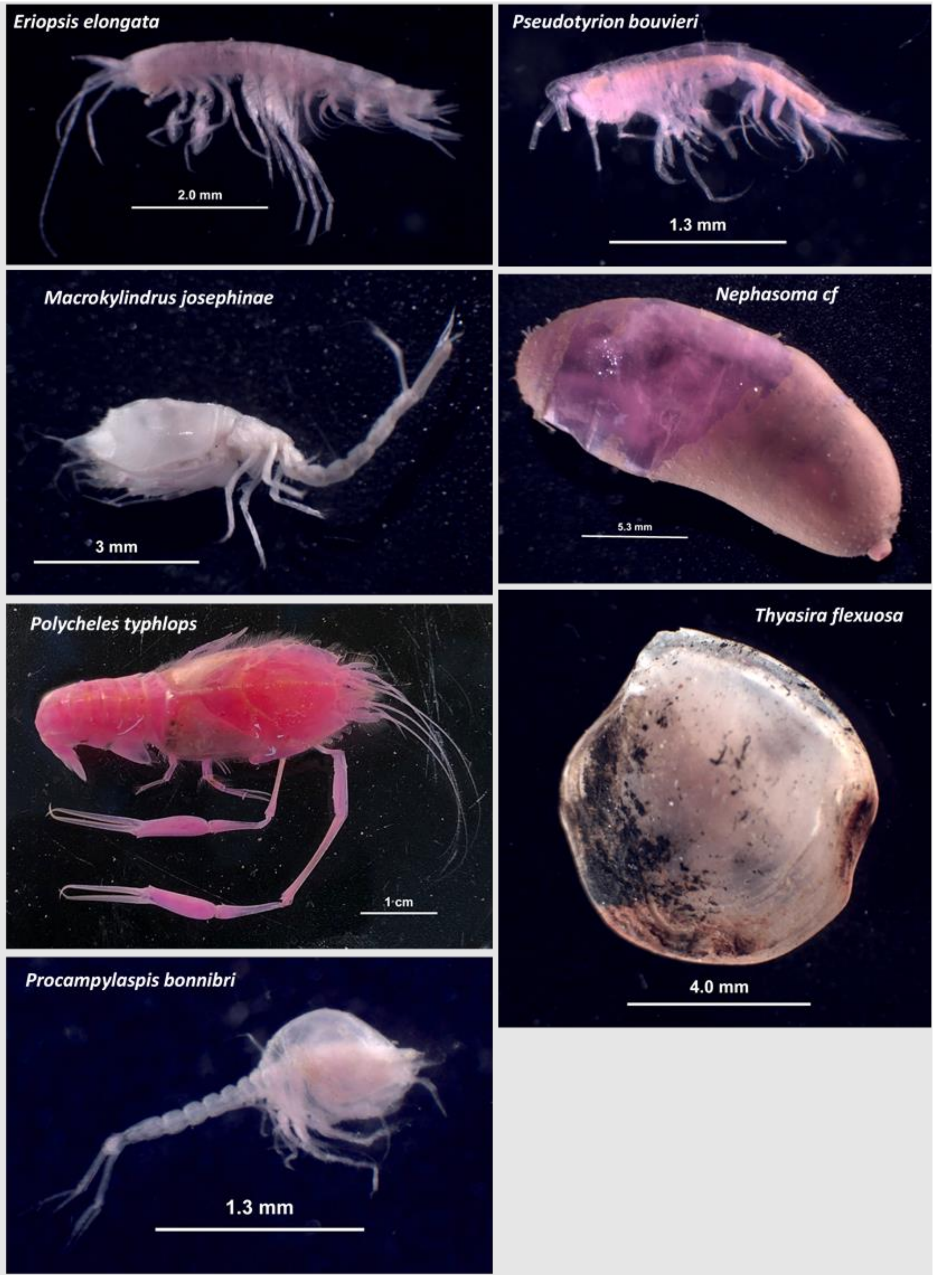


Figure 5.57: Common or abundant species sampled in Block 4 (other taxa)

Source: Keran Liban/Creocean (2019b)

Benthic community structure

Cluster and multi-dimensional scaling (MDS) was used to analyse the structure of the benthic communities to reveal the main groups of stations and their particular characteristics. The differences between the groups of stations identified in these analyses have been assessed by one-way analysis of similarity, and the species responsible for the within-group similarities and the between-group dissimilarities have been assessed with the help of the similarity percentage analysis.

Based on the density data, the stations in Block 4 can be grouped in two highly significantly different groups, which did not show an evident geographical or bathymetric distribution and showed a high level of intermixing. However, Group 1 stations were located more in the western part of the survey area than those from Group 2 (Figure 5.59). Groups 1 and 2 clearly highlighted differences in the composition of the benthic assemblages identified at the sampling stations. These differences were supported by differences in the levels of TOM and total PAH concentrations of the sediments (more than 25% higher in the former), as well as in redox levels and arsenic concentrations (more than 5% higher in Group 1).

Figure 5.58 shows the results of the cluster analysis.

Figure 5.58: Results of the cluster analysis showing the two groups of stations identified at a similarity percentage of 9%. Group 1: green; Group 2: orange

Source: Keran Liban/Creocean (2019b)

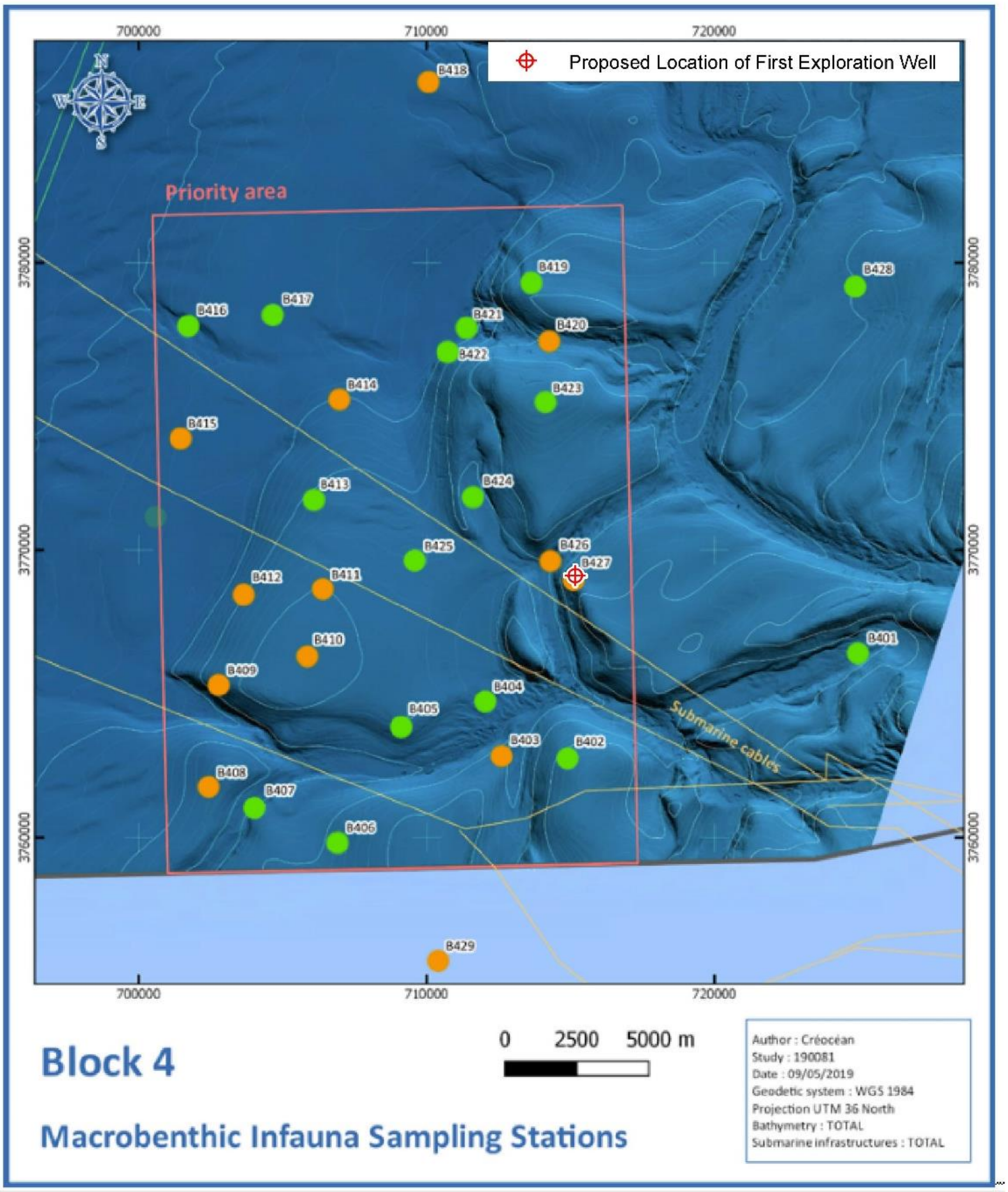


Figure 5.59: Geographical location of the two groups of stations identified in the cluster and MDS analysis

Source: Keran Liban/Creocean (2019b)

Seabed imagery

The ROV observations show a flat muddy seafloor with very few sessile invertebrates on the seabed despite numerous examples of evidence (holes, mounds), as well as a low abundance of mobile species such as red shrimps and few fish (mainly tripod *Bathypterois dubius* fish).

A high abundance and frequency of anthropogenic waste was observed on the seafloor, varying in nature and size (an average of one waste item per 50 m of video transect length, Figure 5.61).

Overall the seafloor presents a relatively flat and homogeneous soft sediment environment, except at transects B4-VT07 and B4-VT13 (Figure 5.21; same location shown in Figure 5.62), within a pre-identified pockmark area, where outcrops have formed dark hard reliefs one or two metres in height. These features likely have originated from the chemical reaction/precipitation of seeping cold gases coming in contact with seawater at the sediment surface. These reliefs were not highly colonised by sessile invertebrates yet abundant molluscs, white sea urchins, crabs and fish were observed (*Diplocanthopoma cf. brachysoma*, *Lepidion* sp.). Throughout the surveyed area of Block 4, this was the only location showing a developed epifaunal community. It is the only area classified as high sensitivity seabed habitat and is located north of the proposed well location (Figure 5.60).

There is a small area of potentially high sensitivity seabed habitat to the south of the proposed well location, another pockmark area. The canyon areas within the Block 4 priority area are classified potentially as low sensitivity habitat (Figure 5.60).

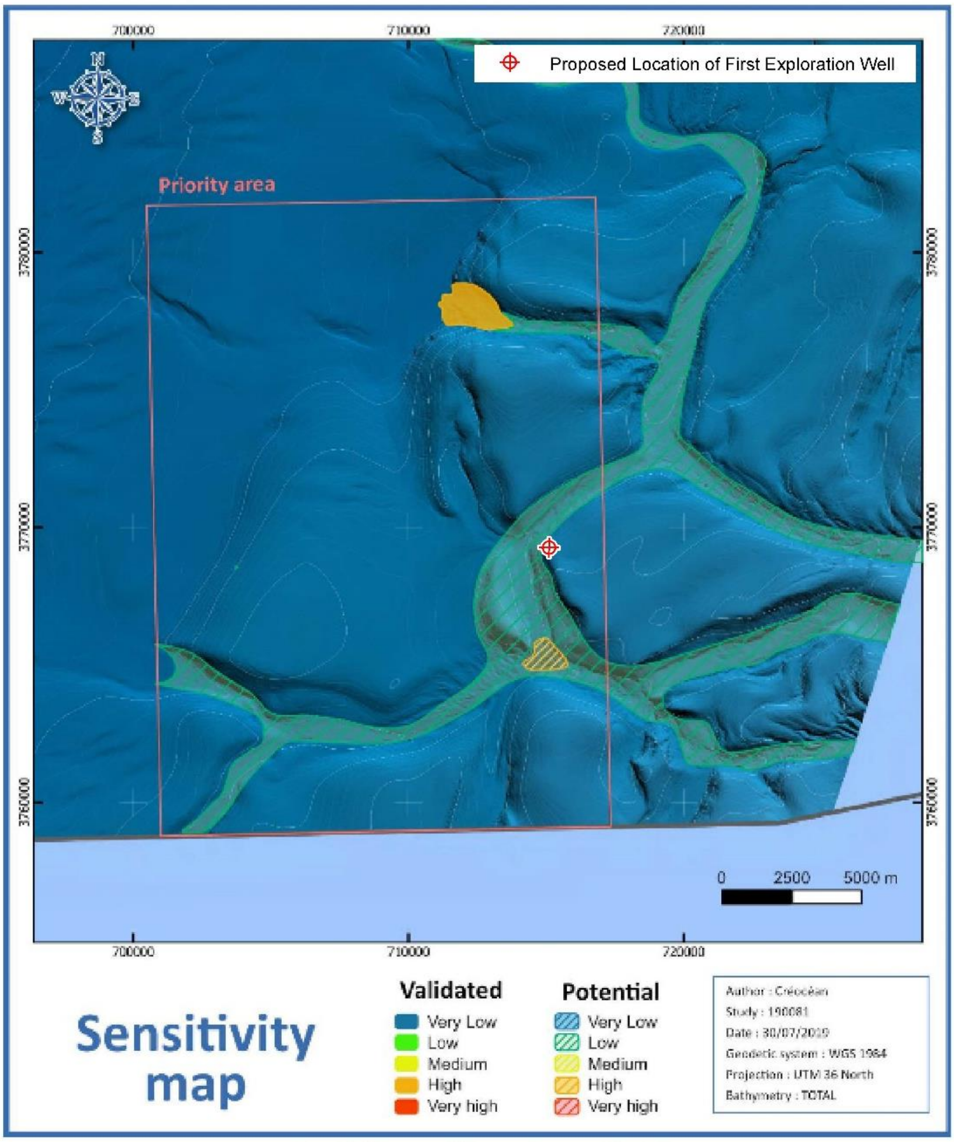


Figure 5.60: Location of sensitive areas determined from the EBS

No coralligenous habitats and rodolith/maerl beds were observed as they had been during the OCEANA survey campaign conducted between 2012 and 2016 (Aguilar et al., 2018). The OCEANA survey described six main habitat types over a broad depth range (36 m to 1050 m): Coralligenous habitats and rodolith/maerl beds; rocky bottom areas; muddy and sandy-muddy bottoms; sandy bottoms; canyon heads; and bathyal mud (CANA-CNRS, 2014; Aguilar et al., 2018). In comparison, Block 4 biota appear to be less diverse when compared to the findings of previous regional campaigns which reported 75 flora counts, 14 fauna of invertebrates, 99 species of molluscs, 82 species of polychaetes, 45 species of crustaceans, 44 species of sponges and 22 species of cnidarians, totalling 650 species and benthic taxa (Abboud-Abi Saab, 2012; Khalaf and Fakhri, 2017). It should be recognised, however, that the range in water depths surveyed in these previous campaigns was greater than that of the surveyed area of Block 4.

Conclusions

Overall, the benthic infauna seems more abundant in Leviathan field to the south of Block 4. However overall species richness is of the same order and species diversity is lower at Leviathan field. These comparative results suggest that the offshore seafloor of the eastern coasts of the Levantine Basin is a low-productive area and supports an impoverished infaunal community, which is consistent with the low organic and nutrient enrichment found in the sediment.

5.4.1.3 Sensitivity

The sensitivity of the benthic fauna is considered low (2), the area is a 'bathyal mud' habitat, which is considered relatively impoverished in the region in terms of species abundance and diversity. Sensitive marine habitats (offshore) are rated as high (4) as one area of highly sensitive habitat is located in the Block 4 priority area. Although this is outside the AOI for the first exploration well, other potentially sensitive habitats may be present in the Block 4 priority area.

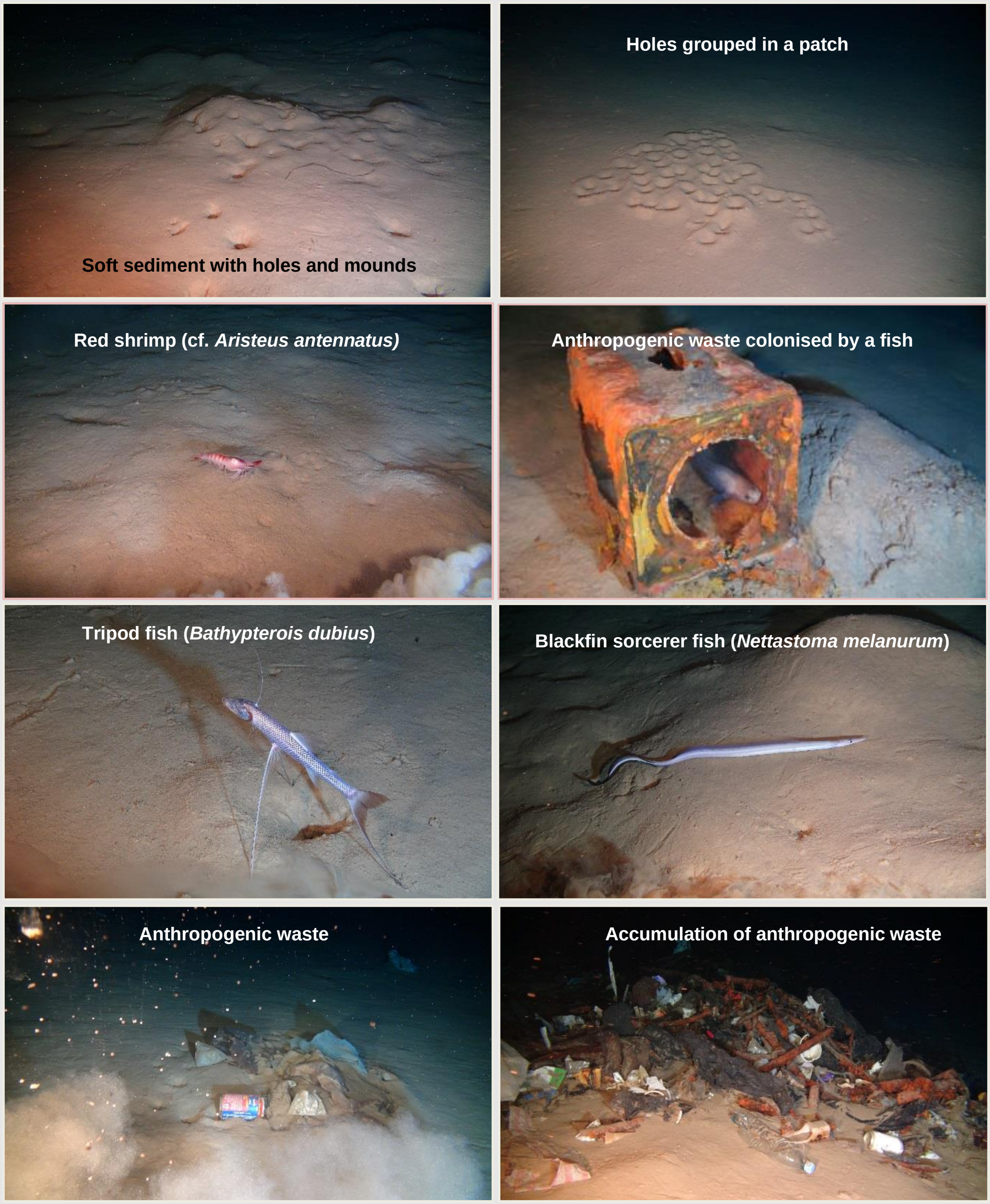


Figure 5.61: ROV images of the typical seafloor throughout Block 4

Source: Keran Liban/Creocean (2019b)

Figure 5.62: ROV images from Transect B4 VT07 showing the seafloor epibenthic communities in the vicinity of potential cold gas seep area

Source: Keran Liban/Creocean (2019b)

5.4.1.4 Coastal benthic communities

Marine biodiversity in Lebanese coastal waters encompasses most groups of marine invertebrates, including several hundred species of sponge, cnidarians, worms, molluscs, crustaceans and echinoderms (e.g., Tortonese et al., 1966; Fadlallah, 1975; Shiber, 1976; Shiber and Fattah, 1977; Khouzami et al., 1996; Bitar and Zibrowius, 1997; Bitar and Kouli-Bitar, 1998; Perez et al., 2004; Bariche and Trilles, 2005, 2006; Vacelet et al., 2007; Harmelin et al., 2009; Morri et al., 2009; Abboud-Abi Saab, 2012; UNEP/MAP RS, 2012, 2013; Crocetta et al., 2013a,b, 2014; Ramos-Espla et al., 2015; Harmelin et al., 2016; Badreddine, 2018). As coastal benthic communities are an integral part of the coastal benthic habitats, the sensitivity of coastal benthic habitats (Section 5.4.2.4) incorporates the sensitivity of coastal benthic communities.

5.4.2 Coastal benthic habitats

The AOI for coastal benthic habitats is limited to the near vicinity of the Port of Beirut during routine activities (vessels transiting from the port to the well site). The study area extends over the whole length of the Lebanese coast to provide context.

5.4.2.1 Macroalgae

Studies on macroalgae along the Lebanese coast are fairly limited and relatively few studies have reported on the diversity. Studies conducted from 1976 to 2003 reported about 220 species/taxa were known in Lebanese waters (Basson et al., 1976; Khouzami et al., 1996; Bitar, 1999; Abboud-Abi Saab et al., 2003). A checklist of marine macroflora and cyanobacteria listed 243 taxa (Lakkis and Novel-Lakkis, 2007). It is relatively well-known that organic pollution has had a negative effect on brown algal species in Lebanese waters, whereas many green algae are considered more tolerant.

5.4.2.2 Seagrasses

Marine seagrasses form a unique ecological entity, as they are flowering plants that grow in the marine environment. Two species of seagrass are present in the Lebanese coastal waters, *Cymodocea nodosa* and *Halophila stipulacea,* which occupy shallow sandy seabeds, often forming meadows. These meadows, or seagrass beds, are considered of great importance in coastal waters, as they constitute nursery and feeding grounds for an array of marine species (Bitar, 2010; Kouyoumjian and Hamze, 2012; Kanaan et al., 2015; MoE/GEF, 2016). Several of the proposed marine protected areas in Lebanon include the presence of seagrass beds in their applicable criteria, see Table 5.16, and Figure 5.70 for known areas of seagrass beds in Lebanon’s coastal waters.

5.4.2.3 Vermetid reefs

Vermetid reefs are bioconstructions created by gastropod molluscs belonging to *Dendropoma* (and related genera) in association with another vermetid *Vermetus triquetrus* and the crustose coralline algae *Neogoniolithon brassica-florida* (Setchell and Mason 1943; Chemello and Silenzi, 2011; Milazzo et al., 2017).

In the Mediterranean basin, vermetid reefs are commonly distributed along the warm-water coasts of the southern part and their largest bioconstructions can be found along the Levantine Sea (Milazzo et al*.,* 2017), including the Lebanese coast.

Vermetid reefs are one of the most important coastal ecosystems of the Mediterranean Sea and guarantee many ecological services, e.g., productivity and biodiversity, refuges and nursery areas (Milazzo et al*.,* 2017). They also protect the shoreline from wave erosion and act as a carbon sink (Chemello and Silenzi, 2011). Figure 5.63 shows a schematic illustration of a typical vermetid reef on the Lebanese coast relative to the sea level.

The death and erosion of vermetid reefs are presently observed in several area of the Mediterranean Sea, particularly along the Levantine coast (Rilov, 2016; Milazzo et al*.,* 2017). Several of the proposed marine protected areas in Lebanon include the presence of vermetid reefs in their applicable criteria, see Table 5.16.

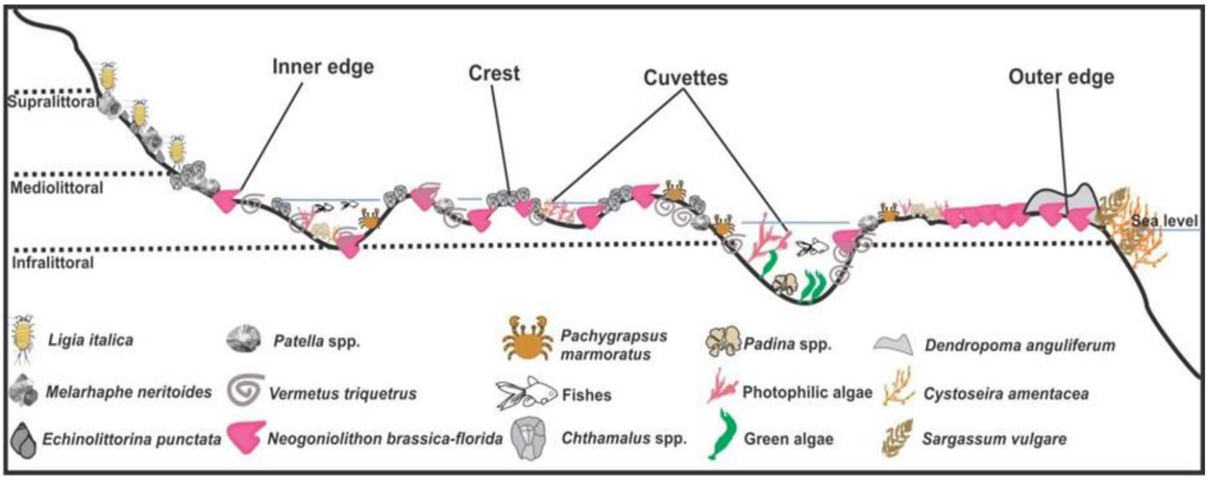


Figure 5.63: Schematic illustration of typical Lebanese vermetid reef
Source: Badreddine (2018)

Table 5.16: Proposed MPAs and applicable coastal benthic habitat criteria

Name of proposed MPA	Vermetid reefs	Seagrass beds	Artificial reef	Coralligeneous concretions
Sidon rocks	✓	✓		
Beirut port outer platform		✓ (vestige)	✓	
Byblos	✓	✓		✓
Batroun Phoenician wall	✓			✓
Litani estuary		✓		
Awally estuary		✓		
Damour estuary		✓		
Nahr Ibrahim estuary		✓		
Arida estuary		✓		

Source: Based on information in Lebanese Ministry of Environment/IUCN (2012)

5.4.2.4 Sensitivity

The AOI (vicinity of Port of Beirut for routine activities) and the wider study area (area that could be impacted in the case of an accidental event) includes sensitive benthic habitats. The sensitivity of coastal benthic habitats such as seagrass beds and vermetid reefs is considered high (4) because these habitats are of international importance that would be difficult to restore if affected.

5.4.3 Planktonic communities

Planktonic communities are pelagic organisms that live suspended in the water column. They are divided into phytoplankton and zooplankton and are usually subdivided based on size. Viruses are considered part of the virioplankton while most of the picoplankton consists of archaea and bacteria. Larger organisms can be categorised based on their sizes (micro-, meso-, macro- and megaplankton) or as autotrophic phytoplankton and heterotrophic zooplankton. All planktonic organisms have limited motive capacity and are dependent on prevailing water movements.

The AOI for planktonic communities is a radius of 25 km around the proposed well site and is the precautionary distance from the wells to which drill fluids and cuttings impacts on water quality, and hence plankton could extend. The study area encompasses Block 4 and all territorial Lebanese waters to give context to the low sensitivity of the planktonic communities' AOI.

5.4.3.1 Phytoplankton

A relatively large number of phytoplankton species (>400 species) have been reported from Lebanese waters (e.g. Abboud-Abi Saab, 1985; 1989; Lakkis, 2011a). Their composition, densities and biomass fluctuate based on season or other factors such as nutrients and light availability or pollution levels in the water column. Species, such as dinoflagellates, that live in waters that contain high levels of phosphates, nitrates and organic matter may grow rapidly and under certain conditions form a bloom.

Spring phytoplankton blooms in the coastal waters of Lebanon are characterised by the presence of diatoms while dinoflagellates are very common during the summer season. The seasonal distribution of the most commonly observed species is shown in Table 5.17 (Lakkis, 2007). Typically, the diversity of phytoplankton populations is lowest in May and highest in September (Abboud-Abi Saab, 2012).

Table 5.17: Seasonal distribution of the most common phytoplankton species in Lebanese waters

Season	Phytoplankton species
Winter	*Chaetoceros curvisetrus, Ch. pseudocurvisetus, Ch. decipiens, Leptocylindrus danicus, Skeletonema costatum, Pseudonitzschia fraudulenta, P.seriata, Cerataulina pelagica, Dinophysis caudata, Protoperidinium divergens, P.diabolus.*
Spring	*Ch. pseudo-curvisetus, Skeletonema costatum, Leptocylindrus danicus, Lminimus, P. fraudulenta, P. seriata, P. pungens, P. closterium*
Summer–autumn	*Chaetoceros affinis, Ch. brevis, Ch. didymus, Ch. Anastomosans, Ch. rostratus, Streptotheca thamesis, Rhizosolenia calcar-avis, Bacteriastrum elegans, Ceratium furca, C. pulchellum, Dinophysis caudata, Protoperidinium divergens, P. Diabolus, Dinophysis caudate, Prorocentrum micans*

Source: Lakkis (2007)

5.4.3.2 Zooplankton

Zooplankton is an extremely diverse group of free-floating fauna in the water column. This group comprises most of the marine zoological groups like protozoans and chordates. The zooplankton also includes the eggs, larvae and juvenile phases of many larger species of marine fauna.

Zooplankton are the most studied group of plankton in Lebanese waters and have been monitored for more than 35 years (Abboud-Abi Saab, 2012) with more than 780 species being reported (Lakkis, 2011b; Abboud-Abi Saab, 2012). Zooplankton include cnidarians, comb jellies, polychaetes, chaetognaths, cirripeds and other crustaceans as well as pelagic tunicates (thaliaceans and appendicularians). Fish eggs and larvae, known as ichthyoplankton, also occur seasonally (Abboud-Abi Saab, 2012).

Zooplankton ecology is affected by the hydrological, hydro-biological and physical/chemical characteristics of the water column they inhabit (MoE/GEF, 2016). In Lebanon, the peak density is reported in the summer months, immediately after the spring phytoplankton bloom. During the winter months, zooplankton densities decrease (Lakkis, 2011b; Abboud-Abi Saab, 2012).

The smallest part of the plankton is constituted of viruses (virioplankton) and bacteria (picoplankton), some of which can be heterotrophic or autotrophic. Autotrophic bacteria are the most important photosynthetic organisms in early stages of biomass production (MoE/GEF, 2016), yet specific data related to these groups is noticeably absent from the literature for this part of the Mediterranean Sea. This is due to the lack of surveys undertaken in Lebanese waters.

5.4.3.3 Block 4 plankton sampling campaign

Methods

Plankton sampling was undertaken as part of the dedicated Block 4 EBS. Samples for both phytoplankton and zooplankton were collected at each of the four water quality sampling stations in Block 4 (as shown in Figure 5.21). Both types of sample (phytoplankton and zooplankton) were collected using WP2 vertical plankton nets, which had a 0.25 m^2 opening. The nets were also equipped with a flowmeter to assess the volume of water filtered. The net used for phytoplankton analysis had a 50-µm mesh and the zooplankton net had a 200 µm mesh size.

Before sampling began, the nets were lowered to a depth just below the thermocline (at approximately 300 m). The nets were then pulled to the surface at a speed of approximately 30 m per minute to keep them vertical in the water column. The flowmeter readings were recorded before and after the deployment so that the volume of filtered water could be calculated.

Once recovered on the vessel, the plankton samples were preserved using a 5% formaldehyde solution (for zooplankton) and Lugol’s solution for phytoplankton and stored for subsequent analysis.

Results

More than 110 taxa of zooplankton and phytoplankton were collected during the EBS. The 50 µm mesh size net sampled both phytoplankton (micro-algae) and zooplankton (small crustaceans, crustacean larvae [nauplii]).

Samples were analysed using the FlowCAM system to assess the diversity of taxa and their abundance and to estimate species diversity and evenness of taxa. While the FlowCAM could identify most organisms present in the samples, some were not identified and considered as “temporary” or “centric”.

A total of 57 taxa were collected using the 50 µm mesh size net, which included a variety of organisms such as micro-algae and nauplii larvae. Bacillariophyta were the most representative in terms of taxa diversity (about 32% of the taxa), followed by Ciliophora (about 27% of the taxa), Holodinophyta (about 8% of the taxa), Radiozoa (about 6% of the taxa) and Arthropoda (approximately 4% of the taxa) (as shown in Table 5.18). Similarly, Bacillariophyta were the most representative in terms of taxa abundances (about 58%) followed by Ciliophora (about 13%), Holodinophyta (about 5%), and Arthropoda (about 5%) (Table 5.19). The Shannon diversity index was 1.48 to 3.37 and the evenness index was 0.3 to 0.69, indicating that taxa were heterogeneously distributed among the four sea water sampling stations.

Table 5.18: Taxonomic groups of plankton in Block 4 by diversity

Stations	B4-01		B4-04		B4-11		B4-15	
	nb./m^3	%	nb./m^3	%	nb./m^3	%	nb./m^3	%
Radiozoa	2	6.90	3	7.69	3	7.32	1	3.45
Arthropoda	3	10.34	2	5.13	1	2.44		
Temporate Ind.	6	20.69	7	17.95	7	17.07	8	27.59
Ciliophora	7	24.14	9	23.08	13	31.71	8	27.59
Bacillariophyta	11	37.93	13	33.33	10	24.39	9	31.03
Cnidaria					1	2.44		
Foraminifera			1	2.56				
Holodinophyta			4	10.26	5	12.20	3	10.34
Mollusca					1	2.44		
Total	29		39		41		29	

nb. = number. Source: Keran Liban/Creocean (2019b)

Table 5.19: Taxonomic groups of plankton in Block 4 by abundance

Phylum	B401		B404		B411		B415	
	nb. ind./m^3	%	nb. ind./m^3	%	nb. ind./m^3	%	nb. ind./m^3	%
Arthropoda	17.203	7.24	5.950	7.57	5.191	6.05	568	1.03
Bacillariophyta	188.162	79.19	4.2076	53.51	42.220	49.19	27.810	50.26
Ciliophora	11.827	4.98	12.750	16.22	12.804	14.92	9.365	16.92
Cnidaria					346	0.40		
Foraminifera			425	0.54	692	0.81		
Holodinophyta			2.975	3.78	8.652	10.08	4.257	7.69
Mollusca					346	0.40		
Other			425	0.54	692	0.81		
Radiozoa	2.150	0.90	2.550	3.24	1.384	1.61	851	1.54
Retaria			425	0.54	346	0.40		
Temporary Ind.	1.8279	7.69	11.050	14.05	13.150	15.32	12.486	22.56
Total	237.622		78.627		85.824		55.337	

nb. ind. = number of individuals. Source: Keran Liban/Creocean, 2019b

Seventy-two taxa were collected using the 200 µm mesh net including a variety of organisms such as copepods, crustaceans and fish larvae. The 200-µm mesh samples larger planktonic organisms belonging to mesozooplankton and macroplankton. The 200 µm mesh net also collected significant quantities of detritus and fibre.

Samples were analysed with the ZooScan system to assess the diversity and abundance of taxa and to estimate diversity and evenness indices. As with the FlowCAM system used for samples collected with the 50 µm mesh net, there were some taxa that the ZooScan could not identify and considered as "temporary".

Arthropods were the most representative in terms of taxa diversity (about 39% of the taxa), followed by Cnidarians (about 17% of the taxa), Chordates (about 13% of the taxa), and Molluscs (about 10% of the taxa) (Table 5.20). Similarly, Arthropods were the most representative in terms of taxa abundances (about 78%) followed by Chordates (about 23%), Molluscs (about 3%), and Cnidarians (about 2%) (Table 5.21). The Shannon diversity index was 2.23 to 4.19 and the evenness index was 0.41 to 0.71, showing that taxa were heterogeneously distributed among the four stations.

Table 5.20: Diversity of taxonomic groups of plankton collected in Block 4

Phylum	Nb. taxa	%
Annelida	3	4.2
Arthropoda	28	38.9
Chaetognatha	3	4.2
Chordata	9	12.5
Cnidaria	12	16.7
Echinodermata	2	2.8
Foraminifera	1	1.4
Harosa	1	1.4
Holodinophyta	1	1.4
Mollusca	7	9.7
Other	1	1.4
Radiozoa	1	1.4
Temporary ind.	3	4.2
Total	72	

Source: Keran Liban/Creocean (2019b)

Table 5.21: Abundance of taxonomic groups of plankton found in Block 4

Phylum	B401		B404		B411		B415	
	nb. ind./m^3	%	nb. ind./m^3	%	nb. ind./m^3	%	nb. ind./m^3	%
Annelida	1	0.783	1	0.58	1	0.67	1	0.60
Arthropoda	133	84.326	137	69.94	148	77.80	188	79.86

Phylum	B401		B404		B411		B415	
	nb. ind./m³	%	nb. ind./m³	%	nb. ind./m³	%	nb. ind./m³	%
Chaetognatha	3	1.804	5	2.66	4	2.31	9	3.75
Chordata	10	6.335	29	14.62	17	8.70	8	3.26
Cnidaria	2	0.965	6	3.22	5	2.59	5	1.96
Echinodermata	3	1.902	5	2.56	5	2.69	3	1.37
Foraminifera	1	0.336		0.00	0	0.15		0.00
Harosa	0	0.112	2	1.18	1	0.32	0	0.12
Holodinophyta	0	0.224		0.00		0.00		0.00
Mollusca	4	2.517	6	3.02	3	1.51	8	3,57
Other		0.000	3	1.60	3	1.63	5	2.32
Radiozoa		0.000		0.00	0	0.01	4	1.51
Temporary ind.	1	0.699	1	0.68	3	1.63	4	1.67
Total	157		196		190		235	

Source: Keran Liban/Creocean (2019b)

Conclusion

The information reported by Abboud-Abi Saab (2012) on seasonal variation of phytoplankton presents a minimum diversity index in May whereas maximum values were obtained in September. Furthermore, Lakkis (2011b) also describes an aquatic environment poor in zooplankton during the winter months in more coastal Lebanon waters, however, with quite high diversity, due to the mixing turnover of water layers.

The EBS survey campaign provided a snapshot of the plankton communities found in the study area of Block 4. These results only provide a semi-quantitative representation of the plankton communities that occur in this area at this time of the year. The plankton samples were quite diverse; however, the abundances were always low, which is consistent in offshore oligotrophic waters typical in the eastern Mediterranean area. It is also consistent with the low nutrient concentrations and spring seasonal conditions during which the EBS was conducted.

5.4.3.4 Sensitivity

Based on the low abundance and seasonal variation of phytoplankton and zooplankton in Lebanese waters, and because these systems are not fragile or unique and are expected to recover quickly, the sensitivity of plankton is considered low (2).

5.4.4 Fish and fishery resources

The AOI for fish communities is a radius of 25 km around the proposed well site and is related to a precautionary distance from the wells to which drill fluids and cuttings impacts on water quality, and hence fish could extend.

The study area encompasses Block 4 and all territorial Lebanese waters to give context to the sensitivity of the fish in the AOI.

The biodiversity of fish in Lebanese waters is well studied related to commercially exploited species. Lebanon's coastal waters contain more than 100 fish species of commercial importance. Artisanal fisheries are the main fishery type with around 5000 fishing vessels, using fishing gear including trammel nets, gill nets, longlines, purse seine nets and beach seines. Section 5.5.3.5 provides details on fisheries.

Fisheries data obtained from the Ministry of Agriculture (MoA) for 2017 show that two species of small pelagic fish accounted for approximately one third of landings: round herring (*Etrumeus teres*) and European anchovy (*Engraulis encrasicolus*). Other fish accounting for the majority of landings included pelagic species of herring (Clupeidae), tuna and mackerels (Scombridae), demersal sea breams (Sparidae) and rabbitfishes (Siganidae) (MoA, 2018). Commercially important pelagic fish in Lebanese coastal waters have been shown to exhibit clear seasonal trends in abundance and biomass (Bariche et al., 2007). European pilchard (*Sardina pilchardus*) and chub mackerel (*Scomber japonicus*) dominate catches between May and June and are then replaced by round sardinella (*Sardinella aurita*) in July and European anchovy in August (Bariche et al., 2006, 2007; MoA, 2018).

There are also species present in Lebanese waters that are included on the IUCN Red List, including the dusky grouper (*Epinephelus marginatus*), which is endangered in the Mediterranean (Cornish and Harmelin-Vivien, 2011); the European seabass (*Dicentrarchus labrax*); and the common dentex (*Dentex dentex*). The populations of European seabass and common dentex in the Mediterranean are classified as near threatened and vulnerable respectively (Yokes et al., 2011; Bizsel et al., 2011).

Spawning information in Lebanese waters is limited. Tsikliras et el. 2010 collected all available information on the spawning season of Mediterranean marine fish. Those applicable to the Block 4 area are summarised in Table 5.22.

Table 5.22: Spawning of Mediterranean marine fish stocks – summary of those applicable to Block 4

Species Country of study and location	J	F	M	A	M	J	J	A	S	O	N	D
Saurida undosquamis (brushtooth lizardfish) Occupied Palestine, Mediterranean coast												
Synodus saurus (Atlantic lizardfish) Occupied Palestine, Mediterranean coast												
Sargocentrum rubrum (squirrelfish species) Occupied Palestine, Haifa Bay												
Spicura smaris (ray-finned fish species) Turkey, eastern Mediterranean												
Pempheris vanicolensis (greenback bullseye) Occupied Palestine, Occupied Palestinian coast												

Species Country of study and location	J	F	M	A	M	J	J	A	S	O	N	D
Mycteroperca rubra (mottled grouper) Occupied Palestine, eastern Mediterranean												
Siganus luridus (rabbitfish species) Lebanon, Batroun												
Siganus rivulatus (rabbitfish species) Syria/Lebanon, Levantine coast												
Rhinobatos rhinobatos (guitarfish species) Turkey, eastern Mediterranean												

Source: Tsikliras et al. (2010)

The sharks and rays in the region have also been characterised (Bariche, 2012). A 2013 survey along the coast of Lebanon from depths of 0–600 m recorded 25 species. This comprised 11 species of sharks and 14 species of rays (including guitarfishes, electric rays, skates and stingrays), as shown in Table 5.23, and includes several deep-water species. Some taxa such as guitarfishes and whaler sharks (Carcharhinidae) were found to be of commercial significance; critically endangered angel sharks (*Squatina* sp.) and blackchin guitarfish (*Rhinobatos cemiculus*) were also recorded (Lteif, 2015). The OCEANA expedition recorded the longnosed skate (*Dipturus oxyrinchus*) for the first time in the eastern Mediterranean and the velvet-belly lantern shark (*Etmopterus spinax*) for the first time in Lebanese waters and the Mediterranean (Aguilar et al., 2018).

Table 5.23: Sharks and rays recorded along the Lebanese coast during 2013 surveys

Common name	Scientific name	IUCN Status
Dusky shark	*Carcharhinus obscurus*	Vulnerable (VU)
Gulper shark	*Centrophorus granulosus*	Vulnerable (VU)
Kitefin shark	*Dalatias licha*	Vulnerable (VU)
Marbled stingray	*Dasyatis marmorata*	Data deficient (DD)
Common stingray	*Dasyatis pastinaca*	Data deficient (DD)
Tortonese's stingray	*Dasyatis tortonesei*	Not evaluated (NU)
Longnosed skate	*Dipturus oxyrinchus*	Near threatened (NT)
Blackmouth catshark	*Galeus melastomus*	Least concern (LT)
Spiny butterfly ray	*Gymnura altavela*	Vulnerable (VU)
Sharpnose sevengill shark	*Heptranchias perlo*	Near threatened (NT)
Bluntnose sixgill shark	*Hexanchus griseus*	Near threatened (NT)
Shortfin mako shark	*Isurus oxyrhincus*	Endangered (EN)
Common smoothhound	*Mustelus mustelus*	Vulnerable (VU)
Bullray	*Pteromylaeus (Aetomylaeus) bovinus*	Data deficient (DD)

Common name	Scientific name	IUCN Status
Pelagic stingray	*Pteroplatytrygon violacea*	Least concern (LT)
Thornback skate	*Raja clavata*	Near threatened (NT)
Brown skate	*Raja miraletus*	Least concern (LT)
Blackchin guitarfish	*Rhinobatos cemiculus*	Critically endangered (CR)
Common guitarfish	*Rhinobatos rhinobatos*	Endangered (EN)
Longnose spurdog	*Squalus blainville*	Data deficient (DD)
Sawback angelshark	*Squatina aculeata*	Critically endangered (CR)
Smoothback angelshark	*Squatina oculata*	Critically endangered (CR)
Round fantail stingray	*Taeniura grabata*	Data deficient (DD)
Spotted torpedo	*Torpedo marmorata*	Data deficient (DD)
Great torpedo ray	*Torpedo nobiliana*	Data deficient (DD)

Source: Lteif (2015), IUCN (2019)

Most of the knowledge on fish in Lebanese waters is for coastal commercial species, with limited information available for offshore fish. The species classified as “threatened” (vulnerable, endangered or critically endangered) (Table 5.23) by the IUCN are predominantly benthic, with most species limited to depths shallower than 1000 m (IUCN, 2019). Only the gulper shark is found is depths approaching 1500 m, while threatened pelagic sharks that could be present in the priority area, such as the shortfin mako shark, are migratory throughout the Mediterranean Sea with the Lebanese coast not considered a breeding or foraging hotspot (IUCN, 2019).

A key characteristic of the fish of the eastern Mediterranean, including Lebanese waters, is Lessepsian migration, whereby fish species of Indo-Pacific origin arrive from the Red Sea via the Suez Canal. In fact, many non-indigenous fish have been recorded in Lebanon since the 1960–70s and in studies since 2005, as detailed in Section 5.4.11 (Invasive Species).

5.4.4.1 Block 4 fish observations

Benthic fish were observed using the methods for the ROV described in Section 5.4.1.2, while any large pelagic fish were recorded as part of the megafauna visual survey using the methods described in Section 5.4.5.1. A small number of deep-water fish species were recorded. The most common species was the tripod fish (*Bathypterois dubius*), which was found along several transects. Other species included ophidiiform fish (*Diplocanthopoma* cf. *brachysoma*), gadiform fish (cf *Lepidion* sp.), as well as spiny eels (*Notacanthus bonaparte*, *Polyacanthonotus rissoanus*) and the blackfin sorcerer (*Nettastoma melanurum*) (Figure 5.61 and Figure 5.64).

The blackmouth catshark (*Galeus melastomus*) and the longnosed skate (*Dipturus oxyrinchus*) were also recorded (Figure 5.64).

Two pelagic fish sightings were made during the survey and included a dolphinfish and a ray.

Figure 5.64: Fish species recorded during the Block 4 EBS

Source: Keran Liban/Creocean (2019)

5.4.4.2 Sensitivity

Based on the available information on the fish assemblage, the sensitivity of fish is considered medium (3).

However, as there may be protected or “threatened” species present in the AOI, these fish are included within the protected/threatened species receptor, which has a high (4) sensitivity.

5.4.5 Marine mammals

The AOI for marine mammals is an 8.6 km radius around the proposed location of the wells and a 900 m buffer zone around the transit routes for the MODU and support/ supply vessels. This AOI encompasses a precautionary zone in which behavioural changes in marine mammals could occur from a stationary source of noise at the well site, and the zone in which strong behavioural reactions may potentially occur in response to vessel noise. The study area encompasses Block 4 and the eastern Mediterranean to provide context for the use of Lebanese waters by marine mammals.

Several species of marine mammals (cetaceans[7] and seals) are reported from the Levantine basin region and include species of whales, dolphins and the Mediterranean monk seal, some of which are threatened. Table 5.24 shows the species that have been recorded in the eastern Mediterranean.

[7] Cetaceans include whale and dolphin species.

Table 5.24: Marine mammal species recorded in the eastern Mediterranean

Common name	Scientific name	IUCN status	
		Global	Mediterranean*
Fin whale	*Balaenoptera physalus*	Vulnerable	Vulnerable
Humpback whale	*Megaptera novaeangliae*	Least concern	
Sperm whale	*Physeter macrocephalus*	Vulnerable	Endangered
Cuvier's beaked whale	*Ziphius cavirostris*	Least concern	Vulnerable
Killer whale	*Orcinus orca*	Data deficient	
False killer whale	*Pseudorca crasssidens*	Near Threatened	
Pygmy killer whale	*Feresa attenuata*	Least concern	
Long-finned pilot whale	*Globicephala melas*	Least concern	Data deficient
Risso's dolphin	*Grampus griseus*	Least concern	Data deficient
Rough-toothed dolphin	*Steno bredanensis*	Least concern	
Common bottlenose dolphin	*Tursiops truncatus*	Least concern	Vulnerable
Striped dolphin	*Stenella coeruleoalba*	Least concern	Vulnerable
Short-beaked common dolphin	*Delphinus delphis*	Least concern	Endangered
Mediterranean Monk Seal	*Monachus monachus*	Endangered	Critically endangered

*Mediterranean subpopulation classifications where available. Source: IUCN (2019)

Although the eastern Mediterranean region has relatively low abundances of marine mammals, its assemblage of species, which includes the Mediterranean monk seal, rough-toothed dolphin, Risso's dolphin and false killer whale, is relatively unique (Ryan et al., 2014). Regularly occurring cetaceans in the region include bottlenose dolphin, stripped dolphin, short-beaked common dolphin, Risso's dolphin, Cuvier's beaked whale and rough-toothed dolphin, while fin whales, sperm whales, and false killer whales are considered visitors to the area. Humpback whales and killer whales are considered vagrant (Bariche, 2010, 2012; Kerem et al., 2012). Some of these species are not well known in the Mediterranean, and certain species such as the rough-toothed dolphin have not been reported in the western region of the Mediterranean.

Data on marine mammals is scarce in Lebanese waters, although the CNRS carries out regular monitoring (MoE/GEF, 2016; CANA-CNRS, 2019). CNRS is currently establishing a network of observations for stranding mammals all along the Lebanese coast and to increase human skills for applying the photograph identification method (CANA-CNRS, 2014).

The common bottlenose dolphin is the most abundant species in Lebanese waters and was observed in high densities off the coast of Beirut during 2010–2011 (Figure 5.65). Just over half of the bottlenose dolphins sighted were within 300 and 600 m depth (MoE/IUCN, 2012). Other species of whales and dolphins (sperm whale, Risso's, striped and rough-toothed dolphins, false killer whale, Cuvier's beaked whale and fin whale) may be seen seasonally in the Block 4 area, as the Levantine basin region is within their migration routes or known areas of use.

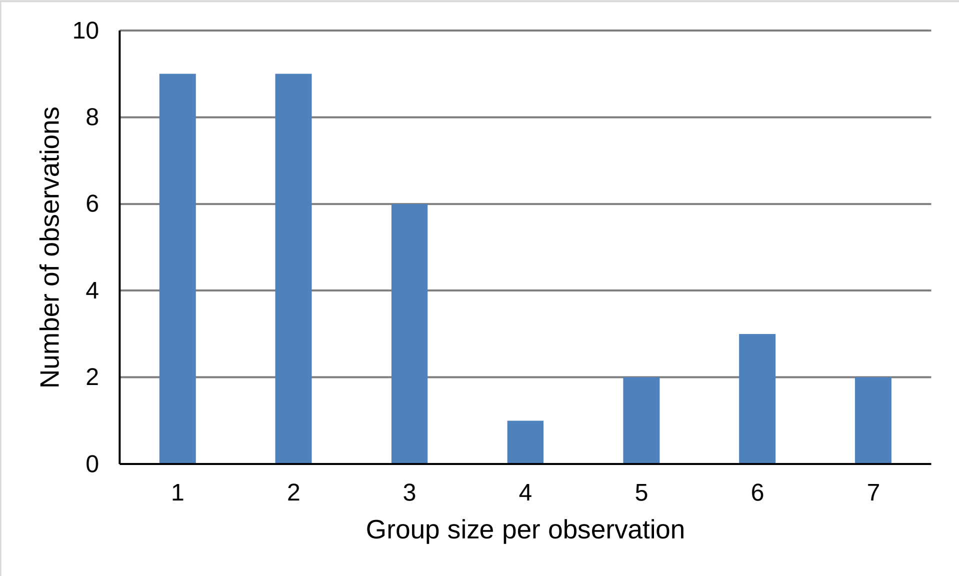


Figure 5.65: Number of bottlenose dolphin groups observed off Beirut coast (2010–2011)

Source: MoE/IUCN (2012)

The Mediterranean monk seal is the only seal species present in Lebanese waters (Karamanlidis and Dendrinos, 2015). While once considered locally extinct, 47 individuals were recorded between 1996 and 2015 along the Lebanese coast, with increased observations during the last 5 years. There were 25 confirmed sighting from 2003 to 2016, which has led to the status of the species being re-evaluated (Bariche and Crocetta, 2016; Ramadan-Jaradi, 2017a). However, the Mediterranean monk seal is extremely affected by socio-economic development and habitat loss (Khalaf and Fakhri, 2017) and is considered critically endangered due to its small population which does not exceed 400 individuals within the Mediterranean Sea.

5.4.5.1 Block 4 marine mammal observations

Megafauna visual survey methods

Two trained and experienced marine fauna officers (MFO) were present on board the survey vessel during the Block 4 EBS. The MFOs conducted observations from an elevated position on the survey vessel, working during daylight hours only (sunrise to sunset and when weather permitted) when the vessel was on station (conducting sampling work), transiting between stations and transiting to and from the port.

The MFOs scanned the water and recorded sightings of marine mammals, marine turtles, seabirds, fish, invertebrates and vessels using handheld binoculars, unaided eye, cameras and a laptop connected to the ship's positioning system.

Sightings data included the following data fields for each group: sighting number, common name, scientific name, number of individuals (i.e., group size), initial time of sighting, behaviour, vessel activity during the sighting (e.g., transit, benthic sampling), location (latitude and longitude), photos taken (frame numbers of each camera), number of calves in the sighting, Beaufort Sea State and water depth. In addition to data specific to marine mammals, other marine megafauna, seabirds or fish sighting, environmental data were recorded during visual observations including wind speed and direction, swell height and direction, relative position of the sun and visibility.

To complement the visual observations during daylight hours, a passive acoustic monitoring (PAM) device to record marine mammal vocalisations was used. With the PAM device, both low- and high-frequency marine mammal vocalisations could be recorded.

When the vessel was stationary or operating at very low speeds during the ROV operations, the PAM device was deployed and retrieved over the bow of the vessel and the data downloaded at the end of each day. It was therefore possible to carry out 33 separate PAM deployments throughout the EBS.

Results

There were only two marine mammal sightings during the visual survey of Block 4, with bottlenose dolphins sighted on two separate occasions within the southern section of Block 4, close to the coast and not within the priority area.

Acoustic recordings did not detect any marine mammal vocalisations in Block 4 during the EBS (the limitations of the EBS are acknowledged in Section 5.1.5).

5.4.5.2 Sensitivity

The sensitivity of seals is considered high as Mediterranean monk seals are a critically endangered species in the Mediterranean. Therefore, Mediterranean monk seals have a high (4) sensitivity as any individual present in Block 4 is internationally important.

Cetaceans (dolphins and whales) are more common than seals. However, while some species are listed as vulnerable or endangered in the Mediterranean, cetaceans are considered to have high (4) sensitivity.

5.4.6 Marine turtles

The AOI for marine turtles is a 1.4 km radius around the proposed location of the wells and a 20 m buffer zone around the transit routes for the support/supply vessels. This AOI encompasses a precautionary zone in which strong behavioural changes in marine turtles could occur from a stationary source of noise at the well site, and the zone in which strong behavioural reactions may potentially occur in response to vessel noise. The study area encompasses Block 4 and the eastern Mediterranean to provide context for the use of Lebanese waters by marine turtles.

Three species of sea turtle are found in Lebanese waters; green turtle (endangered), leatherback turtle (vulnerable) and loggerhead turtle (vulnerable) (IUCN, 2019). Nesting sites for green and loggerhead turtles are found on sandy shorelines in Lebanon, whereas the leatherback turtle is only a visitor to the Mediterranean (MoE/GEF, 2016).

A survey of the Lebanese coast for turtle nesting in 2004 found that the overall nesting potential for marine turtles is greatest in the south (Kasparek and Aureggi, 2005). The most important nesting beach is El-Mansouri in southernmost Lebanon, which is of moderate importance regionally. Surveys there in 2001 recorded a total of 42 nests between 16 June and 18 July, 37 of which were loggerhead turtle, and 5 were green turtle

(Newbury et al., 2002). A further nesting survey between May and September 2004 recorded a total of 49 nests (43 loggerhead, 6 green) (Khalil et al., 2005). In addition to El-Mansouri, nesting has also been reported as occurring nearby at El-Aabbassiyeh and in the Tyre Coast Nature Reserve, with the nesting status on Palm Island off Tripoli requiring clarification (Kasparek and Aureggi, 2005). Hatching of turtles in the Tyre Coast Nature Reserve was reported in August 2015 (IUCN, 2015). Nesting activities of turtles are highly threatened by coastal development.

Stokes et al. (2015) conducted a study where 34 female green turtles were satellite tracked from breeding grounds in four eastern Mediterranean countries with major nesting (Cyprus, Turkey, occupied Palestine and Syria).

Ten foraging grounds were identified, with two major hotspots in Libya accounting for >50% of turtles tracked to conclusive endpoints. A high-use seasonal pelagic corridor running south-west from Turkey and Cyprus to Egypt was also evident, used by >50% of all tracked turtles.

Figure 5.66 demonstrates that green turtle migration takes place along the eastern coast of the Mediterranean through Syrian, Lebanese and occupied Palestinian waters (though to a lesser extent than the corridor between Cyprus and Egypt). A turtle foraging ground was identified off Tripoli in Lebanon (G in Figure 5.66).

5.4.6.1 Block 4 Turtle observations

The method for observing marine megafauna, including turtles, during the EBS is discussed in Section 5.4.5.1.

No marine turtles were observed during the visual survey of Block 4, although two were recorded close to Beirut Port.

5.4.6.2 Sensitivity

Turtles use the coast of Lebanon as a migratory corridor, with foraging grounds off Tripoli. Turtle nesting is predominantly seen in the south of the country. Although there are no known foraging or nesting grounds near the Block 4 priority area, the species present are listed as endangered or vulnerable and therefore the sensitivity of turtles is considered high (4).

5.4.7 Offshore birds

The AOI for offshore birds encompasses the priority area and the southern portion of Block 4 and helicopter transit routes to/from Beirut Airport. Offshore birds are not likely to be affected by routine events, although the helicopter transit route introduces potential disturbance to the inland Important Bird Area (IBA) close to the airport. The study area is wider and encompasses the whole of Block 4 and the length of the Lebanese coast.

Lebanon is situated in one of the world’s key significant migratory bird corridors (see Figure 5.67) and hosts bird species of international significance. However, birds face pressures such as hunting and pollution (MoE/UNEP/GEF, 2016).

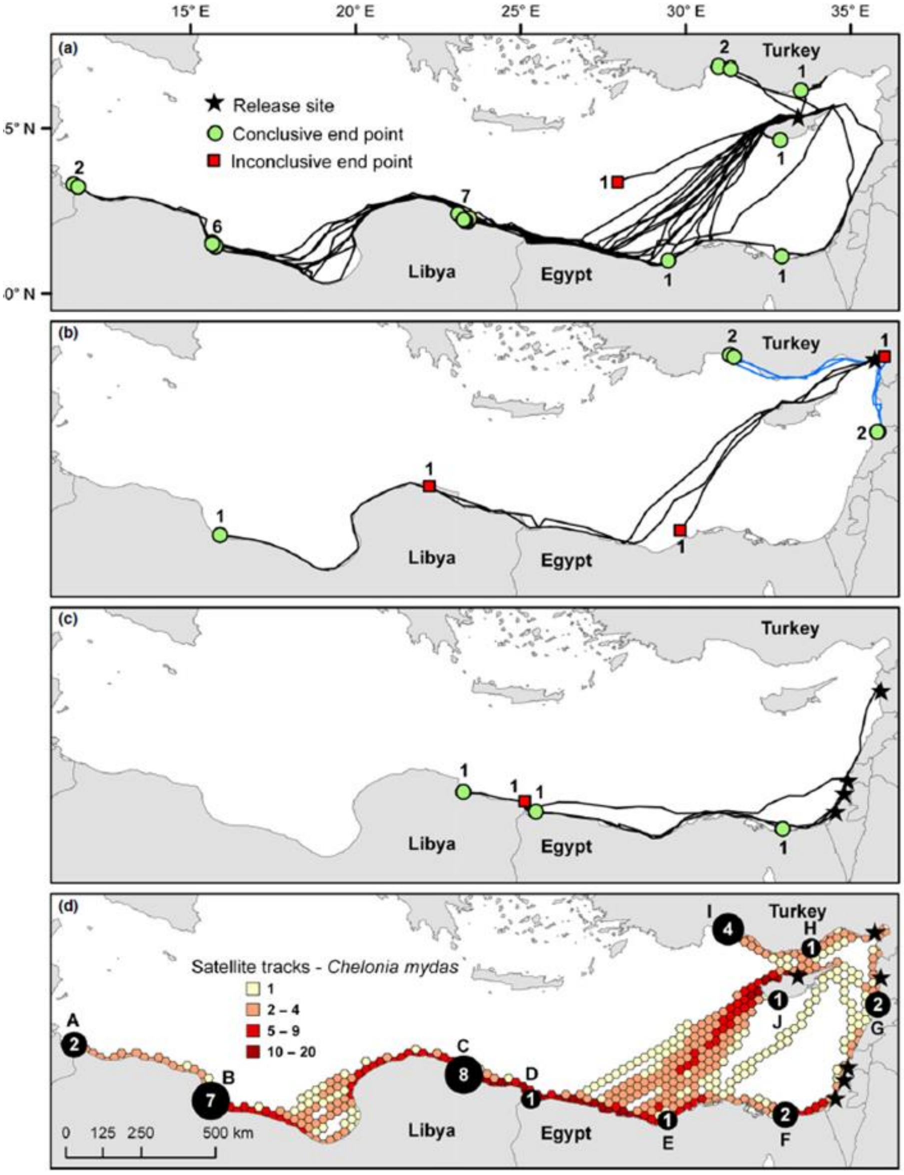


Figure 5.66: Post-nesting green turtle satellite tracks from (a) Cyprus (n = 22), (b) Turkey (n = 8), (c) Syria (n = 1) and Occupied Palestine (n = 3), and (d) migratory corridor density map

Numbers indicate the number of individuals tracked conclusively to each foraging ground. In panel (b), tracks in blue are from the first year of tracking (2004) and those in black are from the second year of tracking (2005). Colour in panel (d) is indicative of the number of satellite tracks that pass through each hexagonal grid cell. Movements to secondary foraging grounds after prolonged stays in initial foraging grounds are not included. Letters in (d) indicate the following foraging grounds: A – Libya/Tunisia border, B – Gulf of Sirte, C – Gulf of Bomba, D – Gulf of Salum, E – Gulf of Arab, F – Lake Bardawil, G – Tripoli, Lebanon, H – Erdemli, I – Gulf of Antalya, J – Episkopi Bay. Source: Stokes et al. (2015)

Figure 5.67: Major flyways between Africa and Eurasia
Source: Birdlife International (2018)

Approximately 186 coastal and marine bird species have been recorded close to the Lebanese coast. Although major migratory routes have been defined, a detailed analysis of important marine areas of seabirds has not yet been prepared (Ramadan-Jaradi et al., 2008).

Many seabird species like gulls live close to the coast, while species like shearwaters live exclusively offshore. MoE/UNEP/GEF (2016) have suggested that important marine areas for seabirds should be identified and a scientific database established for proper monitoring and protection of these birds.

A study by CNRS on the status and dispersal of migrating and breeding marine birds in the north of Lebanon was conducted during the winter and breeding seasons of 2016/2017. The southern extent of the study area was Batroun and covered the area just inshore of the north east corner of Block 4 extending along the coastline to Cheikh Zennad in north Lebanon. Eighty-six different species were documented including

- 35 foreshore species (waders like plovers and sandpipers)
- 18 coastal species (gulls and terns)
- 6 marine species (such as petrels, shearwaters, skuas and gannets)
- 9 duck species
- 6 heron species
- 9 saltwater species (such as cormorants, pelicans and mergansers)
- 3 terrestrial species.

The most abundant species encountered were the yellow-legged gull (*Larus michahellis*), which breeds on Palm Island, and the common black-headed gull (*Chroicocephalus ridibundus*). Other species included the great white pelican (*Pelecanus onocrotalus*), great cormorant (*Phalacrocorax carbo*), little gull (*Hydrocoloeus minutus*) and the Yelkouan shearwater (*Puffinus yelkouan*), a globally threated species classified as vulnerable by the IUCN (Ramadan-Jaradi, 2017b).

Offshore species, such as shearwaters, may have a flightless period after they moult their flight feathers while offshore during winter months (Camphuysen and Van der Meer, 2001) where they form aggregations on the sea surface. However, the importance of the area offshore Lebanon has not yet been defined.

5.4.7.1 Block 4 offshore bird observations

The methods of for observing marine megafauna, including birds, during the EBS are discussed in Section 5.4.5.1.

A total of 419 individual seabirds were observed within the priority area and southern portion of Block 4. The Laridae family (gulls) was the most sighted family of seabirds (Figure 5.68), with the most clearly identifiable species the lesser black-backed gull (*Larus fuscus*).

Table 5.25 shows that along with gulls, other similar species were present in Block 4 as were sighted during the CNRS survey, such as shearwater, skua, duck, heron and saltwater species. Images of species seen during the EBS are shown in Figure 5.69.

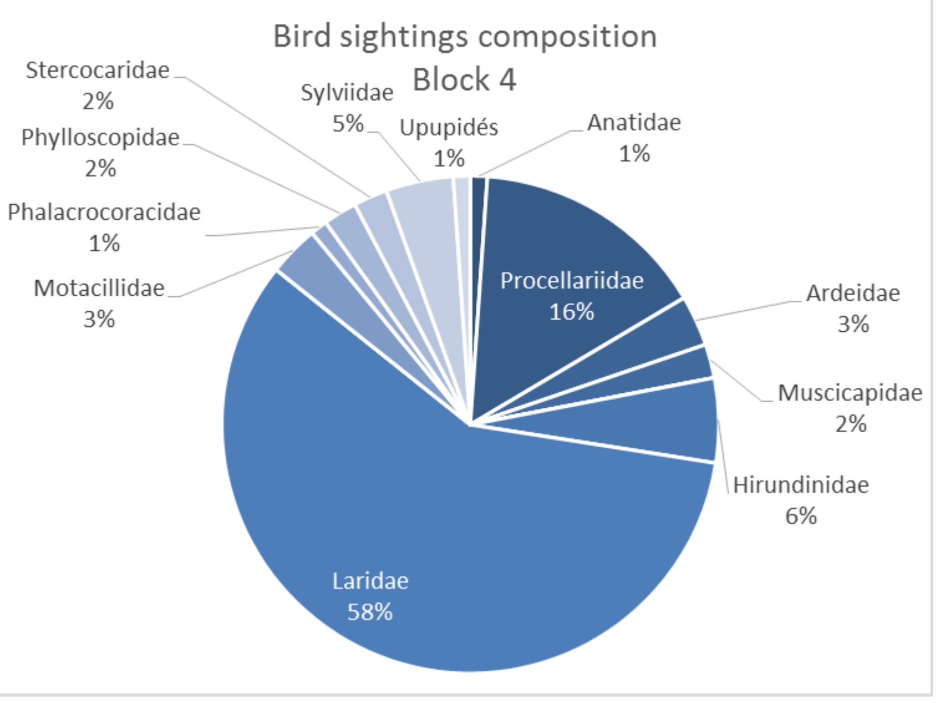


Figure 5.68: Composition of birds observed in Block 4

Source: Keran Liban/Creocean (2019b)

Table 5.25: Birds species observed in Block 4

Species			Block 4	
Family	Common name	Scientific name	No. of sightings	No. of individuals
Anatidae	Duck sp.	*Anatidae* sp.	1	100
Procellariidae	Yelkouan shearwater	*Puffinus yelkouan*	2	2
	Scopoli's shearwater	*Calonectris diomedea*	12	13
Ardeidae	Little egret	*Egretta garzetta*	1	15
	Cattle egret	*Bubulcus ibis*	1	3
	Heron sp.	*Ardea* sp.	1	9
	Finsch's Wheatear	*Oenanthe finschii*	1	1
	Common Redstart	*Phoenicurus phoenicurus*	1	1
Hirundinidae	Barn swallow	*Hirundo rustica*	5	7
Laridae	Larid sp.	*Laridae* sp.	13	30
	Lesser black-backed gull	*Larus fuscus*	40	95
Motacillidae	White Wagtail	*Motacilla alba*	2	2
	Wagtail sp.	*Motacilla* sp.	1	1
Phalacrocoracidae	Shag sp.	*Phalacrocorax* sp.	1	25
Phylloscopidae	Common Chiffchaff	*Phylloscopus collybita*	2	6
Stercocaridae	Pomarine skua	*Stercorarius pomarinus*	2	2
Sylviidae	Whitethroat sp.	*Sylvia* sp.	4	4
Upupidae	Hoopoe	*Upupa epops*	1	1
Bird	Unidentified bird	-	3	102
Subtotal			94	419

Source: Keran Liban/Creocean (2019b)

5.4.7.2 Sensitivity

Although limited data is available on the use of Lebanese waters by seabirds, the Lebanese coast is likely to be an important area for migrating coastal seabirds such as gulls, as well as offshore species such as shearwaters. However, the birds are likely to be transient through the Block 4 area and so the sensitivity of seabirds offshore is considered medium (3) for the majority of the seabird assemblage.

However, as there may be protected or “threatened” species present in the AOI, such as the Yelkouan shearwater which may use the area for a flightless period post-moult, these bird species are included within the protected/threatened species receptor, which has a high (4) sensitivity.

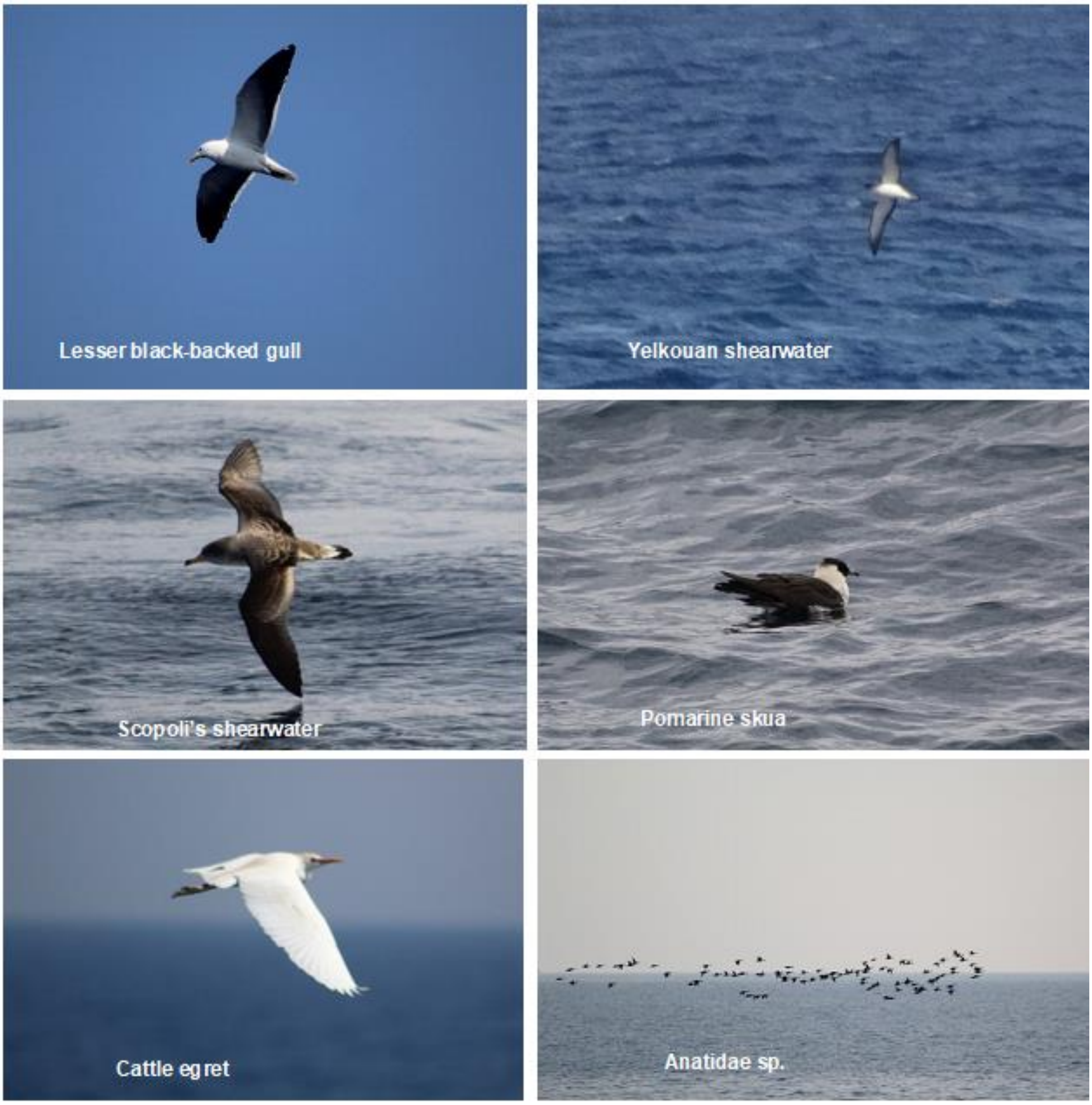


Figure 5.69: Birds observed during EBS
Source: Keran Liban/Creocean (2019b)

5.4.8 Onshore fauna

The location of the onshore logistics base within Beirut Port is presented in Figure 4.7 and the AOI for onshore fauna focuses on the site up to its boundaries. The sensitivity of onshore fauna is assumed to be very low (1) owing to the logistics base location in an existing commercial port area and because the base will be placed on hard standing which does not generally support a diversity of floral and faunal species.

5.4.9 Protected areas

The AOI for protected areas is coastal and offshore areas near the Port of Beirut and along the transit routes for the MODU and support/supply vessels during routine events. The study area encompasses the whole length of the Lebanese coast and offshore area.

Owing to intensive coastal development and exploitation in Lebanon, protected areas are considered crucial to the conservation and maintenance of healthy ecosystems and biodiversity. There are a number of designated protected areas in Lebanon and several proposed protected areas. There are also a number of international recognised conservation areas.

The different types of protected / conservation area designations are listed below:

- Nature Reserve – designated by law by the Lebanese government
- Ramsar site – sites of wetland importance established under the Ramsar Convention
- UNESCO World Heritage Site (WHS) – designated by UNESCO as having cultural, historical, scientific or other importance
- Specially Protected Areas (SPA) of Mediterranean Importance – designated under Barcelona Convention
- Proposed Marine Protected Areas – proposed by Lebanese MoE and IUCN
- Proposed Deep Sea Sites for Conservation – proposed by OCEANA[8]
- Key Biodiversity Area (KBA) – sites identified by IUCN that contribute to the global persistence of biodiversity
- Important Bird Areas (IBAs) – sites identified for birds using internationally agreed criteria applied locally by BirdLife Partners and experts
- Ecologically and Biologically Significant Areas (EBSAs) – identified under the Convention on Biological Diversity.

Locations of existing and proposed protected areas and internationally recognised conservation areas along the Lebanese coast are illustrated in Figure 5.70. Estuarine sites that are currently protected, or proposed for protection, are included in Figure 5.53.

More detailed information on each of the existing and proposed protected areas and internationally recognised conservation areas along the Lebanese coast is provided in Table 5.26 along with distance from Block 4 and the priority drilling area.

There are no protected areas specifically within Block 4, although Block 4 is partially within the ELCA EBSA. The closest sites to the Block 4 priority area are Beirut Port Outer Platform proposed MPA, Raoucheh Cliffs and Caves proposed MPA and three sites identified by OCEANA as deep sea sites for conservation (Saint Georges Canyon, Jouneih Canyon and Beirut Escarpment).

5.4.9.1 Sensitivity

Protected areas are considered under the receptors ‘coastal habitats’ and ‘sensitive marine habitats offshore’. Both of these have been scored as high (4) owing to the presence of species of international importance or high sensitivity ecosystems.

[8] Surveys undertaken by the OCEANA expedition (Aguilar et al., 2018) identified several sites of conservation importance in deep water off Lebanon. The surveyed sites along with their level of conservation interest are presented in Figure 5.71.

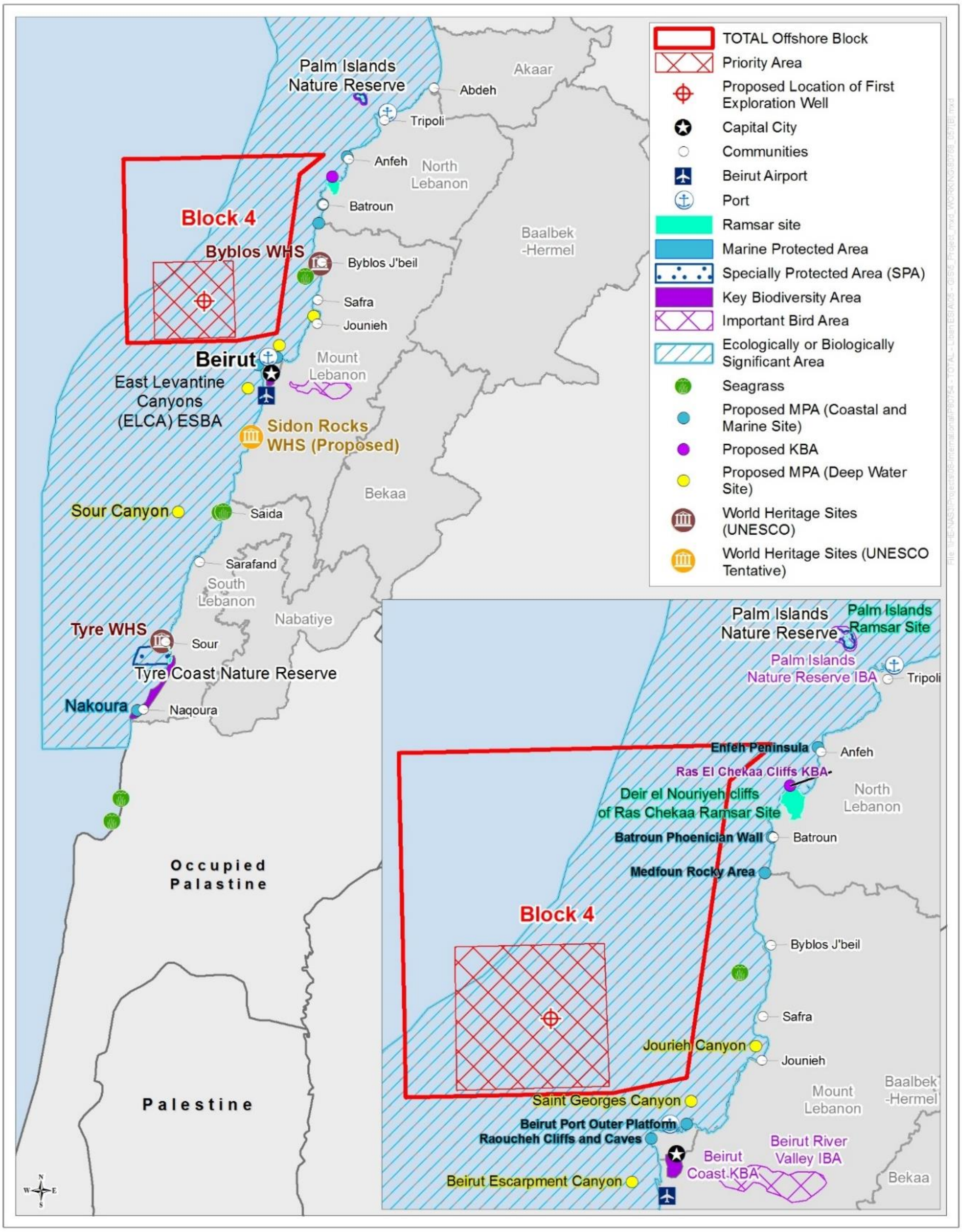


Figure 5.70: Protected areas and proposed protected areas (excluding estuarine sites) in relation to Block 4

Note: Estuarine protected areas shown in Figure 5.53.

Source: MoE/IUCN (2012)

Table 5.26: Details of designated protected areas, proposed protected areas and internationally recognised conservation areas on Lebanese coast

Name of Protected Area	Area (km^2)	Distance from well site (km)	Distance from priority area (km)	Distance from Block 4 (km)	Designation	Summary description
Designated protected areas						
Palm Islands Nature Reserve	5	63.4	52.6	15.9	Nature Reserve Ramsar Site MPA SPA IBA and KBA	Reserve consists of a group of three flat rocky islands of eroded limestone, with associated outcrops and surrounding waters, rising from 1–12 m above the sea. The islands' beaches support the endangered loggerhead turtle *(Caretta caretta)* during nesting and breeding, and the critically endangered green turtle *(Chelonia mydas)* occurs infrequently but regularly in surrounding seas. The endangered Mediterranean monk seal *(Monachus monachus)* was seen regularly until recent years but only very rarely since. The many caves and sheltered coastal rocks provide an important spawning ground for fish, and some 42 species of migratory birds (include six IUCN Red List species) feed and rest on the islands before moving on to the Lebanese mainland for breeding. During winter, freshwater is found in inland pools; a single well, built at the time of the Crusades and associated with archaeological remains of a Crusader church from AD 1224, yields potable water but is over-extracted, increasing groundwater salinity. Alteration of the vegetation cover by a proliferation of rabbits is seen as a threat to the biodiversity. Declared a Nature Reserve in 1992, Palm Island has permitted visitors for guided tours and swimming between July and September since 1998. The area is designated as a Ramsar site and as is important for several nesting birds including the Hoopoe *(Upupa epops)*, White wagtail *(Motacilla alba)* and Graceful Warbler *(Prinia gracilis)*. It also represents an important site for migratory birds from the mainland (Serhal and Bassima, n.d.). The area is also designated as an IBA and a non-avian KBA owing to its important for globally threatened and endemic species, such as the Yelkouan Shearwater *(Puffinus yelkouan)*, the Audouin's Gull *(Larus audouinii),* Mediterranean Monk

Name of Protected Area	Area (km^2)	Distance from well site (km)	Distance from priority area (km)	Distance from Block 4 (km)	Designation	Summary description
						Seal *(Monachus monachus)*, Loggerhead Turtle *(Caretta caretta)* and Green Turtle *(Chelonia mydas)*. Designation law = Law no. 121 of 9/3/1992.
Tyre Coast Nature Reserve	3.8	87.4	76.3	76.3	Nature Reserve Ramsar Site MPA SPA UNESCO WHS	Site is located within the best-preserved stretch of sandy coastline in southern Lebanon; it is remarkable for its biodiversity but threatened by its proximity to the city of Tyre and the Rachidieh refugee camp. Its artesian wells are an important heritage site and give rise to a number of notable freshwater habitats. Beach vegetation is dominated by sea spurge and cotton weed, while the hillocks are dominated by shrubs, grasses and the rush, Juncus. Vegetables, citrus and palm trees are cultivated within the reserve area and irrigated with water from the artesian wells. In the summer months, the area is a popular tourist destination. The beaches of Tyre are thought to be important nesting areas for the green turtle and loggerhead turtle. Ramsar site with 204 species including threatened species pygmy cormorant (*Phalacrocorax pygmeus*), Dalmatian pelican (*Pelecanus crispus*), lesser kestrel (*Falco naumanni*) and corn crake (*Crex crex*). A review by the MedMPA Network in 2014 categorised Tyre Springs (located within Tyre Coast Nature Reserve) as having high conservation value due to rare and interesting habitats, e.g. freshwater springs, littoral caves, maerl beds and corraligenous formations (Alfonso et al., 2015).
Deir el Nouriyeh cliffs of Ras Chekaa (Ras El Chekaa Cliffs)	9.93	41.5	33.0	5.7	Ramsar Site KBA Proposed MPA	Site is part of a coastal limestone promontory just north of Beirut, amid the highly developed narrow coastal plain between Beirut and Tripoli and is described as "a mosaic of woodland and olive groves". The site is significant because of its position as a coastal headland on the Middle East bird migration route: notable bird species include the white pelican and purple heron. The presence of submarine freshwater springs off the coast at Ras Chekaa is thought to enhance the biodiversity of the waters here. Of historical and cultural interest is the convent of Deir el Nouriyeh. The main agricultural use of the site is the cultivation of olives. A review by the MedMPA Network in 2014

Name of Protected Area	Area (km^2)	Distance from well site (km)	Distance from priority area (km)	Distance from Block 4 (km)	Designation	Summary description
						categorised Ras Chekaa as having high conservation value due to pristine nature and presence of rare and interesting habitats (Alfonso et al., 2015). The site is also a KBA due to the presence of globally threatened species. Designation law = Law no. 708 of 5/11/1998.
Byblos	<1	30	27	8	UNESCO WHS Proposed MPA	This site is composed of large vermetid reefs with ponds. Phoenician ruins (UNESCO WHS) are located in area. The site is important for fish nurseries, feeding and spawning grounds, hard and soft bottom habitats and seagrass meadow communities.
Internationally recognised conservation areas						
East Levantine Canyons Area	>10,000	0	0	0	Ecologically or Biologically Significant Area	This area consists of several deep canyons along the majority of the Lebanese coastline – containing important areas such as hydrothermal vents, submarine freshwater springs and Opistobranch formations (Elias et al., 2007; Würtz, 2012; Bakalowicz, 2014). The formation of the canyons is vital for ecosystem functioning – with upwelling of nutrients leading to increased primary productivity. This in turn supports many species including several listed as 'threatened' on the IUCN Red List – such the Mediterranean monk seal *(Monachus monachus)*, smalltooth sandtiger shark (*Odontaspis ferox*; Walker et al., 2005), the spiny dogfish (*Squalus acanthias*; Ellis et al., 2016), the common guitarfish (*Rhinobatos rhinobatos*; Bradai and Soldo, 2016), and marine mammals such as sperm whales, striped dolphins, Risso's dolphin, short-beaked common dolphins and bottlenose dolphins (Dedel et al., 2012). Important areas also include the Turgut Reis Seamount as a host for deep sea shrimp stocks and on bluefin tuna migratory routes (Würtz, 2012), and nesting grounds for green turtles (*Chelonia mydas*) and loggerhead turtles *(Carretta carreta).* The area also contains the two marine protected areas – Palm Island and Tyre Coast.

Name of Protected Area	Area (km²)	Distance from well site (km)	Distance from priority area (km)	Distance from Block 4 (km)	Designation	Summary description
Beirut Coast	5.7	29. 9	15.5	9.3	KBA	Identified as a KBA due to significant populations of threatened species and species endemic to the area. These include several fish, the endangered Schreiber's fringe-fingered lizard *(Acanthodactylus schreiberi)*, endangered loggerhead turtle *(Caretta caretta)* and endangered Mediterranean monk seal *(Monachus monachus)*.
Beirut River Valley	80.96	29.6	21.9	12.8	IBA KBA	This river valley area is inland yet close to Beirut airport. It is identified due to its important for several species of birds – specifically for migration of raptors. During a 2006 autumn count, over 70,000 birds of more than 33 different species were identified.
Jbail coast	0.21	30.3	26.3	7.3	KBA	This site is identified due to significant populations present of threatened and endemic vulnerable species – including the loggerhead turtle *(Caretta caretta)*.
Nakoura	<1	104.4	92.7	92.7	KBA	This site is important for vermetid reefs and corraligenous formations. It is beneficial to fish for nurseries, feeding and spawning grounds. According to a review, Nakoura had high conservation value due to high fish biomass and pristine areas, including littoral caves and freshwater springs (Alfonso et al., 2015). The site is also a KBA due to the presence of globally threatened species such as the green turtle *(Chelonia mydas)*.
Enfeh Peninsula	<1	51.0	41.3	5.7	KBA Proposed MPA	This site consists of limestone rocks and vermetid reefs, hard and soft seabed. It is an important archaeological site and historical site and important for fish nurseries, feeding and spawning grounds, habitats for hard and soft bottom communities. It does have a high human presence. The area is identified as a KBA owing to the presence of globally threatened species such as the loggerhead turtle *(Caretta caretta)*.
Awalli estuary	4.7	50.4	40.1	40.0	KBA Proposed MPA	This site is an estuary of Awali river. Fishing activities are prohibited (as in all Lebanese estuaries – Act no. 1/385). It contains wetland habitats, beaches and marine vegetation and is important for seagrass

Name of Protected Area	Area (km^2)	Distance from well site (km)	Distance from priority area (km)	Distance from Block 4 (km)	Designation	Summary description
						communities, fish nursery, spawning and feeding ground and for vulnerable species. Identified as a KBA also due to its presence of endemic and globally threatened species, such as the loggerhead turtle *(Caretta caretta)*.
Nahr Ibrahim estuary	0.54	29.2	27.0	9.1	KBA Proposed MPA	This is an estuarine site of the river Ibrahim. It is a touristic area and fishing activities are prohibited. The site consists of sandy seabed and seagrass meadows and is important for seagrass communities, marine turtles and as a feeding/shelter ground for many species. Also listed as a KBA due to presence of loggerhead turtle *(Caretta caretta)*.
Proposed Marine Protected Areas						
Sidon rocks	<1	36.2	25.9	24.5	Proposed MPA Proposed UNESCO WHS	This site is close to Saida town. Composed of hard seabed with sandy sediment, vermetid reefs, rocks and corraligenous formations. It contains several archaeological features and has low biodiversity but is important for bottom-dwelling organism and seagrass meadow communities.
Raoucheh cliffs and caves	<1	21.0	12.8	7.6	Proposed MPA	This limestone cliff site contains vermetid reefs, corraligenous formations, caves, crevices and sandy bottoms in deep waters. It’s an important fish nursery, feeding and spawning ground, popular tourist area and has high conservation value related to high fish biomass and pristine areas (Alfonso et al., 2015).
Beirut port outer platform	2	23.0	16.5	6.1	Proposed MPA	This site is composed of a jetty creating artificial reef habitat and is important for fish nursery, feeding and spawning, for hard and soft bottom communities.
Medfoun rocky area	<1	34.7	27.7	6.5	Proposed MPA	This site is rocky with cliffs, hard and soft bottoms. It lies within a military area, is important for fish nurseries, feeding and spawning grounds and habitats for hard and soft bottom communities.

Name of Protected Area	Area (km^2)	Distance from well site (km)	Distance from priority area (km)	Distance from Block 4 (km)	Designation	Summary description
Batroun Phoenician wall	<1	38.4	30.1	6.8	Proposed MPA	This is a rocky site containing vermetid reefs and hard bottom communities. It's an important archaeological, historic and tourist site due to presence of Phoenician wall. It is also important for fish nurseries, feeding and spawning grounds, habitats for hard and soft bottom communities and seagrass meadow communities.
Litani estuary	<1	78.3	67.8	67.8	Proposed MPA	This site is an estuary of Litani river (longest river in Lebanon and important water resource). Fishing activities are prohibited (as in all Lebanese estuaries – Act no. 1/385). It contains wetland habitats, beaches and marine vegetation and is important for marine turtles, seagrass communities, fish nursery, spawning and feeding ground and for vulnerable species.
Damour estuary	<1	38.6	28.3	27.1	Proposed MPA	This estuarine site is located in proximity to city of Damour. Fishing activities are prohibited. The site consists of sandy seabed and seagrass meadows and is important for seagrass communities, marine turtles and as a feeding/shelter ground for many species.
Areeda estuary	<1	89.0	78.4	41.6	Proposed MPA	This estuarine site of the river Areeda consists of sandy bottom and seagrass meadows. It is important for turtles, seagrass communities and as a feeding/shelter ground for many species.
OCEANA proposed deep sea sites for conservation						
Jounieh Canyon	~7	27	24	8	OCEANA proposed deep sea site for conservation	This deep-water site was identified during surveys as part of the Deep Sea Lebanon Project surveys conducted by OCEANA (Aguilar et al., 2018) (see Figure 5.71 for survey locations in relation to Block 4). The area is a fisheries restricted area and consists of open slope systems, submarine canyons, hydrothermal vents and permanent anoxic systems. The area supports several vulnerable habitats including fossil reefs, coralligenous formations, rhodolith and maerl beds. It also supports a high number of species (more than 300) with rare species such as protected molluscs, starfishes and the glass sponge *Farrea bowerbanki*.

Name of Protected Area	Area (km^2)	Distance from well site (km)	Distance from priority area (km)	Distance from Block 4 (km)	Designation	Summary description
Beirut Escarp-ment Canyon		24.5	14.7	11.7	OCEANA proposed deep sea site for conservation	This deep-water site is a fisheries restricted area and consists of open slope systems, submarine canyons, deep basins, seamounts, deep-water coral systems, cold seeps, carbonate mounds, hydrothermal vents and permanent anoxic systems. It was identified following surveys undertaken by OCEANA (Aguilar et al., 2018).
Saint Georges Canyon		21.8	16.6	3.2	OCEANA proposed deep sea site for conservation	This deep-water site is a fisheries restricted area and consists of open slope systems, submarine canyons, deep basins, seamounts, deep-water coral systems, cold seeps, carbonate mounds, hydrothermal vents and permanent anoxic systems. It was identified following surveys undertaken by OCEANA (Aguilar et al., 2018).
Sour Canyon		53.5	42.8	42.8	OCEANA proposed deep sea site for conservation	This deep-water site is a fisheries restricted area and consists of open slope systems, submarine canyons, deep basins, seamounts, deep-water coral systems, cold seeps, carbonate mounds, hydrothermal vents and permanent anoxic systems. It was identified following surveys undertaken by OCEANA (Aguilar et al., 2018).

Source: MoE/IUCN (2012), CBD (2014, 2016), IBAT Alliance (2019), BirdLife International (2019), RAC/SPA (2019), Ramsar (2019)

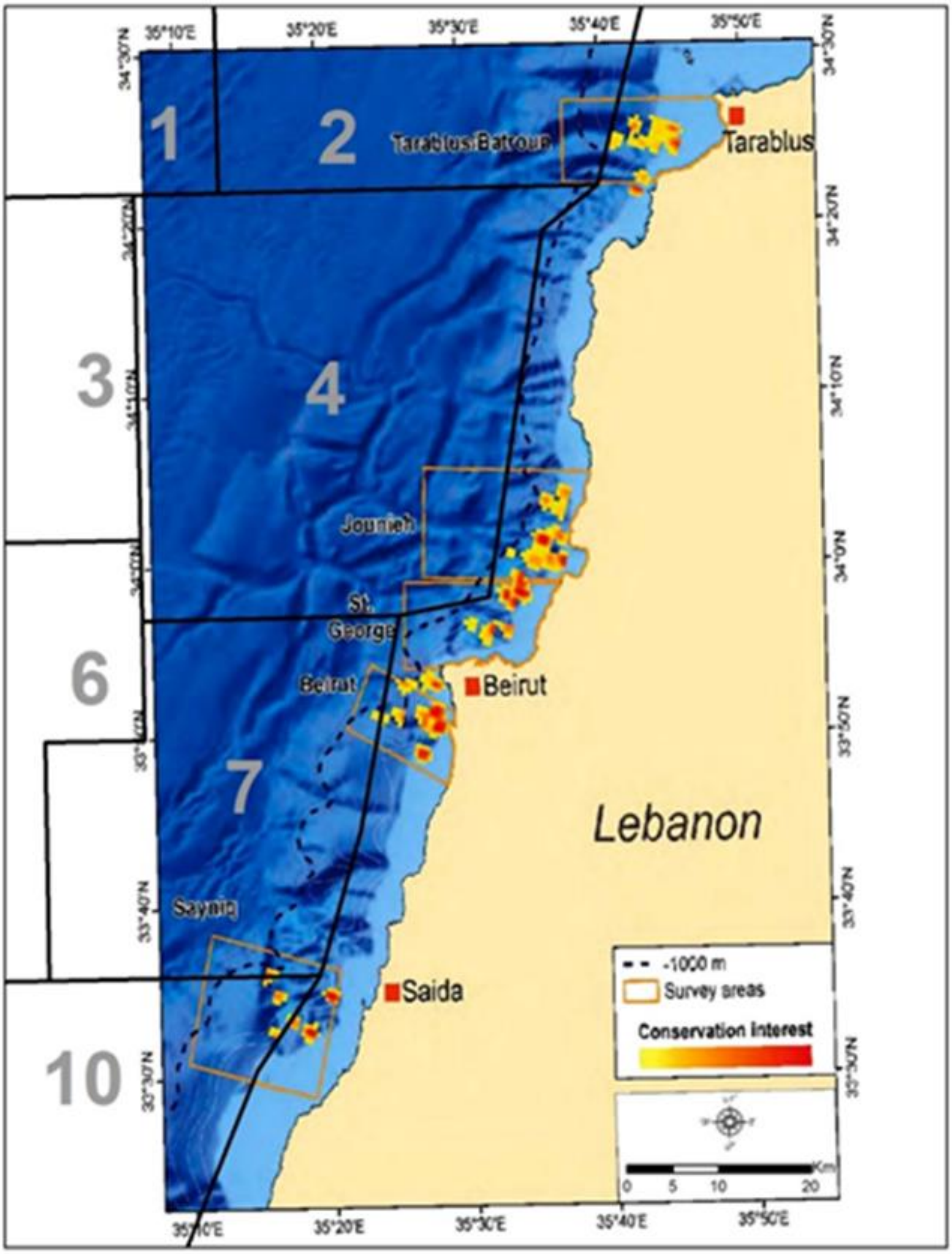


Figure 5.71: Surveyed sites within OCEANA expedition (2016) and their level of conservation interest

Source: Aguilar et al. (2018)

5.4.10 Shoreline oil spill sensitivity

The AOI for the shoreline oil spill sensitivity is the whole length of the Lebanese coast.

As part of the 'National Oil Spill Contingency Plan in Lebanese Waters' (MOPWT-DGLMT, 2017), sensitivity maps were developed classifying the country's shoreline using a vulnerability or environmental sensitivity index (ESI) with values ranging from 1 – 8, where 1 is robust and resilient and 8 represents the most vulnerable.

The maps demonstrate that the majority of the shoreline comprises exposed rocky shore (1A), exposed rocky cliffs (1C), mixed sand and gravel beaches (5) and fine to medium grained sand beaches (3A).

There are rip-rap structures (6B) to protect ports, harbours and jetties and sheltered man-made structures (8B) within the ports and harbours.

Exposed tidal flats (7) are limited to small areas near Hannouch and near Tabarja.

5.4.11 Invasive species

The study area for invasive species encompasses the eastern Mediterranean and the Suez Canal, providing context for Lessepsian migration in Block 4. No AOI was specified for invasive species as they are not considered a receptor of the project, but can represent potential impacts to other receptors, particularly fish.

The recent connection of the Mediterranean with the Red Sea via the Suez Canal has resulted in a direct pathway for the introduction of species of Indo-Pacific origins. For the first time, the Mediterranean's flora and fauna (which are solely of Atlantic origin) have faced competition from invasive animals and plants that established themselves initially in the Suez Canal and later in the eastern Mediterranean. These have included species of fish, macrophytes and invertebrates which have entered in planktonic form.

As the Suez Canal has no locks and the surface levels of the Red Sea are higher than in the Mediterranean, it serves as a continuous tidal strait and an effective pathway for species migration as overall net water movement is typically northwards from the Red Sea into the Mediterranean, driven by tidal currents, and the height and slight density gradient. Inward migration of species from the Red Sea into the eastern Mediterranean, known as Lessepsian migration, has had implications for the marine ecosystem of the eastern Mediterranean.

The relatively shallow water of the Suez Canal (an average depth of around 10 m) is considered a major physical barrier for the migration of deep-water species and as such, most of the invasive species can be found at depths of less than 70 m in the eastern Mediterranean (Nader, 2012).

It is estimated that there are around 775 marine invasive species in the eastern Mediterranean (Zenetos et al*.,* 2012), which comprise a number of groups including fish, plankton, and benthic species.

Invasive species may also be transported in ballast water. Discharged ballast water can contain non-native marine animals and plants which can potentially get established and become invasive. This introduction of non-native species is considered to be one of the five major threats to marine biodiversity identified in the 1992 Convention on Biological Diversity. The introduction of non-native species from ships' ballast water, in addition to other sources, is a matter that is causing increasing concern and is a potentially serious, but highly unpredictable problem, in all coastal marine ecosystems (Carlton, 1996).

There currently are invasive species of macroalgae forming permanent populations along the Lebanese coast, which are competing with native species and colonising their habitats (Bitar, 1999; Bitar et al., 2017). Specifically, one alien invasive brown algae, *Stypopodium zonale*, has been identified that could pose a potential threat to indigenous marine biodiversity (Bitar, 2010).

Several invasive fish species have been recorded in Lebanese waters since the 1960–70s (Table 5.27 below) and new species of fish are being recorded every year. Invasive fish species recorded in Lebanon since 2005 are shown in Table 5.28. In a survey conducted towards Enfeh-Ras Chekaa in 2012, a total of 32 fish species were recorded, of which 6 spp. were Lessepsian species: *Pempheris vanicolensis*, *Stephanolepis diaspros*, *Siganus luridus*, *Siganus rivulatus*, *Sargocentron rubrum* and *Torquigener flavimaculosus*. A National Action Plan on Non-Indigenous Species (NIS) and factsheets for NIS will be made public at the end of 2019.

Table 5.27: Invasive fish species recorded in Lebanese waters since the 1960-70s

Common Name	Scientific Name	Family
Pharoah cardinalfish	*Apogonichthyoides pharaonis*	Apogonidae
Red sea hardyhead silverside	*Atherinomorus forskali*	Atherinidae
Blotchfin dragonet	*Callionymus filamentosus*	Callionymidae
Shrimp scad	*Alepes djedaba*	Carangidae
Spotback herring	*Herklotsichthys punctatus*	Clupeidae
Red Sea tonguesole	*Cynoglossus sinusarabici*	Cynoglossidae
Honeycomb stingray	*Himantura uarnak*	Dasyatidae
Slender rainbow sardine	*Dussumieria elopsoides*	Dussumieriidae
African sailfin flyingfish	*Parexocoetus mento*	Exocoetidae
Striped piggy	*Pomadasys stridens*	Haemulidae
Tropical halfbeak	*Hyporhamphus affinis*	Hemiramphidae
Redcoat	*Sargocentron rubrum*	Holocentridae
Mangrove red snapper	*Lutjanus argentimaculatus*	Lutjanidae
Indian sweeper	*Pempheris mangula*	Pempheridae
Bartailed flathead	*Platycephalus indicus*	Platycephalidae
Reticulated leatherjacket	*Stephanolepis diaspros*	Monacanthidae
Goldband goatfish	*Upeneus moluccensis*	Mullidae
Por's goatfish	*Upeneus pori*	Mullidae
Narrow-barred spanish mackerel	*Scomberomorus commerson*	Scombridae
Dusky spinefoot	*Siganus luridus*	Siganidae

Common Name	Scientific Name	Family
	Sillago suezensis	Sillaginidae
Yellowstripe barracuda	*Sphyraena chrysotaenia*	Sphyraenidae
Lizardfish	*Saurida lessepsianus*	Synodontidae
Diamondback puffer	*Lagocephalus guentheri*	Tetraodontidae
	Lagocephalus suezensis	Tetraodontidae
Fourlined terapon	*Pelates quadrilineatus*	Terapontidae
Small-scaled terapon	*Terapon puta*	Terapontidae

Sources: George et al. (1964), George and Athanassiou (1965, 1966a,b, 1967), George et al. (1971), Mouneimné (1977, 1978, 1979)

Table 5.28: Invasive fish species recorded in Lebanese waters since 2005

Family	Species	Family	Species
Apogonidae	*Cheilodipterus novemstriatus*	Pomacentridae	*Abudefduf vaigiensis*
Carangidae	*Seriola fasciata*	Rachycentridae	*Rachycentron canadum*
Chaetodontidae	*Heniochus intermedius*	Scaridae	*Scarus ghobban*
Champsodontidae	*Champsodon vorax*	Scorpaenidae	*Pterois miles*
Leiognathidae	*Equulites popei*	Serranidae	*Cephalopholis taeniops*
Lutjanidae	*Lutjanus argentimaculatus*		*Epinephelus fasciatus*
Mullidae	*Parupeneus forsskali*		*Paranthias furcifer*
	Pseudupeneus prayensis		*Pseudanthias squamipinnis*
Nemipteridae	*Nemipterus randalli*	Synanceiidae	*Synanceia verrucosa*
Ostraciidae	*Ostracion cubicus*	Syngnathidae	*Hippocampus fuscus*
Platycephalidae	*Platycephalus indicus*	Tetraodontidae	*Sphoeroides pachygaster*
Plotosidae	*Plotosus lineatus*		*Tylerius spinosissimus*
Pomacanthidae	*Pomacanthus maculosus*		

Sources: Bariche (2010a, 2010b, 2011, 2012), Bariche and Saad (2005, 2008), Bariche (2012), Bariche and Heemstra (2012), Bariche et al. (2013a), Harmelin-Vivien et al. (2005), Lelli et al. (2007), Bitar (2013), Crocetta et al. (2015), Dailianis et al. (2016), Gerovasileiou et al. (2017)

5.4.12 Summary of key biological sensitivities

The key biological sensitivities within the study area are

- coastal habitats – seagrass beds and vermetid reefs, the presence of these features in Lebanon’s coastal waters contribute to criteria for proposed marine protected areas
- deep-water macrobenthic communities – dominated by polychaetes and other fauna associated with the deep-water sediments of the eastern Mediterranean. The benthic faunal assemblage is considered relatively impoverished in terms of species abundance and diversity, reflecting the low levels of organic matter and nutrient enrichment. The seabed benthic community structure shows a number of similarities with Leviathan field to the south. Predominantly, the habitat is

considered to be 'bathyal mud' throughout the Block 4 seabed survey area. ROV footage indicated the presence of deepwater biodiversity hotspots where potential cold gas seep areas have created elevated hard relief above the surrounding seabed. The area surveyed within Block 4 did not have a highly developed sessile benthic community, but a number of epifaunal species of crab, fish and sea urchins were observed.

- phytoplankton communities – spring phytoplankton blooms in the coastal waters of Lebanon are characterised by the presence of diatoms, while dinoflagellates are common during the summer season. Diversity is lowest in May and highest in September. There is lower primary productivity offshore due to stratification of water column, which is considered to be relatively oligotrophic.
- zooplankton communities – diversity was moderate to high, while abundances in the Block 4 area were low and dominated by arthropods (predominantly copepod crustaceans), followed by cnidarians
- fish – Lebanon's coastal waters contain more than 100 fish species of commercial importance. Round herring (*Etrumeus teres*) and European anchovy (*Engraulis encrasicolus*) make up a third of commercial landings from Lebanese waters. The majority of commercially caught fish in Lebanon spawn in Lebanon's waters in the spring to autumn months. Dusky grouper (*Epinephelus marginatus*) (endangered in the Mediterranean), the European seabass (*Dicentrarchus labrax*) (near threatened in the Mediterranean) and the common dentex (*Dentex dentex*) (vulnerable) are all present in Lebanon's waters. Twenty-five species of sharks and rays are present in Lebanon's waters, including a number with commercial significance. The angel shark (*Squatina* sp.) (critically endangered), long nosed skate (*Dipturus oxyrinchus*) (near threatened), and the velvet-belly lantern shark (*Etmopterus spinax*) (near threatened) are also present.
- marine mammals – several species are reported from the eastern Mediterranean region and include species of whales, dolphins, and the Mediterranean monk seal (critically endangered in the Mediterranean). Overall marine mammal abundances are low in Lebanon's waters, with the bottlenose dolphin (*Tursiops truncatus*) being the most commonly sighted. Sightings of the Mediterranean monk seal (*Monachus monachus*) along the Lebanese coastline has increased in recent years. During the Block 4 EBS campaign, only two sightings were made of bottlenose dolphins.
- turtles – three species of marine turtle are found in Lebanese waters; green turtle (endangered), leatherback turtle (vulnerable) and loggerhead turtle (vulnerable). Nesting sites for green and loggerhead turtles are found on sandy shorelines in Lebanon, whereas the leatherback turtle is only considered a visitor to the Mediterranean. Nesting beaches are predominantly in the south of Lebanon, however foraging areas are present throughout Lebanon's waters and migration through Lebanon's waters also occurs. Nesting occurs between spring and autumn. No sea turtles were observed during the Block 4 EBS campaign.
- birds – 419 individual seabirds were observed within the priority area during the Block 4 EBS campaign. The Laridae family (gulls) was the most sighted family of seabirds, with the most clearly identifiable species the lesser black-backed gull (Larus fuscus). Other gull species were also recorded along with shearwaters, skuas, ducks, and herons.
- protected areas –several designated and proposed protected areas in Lebanon are as shown in Figure 5.70 and Section 0. There are no protected areas specifically within Block 4, yet the block lies in close proximity to several areas (25 km to Palm Islands Nature Reserve, close to Byblos reefs, Medfoun, Batroun Phoenician Wall, Ras El Chekaa Cliffs and Nahr Ibrahim Estuary).

- invasive species – Lessepsian migration via the Suez Canal has altered the biodiversity of the eastern Mediterranean. Other pathways for the introduction of invasive species to the region is via biofouling on ships' hulls and through ballast water exchange. It is estimated that there are around 775 marine invasive species in the eastern Mediterranean.

5.5 Social environment

5.5.1 Introduction

This section summarises the socio-economic baseline characteristics within the project's AOI. The information provided has a particular focus on the socio-economic activities near Block 4 and the associated coastal communities.

Figure 5.72 shows the location of Block 4 in relation to the coastal communities referred to in this section.

5.5.1.1 Study area

According to the sector-specific EIA guidelines for oil and gas reconnaissance and exploration drilling activities in Lebanon, the study area should encompass the AOI but may be larger to help in understanding the context in which the social receptors covered in the AOI exist, including any trends and pressures on the condition of the receptor. The study area therefore includes the entire country of Lebanon. The study area provides socio-economic and cultural heritage information at a national level to give context and to support the assessment of any regional/national impacts (often indirect).

5.5.1.2 Social receptors[9]

Section 5.1.2 describes how the receptors within this baseline chapter have been selected, social receptors are listed in Table 5.2 together with the reason for inclusion in this baseline.

5.5.1.3 Desktop study stage

A desktop social baseline study was undertaken in March 2019 that included a review of literature and secondary data for the different receptors. This included reports, maps, websites and articles. All sources used are listed in the references section.

The qualitative and quantitative data from the various sources were used to provide national and governorate level contextual information for the AOI and to highlight any information gaps, which informed the primary data collection. In addition, a series of maps were produced showing the land use and infrastructure in the AOI (see Figure 5.74 to Figure 5.81).

[9] Receptors are components of the natural and human environment that are considered to have scientific, ecological, economic, social, cultural, archaeological, historical or other importance.

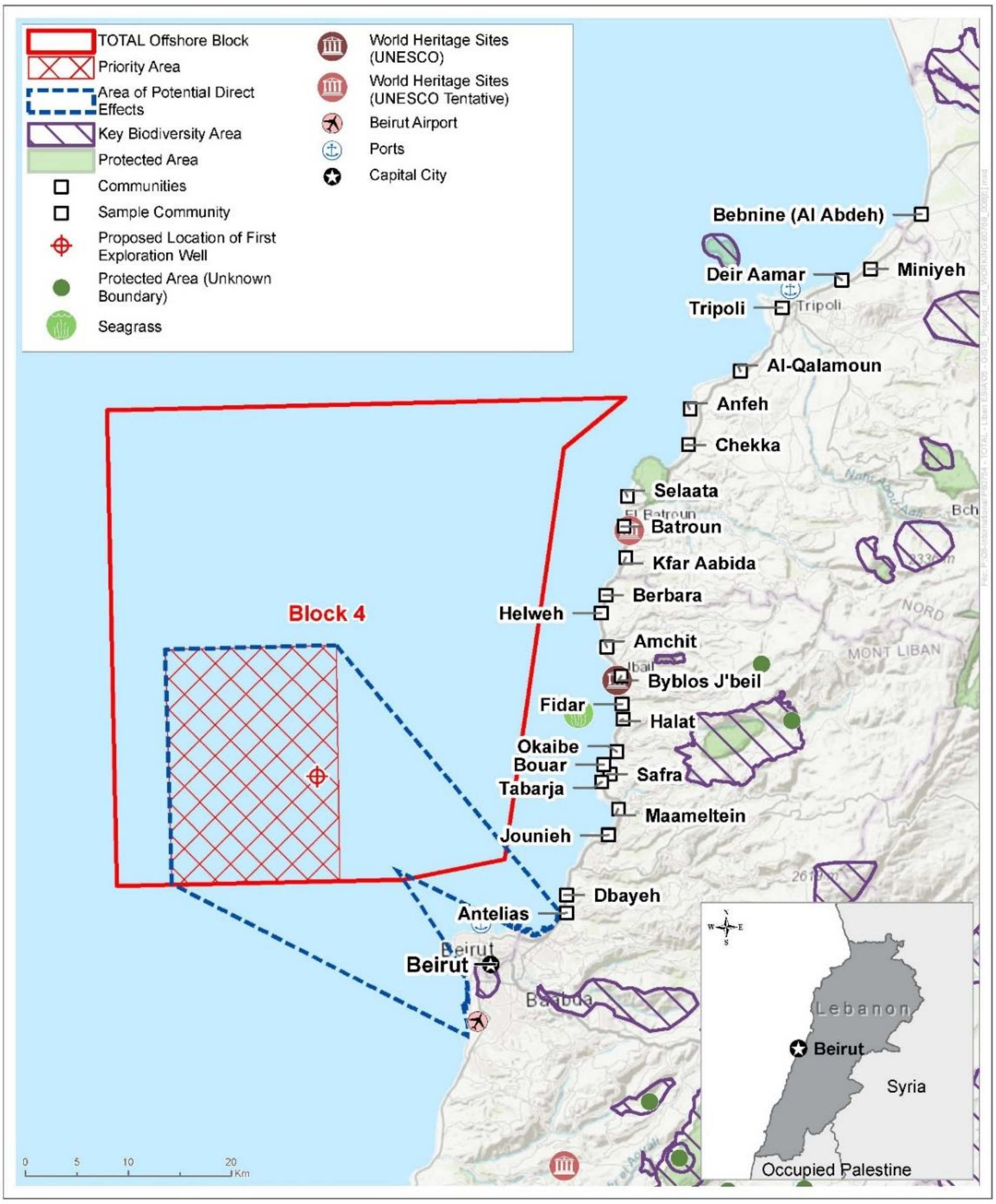


Figure 5.72: Location of Block 4

5.5.1.4 *Primary data collection stage*

Primary data were collected at local and national level by consultants from DAR and InfoPro (Lebanese nationals) with support from RSK. Participants included in the study are outlined below.

National level

One-to-one interviews were carried out with key informants with specialist knowledge of receptors. A semi-structured questionnaire related to the receptors was used during the interviews. The meetings were organised at a convenient time and location to the informant. All meetings were conducted in Arabic. The questionnaires used are included in Appendix 5.1.

Key informants at national level included

- Ministry of Energy and Water (MOEW)
- Ministry of Culture (MOC) – Directorate of Antiquities
- Ministry of Agriculture (MOA) – Directorate of Fisheries and Aquaculture
- CNRS (RS department)
- CNRS (Geology department)
- CNRS (Geophysical department)
- CNRS (NCMS)
- Ministry of Public Works and Transport (MOPWT) – Directorate General of Land and Maritime Transport
- Disaster Risk Management Unit (DRM)
- Port of Beirut
- Ministry of the Displaced
- Ministry of Tourism
- Ministry of Social Affairs (MOSA)
- Ministry of Justice (MOJ)
- Ministry of Foreign Affairs (MoFA)
- Lebanese Atomic Energy Commission (LAEC).

AOI level

Sampling

A sample of communities was selected for primary data collection along the coast of Lebanon from Beirut northwards (to accommodate potential impacts of a worst-case spill scenario). Communities were selected using purposive sampling[10], based on a diversity of land uses and activities linked to the receptors (see Figure 5.74 to Figure 5.81). The sample aimed to include the receptors important for the impact assessment and included communities with the following characteristics:

- urban and rural populations
- fishing ports
- fishing activities
- tourist resorts, areas providing touristic services and areas where recreational activities are undertaken (e.g., swimming, sea angling, dive centres, boat tours)
- industrial areas
- agricultural areas
- areas where natural resources are collected (e.g., salt production)
- cultural heritage
- United Nations Educational, Scientific and Cultural Organisation (UNESCO) World Heritage Sites (WHS).

Table 5.29 sets out the sample communities and the governorate in which they are located. Sample communities are illustrated in Figure 5.73.

[10] Purposive sampling is a non-probability sample and is selected on particular characteristics of the population relevant to the objective of the study.

Table 5.29: Sample communities and governorates (north to south)

Sample community	Governorate
Bebnine (Al Abdeh)	Akkar
Al-Mina (Tripoli)	North Lebanon
Anfeh	North Lebanon
Chekka	North Lebanon
Batroun	North Lebanon
Kfarabida	North Lebanon
Aamchit	Mount Lebanon
Byblos (Jbeil)	Mount Lebanon
Fidar	Mount Lebanon
Okaiba	Mount Lebanon
Safra	Mount Lebanon
Jounieh	Mount Lebanon
Dbayeh	Mount Lebanon
Beirut	Beirut

Some sample communities have two names, as indicated in brackets. Within this chapter, the first name has been used.

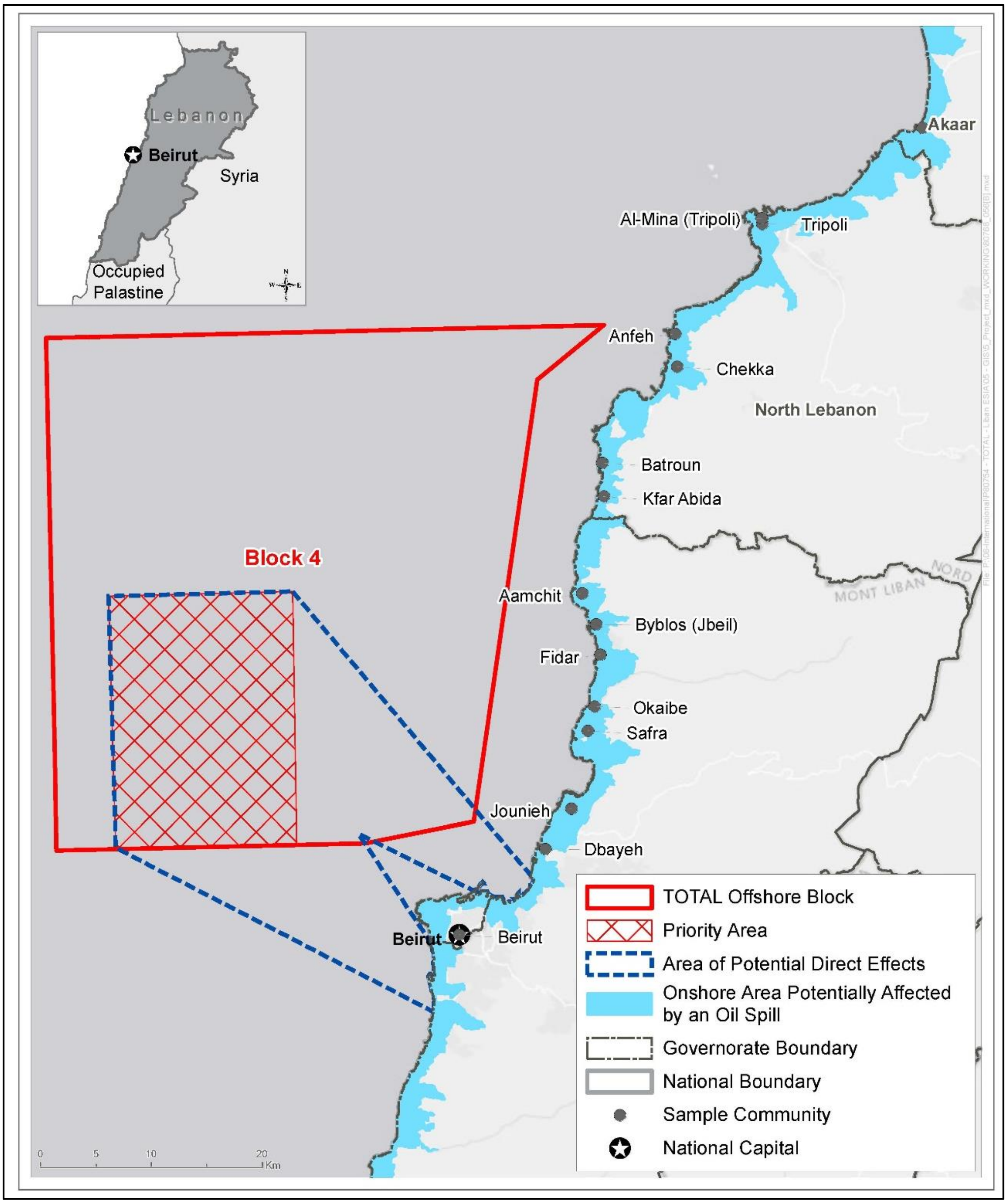


Figure 5.73: Sample Communities

Land use and infrastructure in the sample communities set out in Table 5.29 are shown in the maps below (see Figure 5.74 to Figure 5.81).

Figure 5.74: Land use and infrastructure in Bebnine (Al Abdeh)

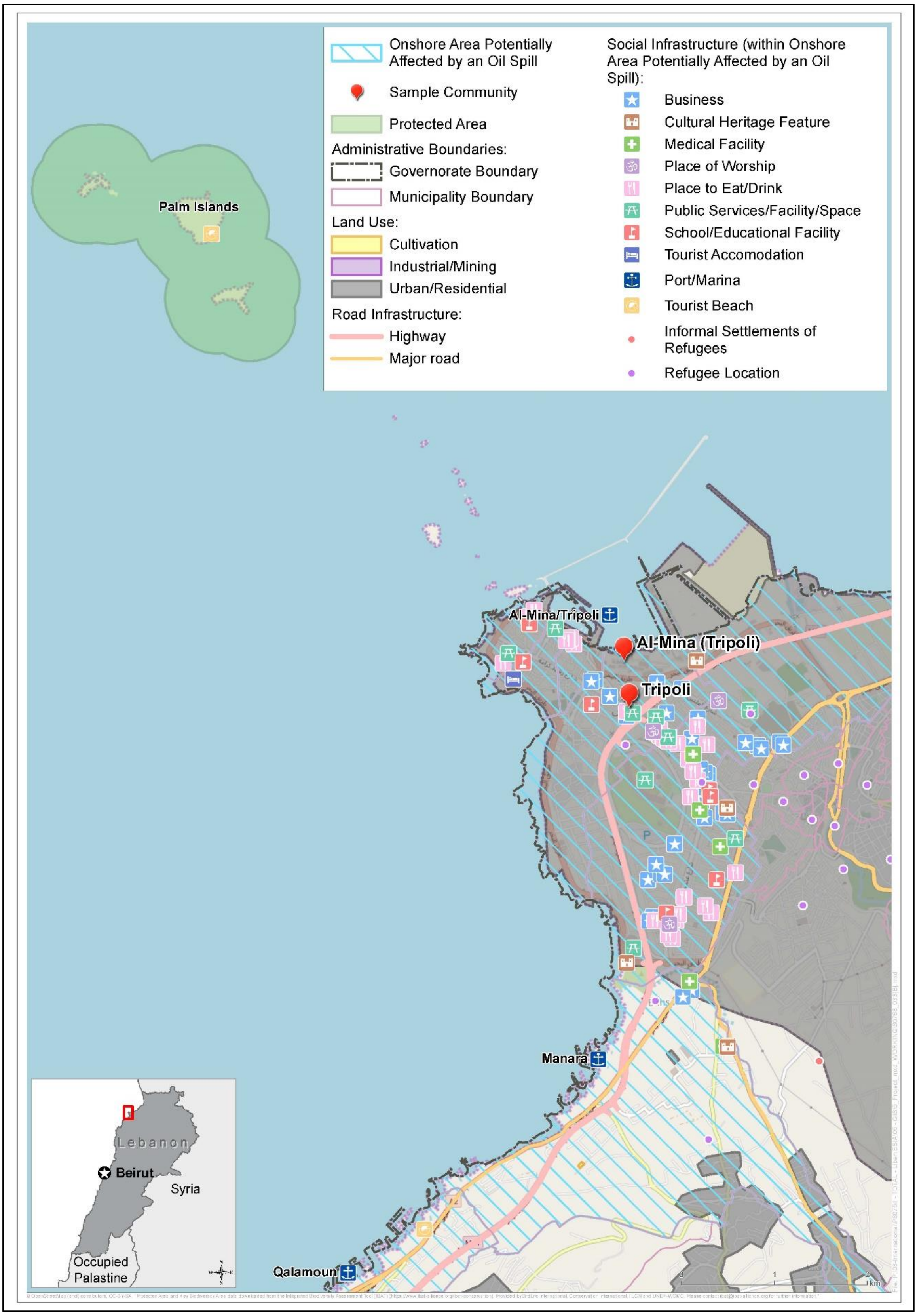


Figure 5.75: Land use and infrastructure in Al-Mina (Tripoli)

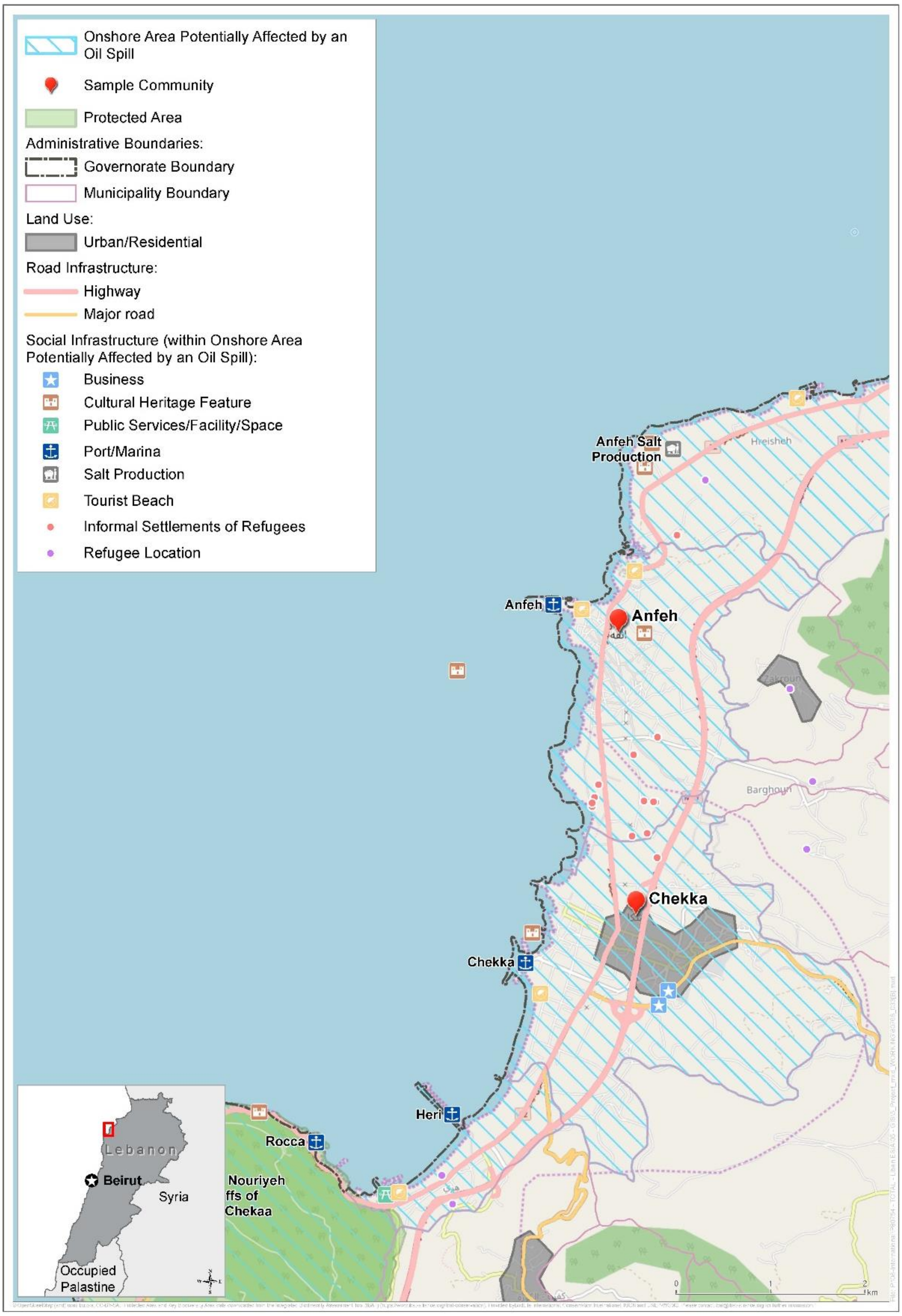


Figure 5.76: Land use and infrastructure in Anfeh and Chekka

Figure 5.77: Land use and infrastructure in Batroun and Kfarabida

Figure 5.78: Land use and infrastructure in Aamchit, Byblos (Jbeil) and Fidar

Figure 5.79: Land use and infrastructure in Okaiba and Safra

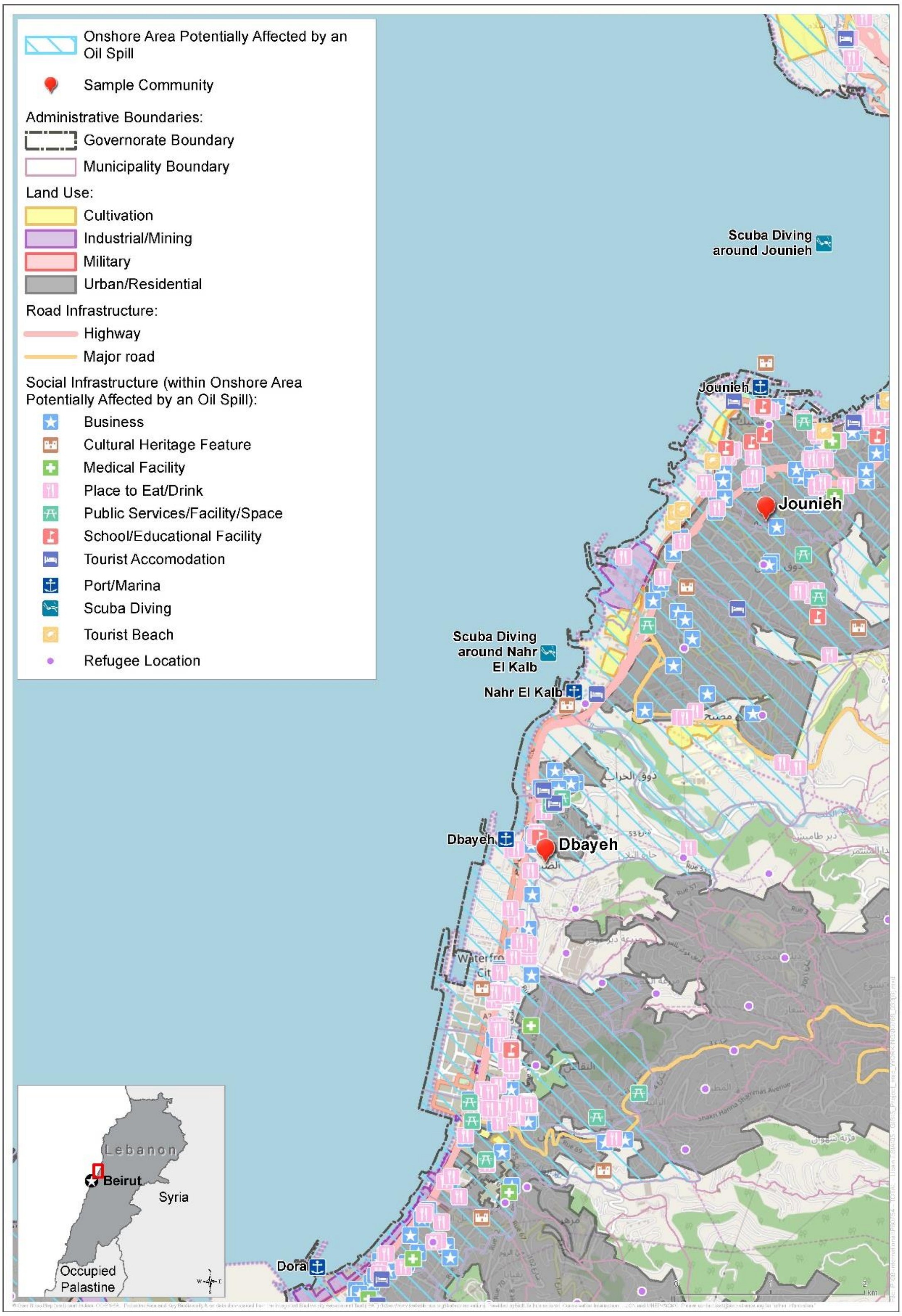


Figure 5.80: Land use and infrastructure in Jounieh and Dbayeh

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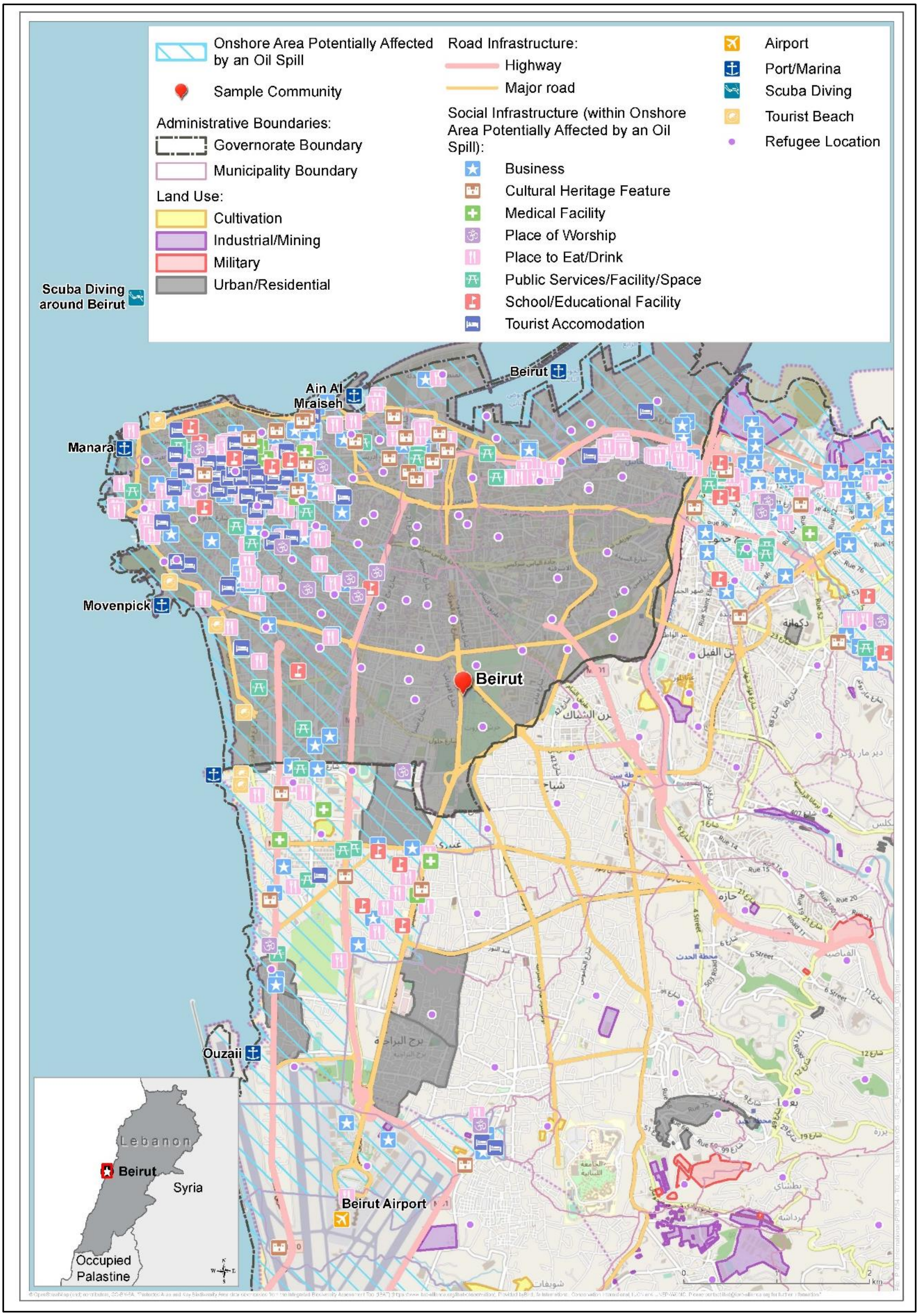

Figure 5.81: Land use and infrastructure in Beirut

5.5.1.5 Data collection

To collect primary data at community level, the following data collection activities were conducted (see Appendix 5.2).

Focus group discussions (FGD) were held with the following potentially affected groups:

- fishermen and those engaged in the fisheries supply chain
- recreational fisheries (e.g. sea angling)
- women (specifically women within fishing households, women involved in coastal farming activities)
- coastal farmers
- natural resource users-
- potential vulnerable groups (e.g. youth (male and female), women, minority or marginalised groups, artisanal fishermen and shell collectors).

Focus groups consisted of discussions with a small group of participants led by a facilitator, using semi-structured questions. In general, 12 people were invited to the meetings to ensure that a minimum of six attendees was achieved. Focus group sessions were held in locations near the participants' places of residence to overcome religious and cultural barriers that might hinder their participation. In addition, obstacles to participation, such as gender and vulnerability, were overcome by engaging women and vulnerable groups, such as youth, women and natural resource users, separately to ensure their voices were heard. The facilitator, through careful management of the discussion, ensured that all participants were able to contribute.

Key informant interviews (KII) were held with persons who are engaged in different activities relevant to the receptors identified. These included

- coastal industry
- leisure industry (e.g., beach resorts, hotels, restaurants)
- UNESCO cultural heritage site operators
- fishing cooperatives
- administration (e.g., municipality)
- community-based organisations (CBOs) and civil society organisations (CSOs), whose mandate was concerned with either education, health, development, human rights, the environment, and who were actively implementing projects within these realms
- municipal mayors.

Structured and semi-structured questionnaires were used related to topic areas relevant to the receptors. These are presented in Appendix 5.3. The meetings were organised at a convenient time and location to the informant.

FGD and KII findings are presented in Appendix 5.4.

Observations

Observational records were made of the contexts of sample communities in respect to the receptors set out above. Where possible, photos were taken and geo-referenced.

Field Mission

A field plan was developed for the local level data collection (see Appendix 5.2) and the meetings were carried out between 21 and 31 May 2019. The team structure was one FGD team and one KII team, comprising two people (a moderator and an assistant moderator) per team.

In total, 29 KII and 14 FGD were undertaken at the local level. The attendance lists for all these meetings is provided in Appendix 5.5.

Both FGD and KII meetings were recorded using a voice recorder and then transcribed. The FGD assistant moderator took additional notes to capture the content of the discussion.

Data were entered into a database. Findings from different informants were then compared and triangulated for each receptor. In-depth data collected at local level were embedded in the governorate and national context to ensure both depth and breadth.

The next sections of this chapter are based on the data collection process described above.

5.5.2 Assumptions and data considerations

Assumptions and data considerations include the following.

Lebanon is classified as a sectarian-based consensual democracy, where demographic data are considered politically sensitive and directly associated with governance. As such, the last official census conducted in Lebanon was in 1932, which was followed by an unofficial census in 2013 (LIC, 2013). With significant population changes in the past few years, published data should be treated with caution. Furthermore, during the field studies people were often not prepared to discuss demographic aspects due to their sensitivity. This challenge has been overcome as far as possible by sourcing data from commissioned studies (e.g., MoE *et al.,* 2016; MoPH, 2017a; UN 2017b), available information in the public domain and newspaper articles.

The fisheries sector suffers from a dearth of recent data. The sector is not monitored due to absence of adequate financial and human resources. The CAS focuses data collection on agricultural activities rather than fisheries. This has been overcome as far as possible by using commissioned studies (e.g., Pinello and Dimech, 2013; Pinello and Majdalani, 2018), qualified with KII and FGD findings.

The term 'refugee' is sensitive within the Lebanese context. The government officially recognises Palestinian, Iraqi and Sudanese people who have sought safety in Lebanon as ‘refugees’. However, though the Lebanese government acknowledges that most Syrians seeking protection in Lebanon are likely to meet the refugee definition, the government refers to these people as ‘displaced’. This report adopts the governments definition of those Syrian citizens who have fled into Lebanon after March 2011 as ‘displaced people’.

Informants’ responses could have been distorted through the process of translation, thereby influencing the validity of responses. To counter this, checks were incorporated to ensure the reliability in the translation and the consultation process.

Fieldwork took place during the Muslim holy month of Ramadan, which affected the availability of some identified informants and participants. This was overcome by choosing a time and location that was suitable for the participants in the context of their Ramadan activities.

During the FGD and KII, permission was requested to take photographs of the participants, most of whom declined.

The study intended to meet sand miners to understand natural resource usage of the coastal zone. Although secondary data indicate that sand mining is active, the field team was unable to find informants who were willing to discuss the activity.

5.5.3 Socio-economic baseline summary

As onshore and offshore socio-economic activities are generally interlinked, they are reported in an integrated manner. Data for national, governorate and local level, where relevant, are presented.

5.5.3.1 Political and administrative context

Political structure

Lebanon is an independent, sovereign, parliamentary republic with a parliamentary structure based on confessionalism, which demands proportional government representation for the country's main religious groups. The President of Lebanon must be a Maronite Christian, the Prime Minister a Sunni Muslim and the Speaker of the Parliament a Shia Muslim.

The legislative power is entrusted in the parliament elected by universal suffrage, for a four-year term. The number of seats is distributed according to caza and confessions. Each religious community has an allotted number of seats. The last parliamentary election took place in 2018.

Administrative structure

Lebanon's administrative structure is based on the principle of decentralisation. The country is divided into governorates (mohafazas), chaired by a governor, which are further divided into districts (cazas or qadas). Districts are presided by a district chief (qaymaqam) (DRI, 2017).

The next level down consists of municipalities, which are governed by an elected council and headed by a mayor. Municipalities can be villages or cities, and local elections are held every six years.

Figure 5.82 shows the administrative divisions of Lebanon.

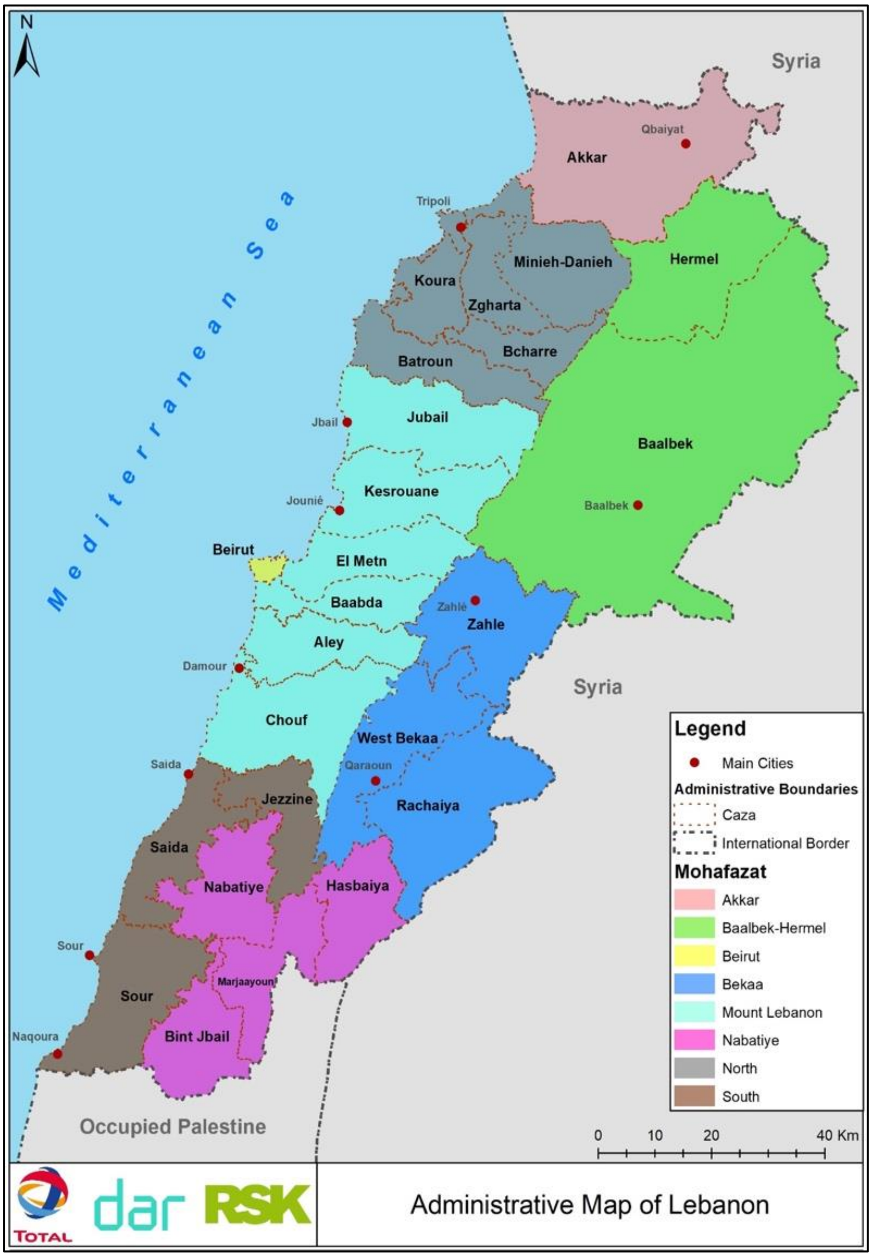

Figure 5.82: Administrative map of Lebanon

Judiciary

The independent Judicial Power consists of the State Council Court (*Conseil d'états*) which is administrative, and judicial courts with different levels of jurisdiction. The Supreme Court is the highest court of appeal for civil, commercial and criminal matters. Constitutional matters and conflicts relating to elections are referred to the Constitutional Council. The Lebanese judicial system guarantees equal rights for all residents, including Lebanese and foreigners, to have recourse to the Lebanese courts. The criminal justice system in Lebanon is ruled by the Code of Criminal Procedure. The judiciary is comprised of ordinary, exceptional and military courts each with their requisite jurisdiction.

Human rights

Lebanon adopted the Universal Declaration of Human Rights (UDHR) in 1948 and has ratified several international conventions which supersede national laws. The protection of human rights in Lebanon covers areas such as freedom of association and collective bargaining, the elimination of forced and compulsory labour, the elimination of discrimination with respect to employment and occupation and the abolition of child labour. As part of its compliance with international treaties and human rights mechanisms, Lebanon submitted its first Universal Periodic Review (UPR) to the fifteenth session of the Human Rights Council (HRC) on 10 November 2010. A committee composed of representatives of the relevant ministries and other stakeholders was established in 2013 to follow-up on the UPR recommendations and a further Secretariat for the National Coordination Mechanism was set up to improve reporting to international human rights bodies in 2018.

Anti-corruption

Lebanon ratified the United Nations Convention Against Corruption (UNCAC) on 22 April 2009, which is currently considered part of the national legal system. In 2016, a new ministry for anti-corruption was established, but has been discontinued by the current government.

Despite this, there is a widely spread public perception of corruption and elite-capture within Lebanon's body-politic (UNSF, 2017). Based on the 2018 Corruption Perceptions Index carried out by Transparency International, Lebanon ranked 138th out of 180 countries (Transparency International, 2018).

Oil and gas sector

In a move to bolster transparency in the nascent oil and gas sector, the government of Lebanon has indicated its readiness to enforce the 2016 Extractive Industries Transparency Initiative (EITI), a standard for transparency and good governance in the extractive sector.

5.5.3.2 Demographics

While the project will not impact the demographics of Lebanon, the whole country has been considered as the study area to provide context for Block 4.

National level

The total population of Lebanon, excluding Syrian displaced people and Palestinian refugees, was 4.5 million in 2017 (MoPH, 2017b). The country has a high population density, estimated at 496 persons per km^2 (MoE et al., 2016), and an average household size of 4.3 (UN, 2017b).

Lebanon's recent population growth (33% increase since 2011) is the result of an influx of displaced people, which peaked in 2014 after which the numbers started gradually decreasing.

The gender distribution of the population is fairly equal with 49.4% male and 50.6% female (MoPH, 2017a). The birth rate (per 1000 people) is estimated as 14.1. The life expectancy is 76.6 for males and 79.3 for females (CIA, 2018). The human development indicators for Lebanon are presented in Table 5.30.

Table 5.30:Human development indicators (HDI) for Lebanon

Indicator	Data
Education	
Adult literacy rate (% ages 15 and older)	91.2%
Gross enrolment ratio, secondary (% of secondary school-age population)	60%
Population with at least some secondary education (% aged 25 and older)	54.3%
Demographics	
Sex ratio at birth (male to female births)	1.05
Percentage of urban population	88.4%
Dependency ratio, young age (0–14) (per 100 people ages 15–64)	33.8
Dependency ratio, old age (65 and older) (per 100 people ages 15–64)	12.4
Gender	
Estimated gross national income per capita, female, 2011 Purchasing Power parity (PPP) in USD	5,523
Estimated gross national income per capita, male, 2011 PPP in USD	21,182
Life expectancy at birth, female (years)	81.6
Life expectancy at birth, male (years)	78.2
Mean years of schooling, female (years)	8.5
Mean years of schooling, male (years)	8.9
Mobility and communication	
Internet users (% of population)	76.1
Mobile phone subscriptions (per 100 people)	81.4
International inbound tourists (thousands)	1,688
Environmental	
Carbon dioxide emissions per capita (tonnes)	4.3
Forest area (% total land area)	13.4%
Forest area (total change %)	4.8%
Renewable energy consumption (% total final energy consumption)	3.6%
Fossil fuel energy consumption (% of total final energy consumption)	97.6%
Mortality rate attributed to household and ambient air pollution (per 100,000 people)	51.4

Source: UNDP (2019)

Lebanon, over the centuries, has experienced continual population movements resulting in a diverse ethnic composition of its population. The predominant cultural backgrounds and ancestry of the Lebanese population includes Canaanite (Phoenician), Aramean

(Ancient Syria), Greek (Byzantine) and Arab. The ethnic identity of Lebanese citizens is closely linked to religious affiliations.

There are 18 officially recognised religious groups which include 4 Muslim groups, 12 Christian groups, the Druze group and Judaism. The main branches of Islam practiced are Shia and Sunni. The Maronite community is the largest Christian group, and the second-largest Christian group is Greek Orthodox. Lebanon's religious diversity extends beyond the country's 18 recognised faiths. For decades, Lebanon has hosted many religious minority groups that are un-recognised, even by the country's inhabitants. These include, for example, Bah'ai, Hindus, Buddhists and Jehovah's Witnesses.

The official language in Lebanon is Arabic. French and English are taught in mainstream schools and Armenian is taught in Armenian schools.

There are no formally identifiable indigenous peoples in Lebanon, although there are numerous religious minorities (as discussed above).

Governorate and local level

The Lebanese population is concentrated in several urban areas in the coastal zone and notably in Beirut. As of 2017, Beirut and the surrounding Mount Lebanon region accounted for 1.97 million people, or 44% of the total resident population.

The population of the sample communities is presented in Table 5.31 from north to south.

Table 5.31: Population of the sample communities

Community	Population size
Bebnine	45,000
Al-Mina	500,000
Anfeh	7,216
Chekka	10,000
Batroun	40,000
Aamchit	33,000
Byblos	35,000
Fidar	4,000
Okaiba	10,000
Safra	10,000
Dbayeh	60,000
Beirut	1,300,000

Source: KII with municipality mayors, FGD with fishermen

As shown in Table 5.31, the population size varies considerably across sample communities, with Beirut and Al-Mina boasting the largest population sizes. The population of Fidar (4000 inhabitants) has remained small and relatively stable in recent years. Local informants indicated that this may be due to lack of job opportunities.

Nearly all of the sample communities reported that they have experienced in-migration since the start of the Syrian conflict. Anecdotal reports provide the following examples:

- In Anfeh, an estimated 2,500 displaced Syrians live in camps within the municipality, approximately 35% of the overall population.
- The Mayor of Bebnine estimated that 20,000 displaced people and refugees are residing in his area, approximately 44% of the overall population.
- The predominant religious groups identified across sample communities are Sunni Muslim and Christians (Maronite and Greek Orthodox). In Al-Mina and Bebnine the majority of the population is composed of Sunnis, whereas in Batroun and Okaiba Christianity was identified as the main religion.

5.5.3.3 Education and training

The AOI for education and training includes the country as a whole; education data provides important social indicator of the standard of living in Lebanon. The study area is the same as the AOI.

National level

The education system in Lebanon comprises a number of tiers of schooling: pre-primary, primary, intermediate and secondary (general or vocational). This is followed by tertiary and vocational and technical level education.

Figure 5.83 shows the gross enrolment rate (GER) by level of education in Lebanon.

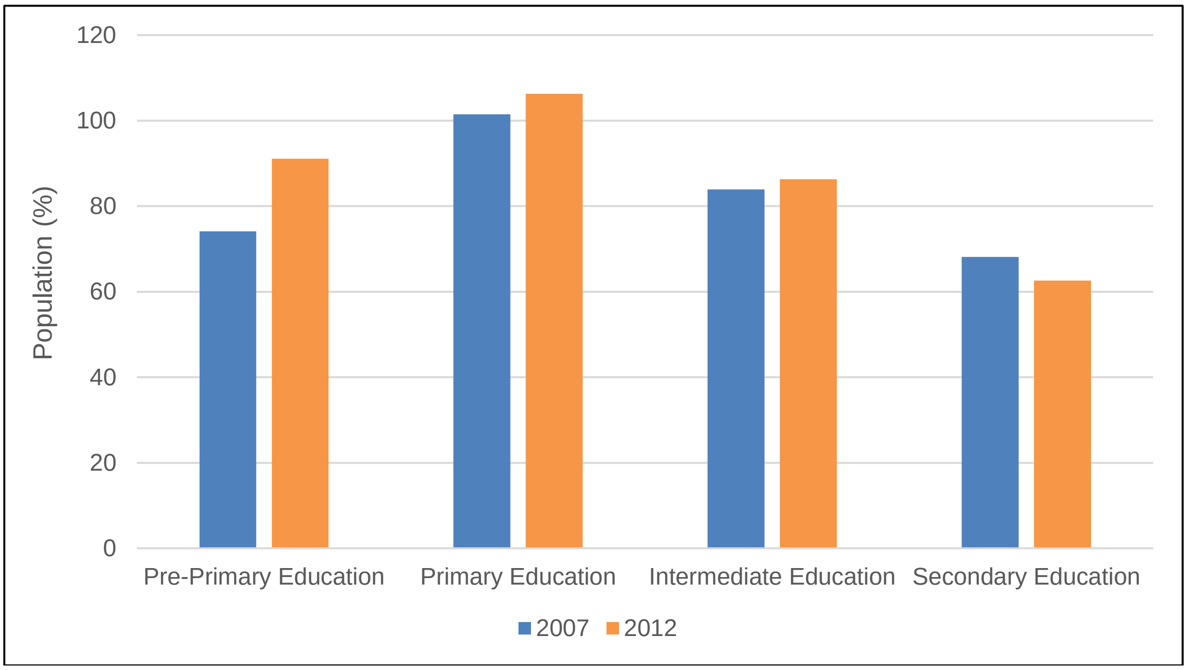

Figure 5.83: Gross enrolment rate by level of education, 2007 – 2012

Source: BankMed (2014a)

As illustrated in Figure 5.83, enrolment in pre-primary education, primary education and intermediate education all witnessed increases between 2007 and 2012. The GER for secondary education decreased from 68.1% in 2007 to 62.6% in 2012 (BankMed, 2014a).

The tertiary education institutions in Lebanon are categorised into universities and university colleges. There are 32 universities, 7 university colleges and 3 university colleges with religious studies affiliations. These institutions offer approximately 160 programmes which award bachelor's degrees, master's degrees and doctorates (BankMed, 2014a).

The gross enrolment ratio for tertiary education in 2017 was 38.14% (UNESCO, 2019). The number of students attending higher education in universities has been increasing since 2014 (see Table 5.32).

Table 5.32: Number of university students in Lebanon

	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
Public university students	71,440	NA	69,994	72,518	75,956
Private university students	120,348	NA	120,163	127,161	124,851
Total	191,788	NA	190,157	199,679	200,807

Source: CRDP (2018)

Vocational and technical education comprises two basic fields in Lebanon, each with a number of levels. Vocational training focuses on jobs which require practical and manual competencies and skills, whereas technical education relates to occupations which require extensive theoretical knowledge and a solid scientific base.

Vocational and technical education is a growing sector in Lebanon managed by the Ministry of Education and Higher Education through the Directorate General of Technical and Vocational Education. This sector covers both the public and private education system in Lebanon with the private sector accounting for 75% of vocational and technical institutions (BankMed, 2014a).

In 2011/2012, approximately 76,157 students were enrolled in vocational and technical education, 42,529 of whom were enrolled in *baccalaureat technique* (BT) certificate programmes and 17,862 in *technicien supérieur* (TS) certificate programmes (BankMed, 2014a). The highest level of enrolment for vocational and technical education is in Beirut, followed by North Lebanon and South Lebanon. The lowest level of enrolment is in Mount Lebanon (BankMed, 2014a).

According to GFA et al. (2019), the number of students enrolled in vocational and technical education is rising, reaching 85,244 students in 2016 – 2017.

Lebanon has launched a national strategic framework to upgrade the quality and accessibility of its technical and vocational education and training (TVET) system with the aim of addressing youth unemployment and boosting economic growth (ILO, 2017).

Governorate and local level

The number of education facilities is fairly evenly distributed across the governorates in Lebanon. A total of 265 public schools are located in North Lebanon and 163 in Akkar (Ramboll, 2019).

High levels of education were reported in all of the sample communities. Consistent with data at the national level, little difference was reported in terms of the education levels of men and women across the sample communities. However, educational levels amongst some groups such as fishermen (particularly elderly) were reported to be lower than amongst the population at large.

There are a large number of primary and secondary schools compared to tertiary level schools in all sample communities. The distribution of schools across the sample communities varies and correlates with the population size of the community with the denser communities having a larger number of schools. The smaller sample communities of Anfeh has only one school, covering both primary and secondary levels, and there are no university facilities. In contrast, Bebnine has 21 primary and secondary schools respectively, alongside technical and vocational institutes and universities.

Communities with fewer schools may limit students' access to education, in particular tertiary education, where the available infrastructure cannot meet local demand. This was emphasised in a meeting with youth in Anfeh where it was reported that those wishing to continue their education must leave the village and pursue their studies in neighbouring settlements, namely Chekka and Beirut. The large cities of Tripoli and Beirut provide good access and a variety of tertiary education facilities.

The number of university students and graduates in the sample communities were not available at the time of writing. Nevertheless, references to a highly educated population and large pool of university graduates was a recurrent theme in discussions across the sample communities, suggesting high enrolment rates at the tertiary level.

University graduates reportedly face difficulties transitioning from further education establishments to the Lebanese labour market. Municipality Mayors in the sample communities of Anfeh, Safra and Byblos highlighted the production of a large pool of university graduates with skills which are inappropriate for, and do not reflect, the current demands of the Lebanese economy. In North Lebanon, 48% of workers reportedly have an education degree that does not fully match local job opportunities (World Bank, 2017). As a result of the skills mismatch, there are limited employment opportunities for youth leaving university, leading to high levels of unemployment and potentially negative implications for the human rights to work and an adequate standard of living.

According to recent assessments of labour needs by the International Labour Organisation (2015) and United Nations Development Programme (2016b), skills shortages in Lebanon include

- managerial skills, specifically those required for the food industry, such as quality assurance, chefs and waiters in the hospitality industry
- mechanics and electro-mechanical skills, specifically at the level of technician
- welders for ships that need maintenance and on small boats used for tourism purposes
- agribusiness and farm management skills (particularly in Akkar, which, compared with Bekaa and other rural areas, does not possess required farm management and pest management skills)
- construction skills, including waste management specialists, environmental consultants, mathematicians (skilled jobs) and plumbers, heating and cooling specialists and carpenters (semi-skilled jobs)

- information and communication technology (ICT) industry skills (e.g. software engineers, web developers and computer programmers) (ILO, 2015; UNDP, 2016b).

Key trends and sensitivities

- The number of students attending universities has been increasing since 2014, although enrolment remains biased towards certain degree courses.
- There is an apparent mismatch between the degrees of university graduates and the requirements of the local labour markets, exacerbating the high graduate unemployment rate.
- The influx of displaced Syrians is putting increased pressure on school infrastructure which impacts negatively on the quality of education.
- Training of Lebanese employees for the onshore logistics base will be prioritised. Opportunities are limited in the exploration phase however there is still potential for a low positive impact.

Taking into account that Lebanon has a well-educated population the sensitivity of this receptor is considered to be low (2). If the exploration phase is successful and the oil and gas industry presents more opportunities for employment of the Lebanese population, the educational institutions within the country will be able to help in providing appropriate education and training.

5.5.3.4 General economy and industry

According to planned activities, AOI for general economy and industry includes the areas in the immediate vicinity to the logistics base at the Port of Beirut as this is where most opportunities for employment and provision of goods and services will be located. To provide context, the study area has been broadened to include the country as a whole.

National level

Lebanon’s macro-economy is predominantly dependent on the services sector (tertiary sector) (World Bank, 2018), which constituted 72.4% of real Gross Domestic Product (GDP) over the 2004–2016 period, while industry (secondary sector) and agriculture (primary sector) constituted 4% and 4.3% of GDP respectively (World Bank, 2018).

Real estate (including construction) is the largest services sector. Wholesale and retail trade occupied the second largest share of the services sector, accounting for 13.4% of GDP (World Bank, 2018). The direct contribution of tourism accounted for 6.5% of Lebanon’s GDP in 2017 (IDAL, 2019a), whereas the total (direct and indirect) contribution of tourism accounted for 18.4% of GDP (IDAL,2017).

In addition to agriculture, the primary sector also includes fishing and other raw material production including mining, forestry, grazing, hunting and gathering and quarrying. It is estimated that Lebanon’s fishing industry employs approximately 10,000 people during peak seasons (Al Jazeera, 2014). However, the contribution of the fishery sector to the national economy remains very limited (Pinello and Majdalani, 2018).

Small and medium-sized enterprises (SMEs) play an important role in the economy of Lebanon (Hamdar et al., 2017). It is estimated that there are over 225,000 SMEs in Lebanon, two-thirds of which are concentrated in the economically dominant regions of Beirut and Mount Lebanon (IRC, 2016).

Economic growth has slowed since 2011 and the start of the Syrian Crisis (at around 1.6% each year). The International Monetary Fund (IMF) forecasts growth rates of between 1% and 3% between 2017 and 2023, reflecting expectations that the economic situation will improve as a result of the anticipation of a resolution of the Syrian crisis, and improved economic outlook in the region more broadly.

There are however a number of important constraints on economic growth, including macroeconomic volatility, infrastructure gaps and deficiency in the banking sector intermediation (World Bank, 2016).

Data from CAS and the World Bank (2015) indicates that in 2011/12 approximately 45% of individuals aged 15 years and above were employed in the labour market whilst 51% were unemployed. There is a considerable difference between employment rates among women and men, which becomes more pronounced after the age of 34 (see Figure 5.84) and is mainly due to social, economic and cultural factors that limit many women from pursuing professional careers or engaging in activities outside of the household to generate income. For young people, the transition from education to employment in the labour market is challenging due to an apparent skills mismatch. Additionally, graduates are often unwilling to accept jobs at the level of remuneration that many smaller companies can offer. The most difficult positions to fill are those of skilled technicians, engineers and managers (UNDP, 2016b).

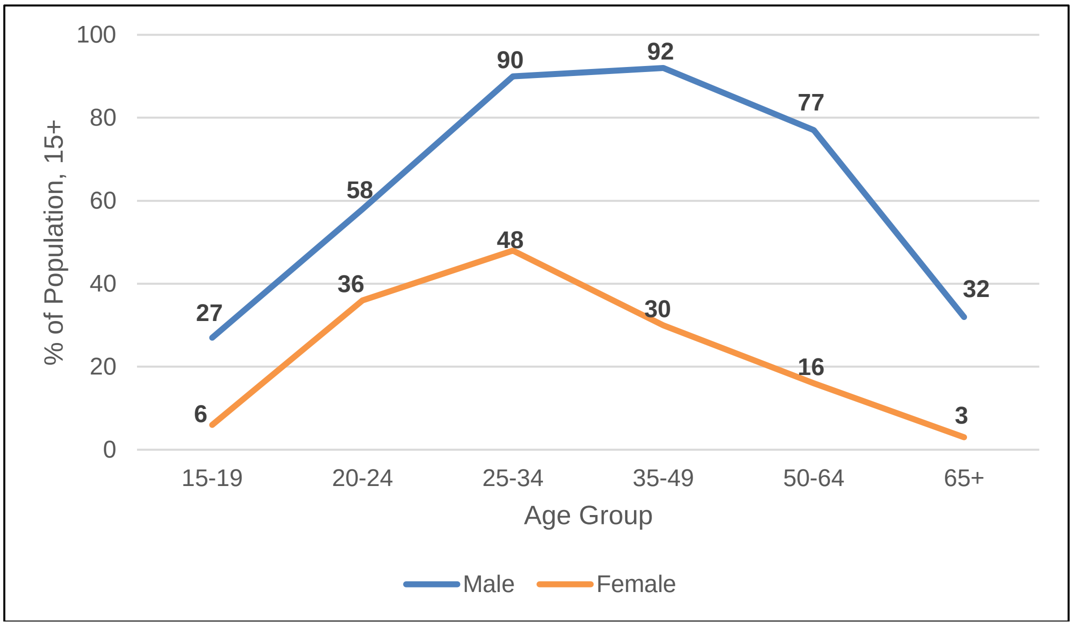

Figure 5.84: Employment rate by gender and age group (%)

Source: CAS and the World Bank, 2015

The influx of displaced persons is estimated to have increased the size of the Lebanese workforce by around 35%. Being predominantly young, unskilled and faced with few employment opportunities, the majority of displaced persons have joined the supply of low-skilled or unskilled workers in the informal sector. Almost half of displaced Syrian workers are involved in agriculture, domestic services or the construction sector. Competition between Lebanese and displaced workers for low-skilled jobs has increased, leading to higher overall unemployment rates and lower wages.

Daily casual labour wages have decreased by 60% since displaced people have taken up full-time jobs, with remunerations as low as 200 USD per month. This is below the national minimum wage of 450 USD per month. The increase in cost of living, combined with the reduction in incomes, has considerably increased the vulnerability of households.

World Health Organisation (2016) reports that poverty in Lebanon is widespread and increasing. Figures from 2016 indicate that approximately 28.5% of the Lebanese population can be identified as 'poor' (living on less than 4 USD per day), whilst approximately 300,000 individuals can be classed as 'extremely poor' (living on less than 2.40 USD per day), being unable to meet their basic human needs (UNDP, 2016a). As many as 20% of Lebanese citizens live with unimproved sanitation facilities and 10% of poor households lack access to potable water (The Borgen Project 2017).

While Lebanon's social programmes are still relatively young, the government has formed two primary means of alleviating poverty in Lebanon: The National Social Security Fund (NSSF) and the Emergency National Poverty Targeting Programme (The Borgen Project, 2017).

Governorate and local level

The main economic sectors in the sample communities include

- the services sector, specifically tourism and wholesale and retail trade
- the industrial sector (including food, beverages and cement)
- the primary sector (agriculture and fishing).

Labour market participation rates, unemployment and employment type (wage versus self-employment, formal versus informal employment) differ across the different geographical regions; the country's economic activities and jobs are concentrated in a limited number of coastal cities (e.g., Tripoli, Byblos and Beirut). Disadvantaged regions tend to have lower participation and higher unemployment rates as a result of the spatial disparities in infrastructure and service delivery. Labour market participation rates are lower in North Lebanon (at 38%) compared to Mount Lebanon (53%).

In North Lebanon the majority of the population (58%) is self-employed whereas in Mount Lebanon over half of the labour force (55%) comprises wage-based employees. Agriculture and fishing constitute the main sources of employment in Akkar, followed by public administration and the armed forces (Ramboll, 2019).

Key trends and sensitivities

- Economic growth has been visibly muted since 2011 and the start of the Syrian Crisis (at around 1.6% each year). The heightened security risk, threat of spill overs and domestic incidences have led to weakened performance.
- Growth rates of between 1% and 3% between 2017 and 2023 reflect expectations that the economic situation will improve as a result of the anticipation of a resolution of the Syrian crisis, and improved economic outlook in the region more broadly.
- Lebanon's industrial sector comprises mostly small-sized establishments that specialise in light-manufacturing activities. Much of the specialised equipment required for the project will come from abroad.
- The main direct and indirect economic benefits of the project will be from job creation, but this will be limited during the exploration phase.

The industrial sector in Lebanon is relatively small in terms of contribution to the overall economy. As this is the sector most likely to be able to supply goods and services to the project (which is of short duration), sensitivity is considered low (2).

5.5.3.5 Livelihoods

The following livelihoods are pertinent to the coastal regions:

- Fisheries and aquaculture
- land-based livelihoods (e.g. agriculture, livestock rearing and natural resource use)
- tourism and recreation.

These are detailed in the subsections below.

Fisheries and aquaculture

The AOI for fisheries and aquaculture encompasses the transit routes of the support/supply vessels and the 500 m radius of the exclusion zone around the MODU at the proposed well sites. To provide context, the study area has been broadened to include the country as a whole.

National level fisheries

Lebanon does not have a commercial fishing fleet. Instead, the fishing industry relies on a traditional, small-scale fleet of motorised wooden vessels generally under 12 m in length, with approximately 1460 licensed vessels recorded in 2011. By virtue of the boats and gears used (e.g., trammel nets and longlines, purse seine nets and beach seines), fishing operations are mostly carried out in inland waters, at depths of up to 50 m (Pinello and Majdalani, 2018).

The Lebanese coastline is punctuated with 44 landings points, including both official ports and unofficial landing sites. The former are managed by port authorities. The majority (over 75%) of registered vessels are located along the north coast, which correlates with the national distribution of ports, the majority of which are located in North Lebanon and Mount Lebanon.

At local and professional level, the fishing community is organised into cooperatives and syndicates. There are approximately 33 fishermen’s cooperatives and seven syndicates representing fishermen. It is estimated that 86% of fishers hold a personal licence (Pinello and Majdalani, 2018). Fishing cooperatives exist in respective ports and are a conduit for external support (donor and government) and aim to facilitate value chain linkages.

MOA catch data for 2016 indicated that 17 species/families of fish accounted for 80% of catch. Sardines and anchovies (Clupeidae) are the most important commercial species, representing approximately 30% of production (Pinello and Majdalani, 2018).

Fish production is marketed to consumers on port stalls, by licensed and unlicensed shops and supermarkets, and fish stalls, directly by fishermen and by street vendors (Pinello and Majdalani, 2018).

Recent socio-economic surveys of the marine fisheries sector reveal that the average monthly income of fishermen was approximately 283 USD in 2016, i.e., 38% less than the minimum salary set by the government (Pinello and Majdalani, 2018).

Governorate and local level fisheries

Most of the ports of Lebanon are concentrated in Akkar, North Lebanon and Mount Lebanon.

The main fishing harbours within the AOI are Bebnine, Tripoli, Qalamoun, Anfeh, Chekka, Batroun, Kfarbida, Aamchit, Byblos, Okaiba, Al Boire, Tabarja, Jounieh, Dbayeh, Dora, Aïn-el-Mrayseh, Al Manara, Dalieh and Ouzaii (East Med and FAO, 2011) (see Figure 5.85).

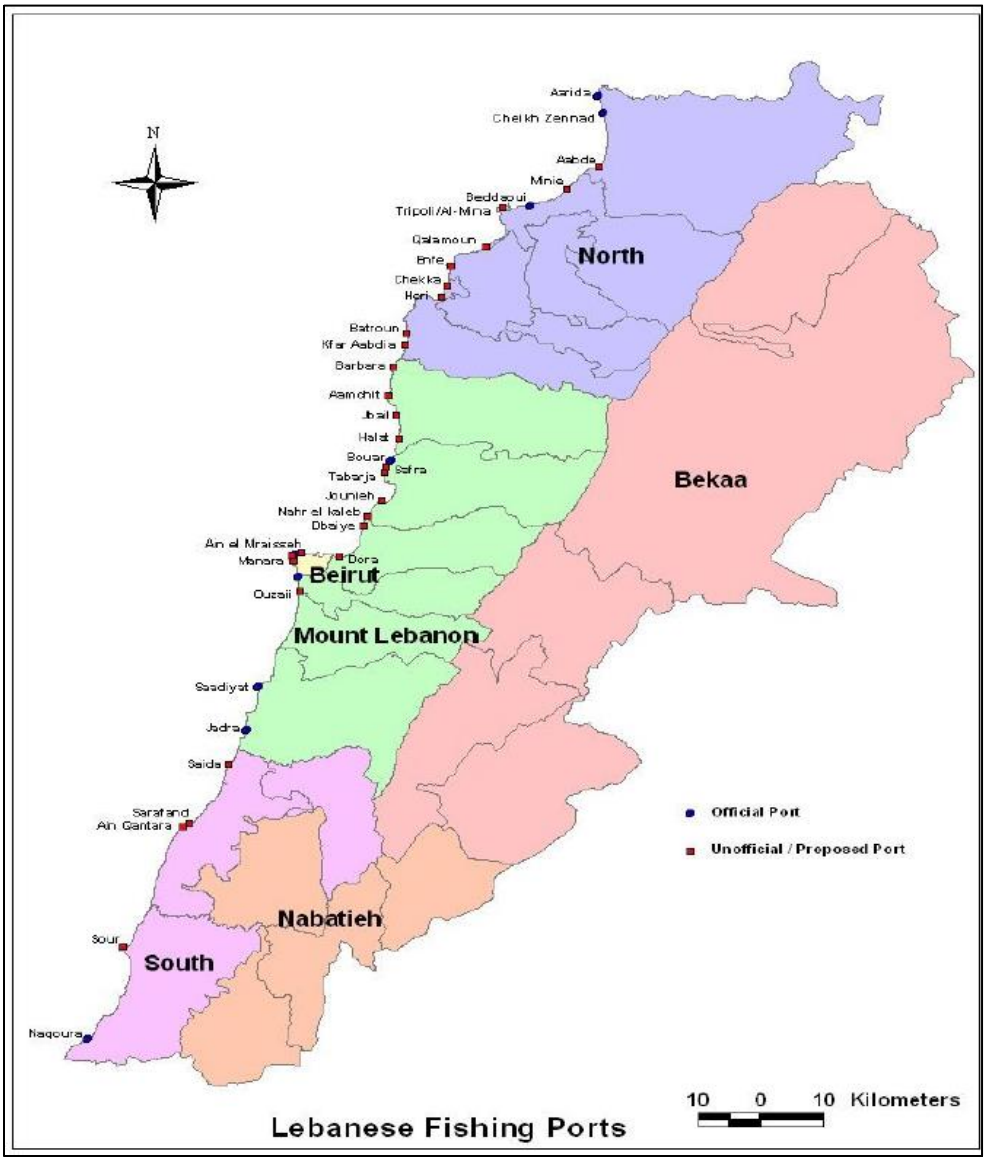

Figure 5.85: Fishing ports on the coast of Lebanon

Source: Pinello et al. (2013)

The activity is artisanal and those engaged in fishing generally do so on a full-time basis with no alternative livelihood activities or social security arrangements. Only a small number of fishermen fish on a part-time basis, sharing their time between formal employment and fishing. Vessel crew are mainly composed of family members of the vessel owner including their children. In some cases, crew is employed, but with dwindling fish stocks and reduced incomes from catches, vessel owners are reticent to do so, as a daily payment of up to 13 USD is requested. Employed crew generally consist of Syrian nationals, Bangladeshi and to lesser extent Egyptian nationals who assist in activities such as hauling in nets on the vessels, cleaning fish on land, cleaning vessels, collecting and waxing nets and other maintenance tasks. Women are engaged to a very small extent in the fisheries supply chain, assisting in cleaning activities, marketing and, in some cases, making nets. Other supply chain actors include traditional boat builders and those involved in marketing (predominantly wholesalers and auction yards).

The main fishing gear used are trammel nets, gillnets (drift nets also known as shovels), long lines (with hooks), drifting long lines, hand lines and trolling lines, purse seine nets, lampara[11] and to a lesser extent beach seines.

Fishermen travel perpendicular as well as parallel with the coast. Fishermen consulted are aware of the legislation that restricts fishing grounds to six nautical miles offshore. Fishing is mostly concentrated within 6 nm and 3 nm closest to the shore, particularly off the coast of the governorate of Beirut. This has led to high pressure on coastal fisheries resources within these areas. Fishing usually occurs to a maximum depth of up to 200 m, while most activities take place at an average depth of 50 to 100 m.

The Lebanese Navy monitors fishing vessel movements in coastal waters. If vessels are discovered beyond the 6 nm limit, they are escorted back. Nevertheless, some fishing vessels venture beyond this limit (see Figure 5.86 below). Fieldwork found that fishermen from ports in Mount Lebanon and Northern Lebanon are more prepared to travel beyond the 6 nm limit, and distances of up to 25 nm offshore are covered to reach fishing grounds. Fishermen also travel up and down the coast with some travelling from southern Lebanon Governorate travelling up the coast to fish in waters off Beirut.

A wide range of fish species are caught, and species differ according to the seasons. During the warmer summer months, fish are most plentiful. Tuna, targeted during the summer, is a popular species across the sample fishing communities as it commands a high market price.

Fish stocks were perceived to be in decline across the entire coastline, with fishermen indicting that they had to travel further out to sea to cast nets, when in previous years fish were in abundance in coastal waters up to 500 m offshore. Furthermore, fishermen across all the sample sites stated that invasive species such as the blowfish (Nefaykha) and the Khaliji have become plentiful in coastal areas. These are hazardous to handle, ruin nets and impact negatively on indigenous stocks.

[11] The lampara net is a type of surrounding net, working without a purse line to close the bottom part of the enclosed net. The length of the net is up to 200 m and the height is not more than 25 m (East Med and FAO, 2011).

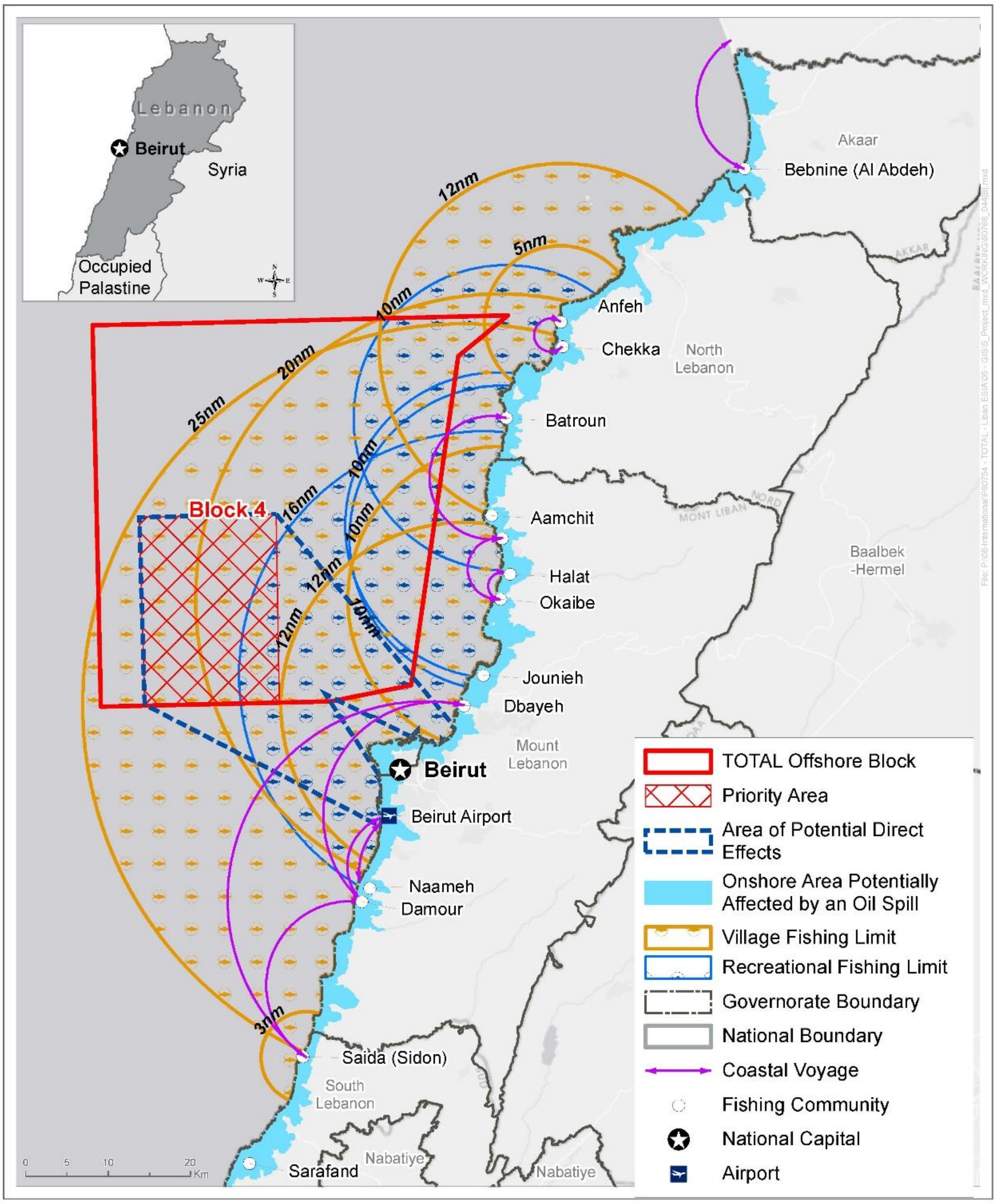

Figure 5.86: Distances travelled to fishing grounds

The annual revenue of a fisherman (non-vessel owner) varies but focus group discussions found that monthly incomes range between 330 and 660 USD. Many fishermen felt that they were economically vulnerable as households were dependent on fishing activities as a sole income stream with no alternative livelihood activities to diversify income and safeguard against periods when they are unable to fish (e.g. due to weather condition or the season).

Aquaculture

There is only one shrimp farm along the north coast, in Akkar Governorate. Aquaculture activities are considered highly sensitive to changes in marine habitat.

Land-based livelihoods

Land-based livelihoods in the study area consists of agriculture and natural resource usage. However, given the offshore nature of the exploration activities, only a brief overview of agricultural activities has been provided as one of Lebanon's main agricultural producing areas is in the coastal zone, but it is not dependent on coastal resources.

National level agriculture

The agricultural sector remains under-developed in Lebanon. It provides only 3.5% of Lebanon's GDP and employs 6% of the Lebanese labour force (IDAL, 2017). A small percentage of the population undertakes livestock rearing; those who do, rear small herds of cattle, sheep and goats (FAO, 2015).

Lebanon imports about 85% of the country's food needs (FAO, 2012).

Agricultural activities in the coastal zone are clustered. The largest area in the AOI is the Nahr El Bared Valley in North Lebanon and the Akkar Plain in Akkar. Agricultural production is dominated by market gardening, mostly in greenhouses but also in fields where olives, citrus and bananas are cultivated.

National level natural resources

Sand and gravel extraction, salt production and seashell collecting constitute a significant part of the subsistence economy in the coastal zone. It is the poorest segment of the community, with low education and skills levels wo depend on these resources for their livelihood.

Sand and gravel extraction has flourished with the increased reconstruction activities in the country. Gravel extraction mainly takes place in the mountainous regions but also behind the coastline (such as in Mayrouba, Mount Lebanon and Chekka, North Lebanon). Sand extraction takes place in open pits on or near beaches, inland dunes and ocean and riverbeds. This activity has created widespread irreversible environmental damage (Independent, 2018).

Governorate and local level natural resources

Natural resource usage was not considered an important livelihood activity in the sample communities.

However, sand and gravel extraction is still carried out to a small extent (and illegally) in the coastal zone of the Dbayeh area in Mount Lebanon Governorate.

Seasonal salt production along the coastline of Lebanon has declined over time and now only takes place in the coastal community of Anfeh. There are 12 salt producers operating in a 27,760 m^2 area on the coastal zone.

Artisanal salt production in Anfeh is part of the heritage of the coastal town. Salt is produced by pumping sea water into shallow evaporation ponds on the edge of the coast.

While sand mining in the coastal areas is disappearing due to the high real estate value of coastal land and the availability of cheaper imported salt, a significant part of the cultural history and visual landscape of Anfeh would be lost without salt production.

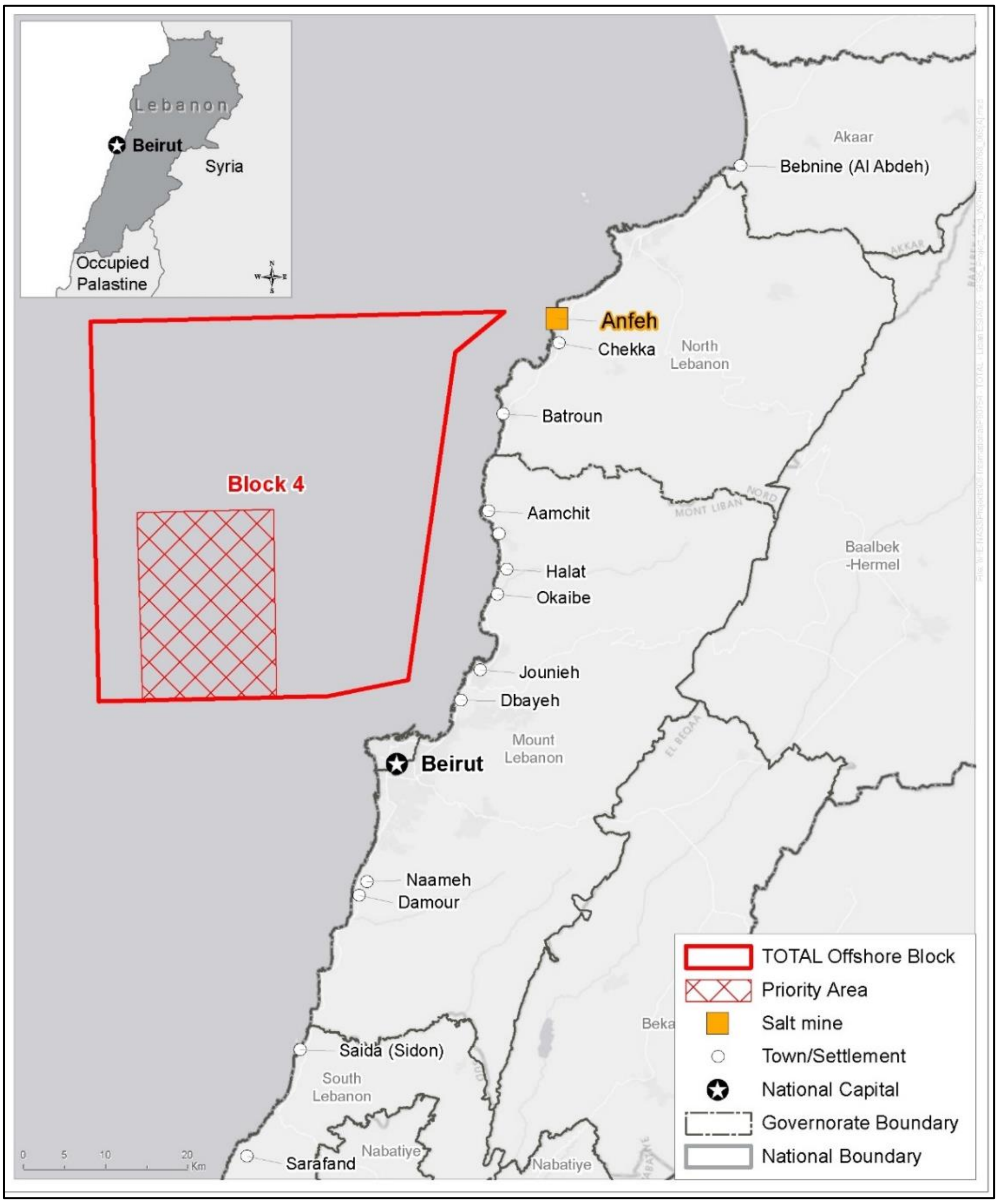

Figure 5.87: Coastal salt mines in Anfeh

A small number of seashell businesses were found in Tripoli and Chekka. This is a minor livelihood activity undertaken alongside other livelihood activities. Shells are collected on the beaches along the coastline or by divers from the seabed. They are subsequently sold on highways (e.g., the Jounieh Highway) and in urban corniches to tourists.

Key trends and sensitivities

- Lebanon’s fishing industry is predominantly traditional, with most vessels fishing in shallow inland waters. However, it is reported that some vessels venture beyond the 6 nm limit. Over 75% of registered vessels are located along the country’s north coast.

- Those engaged in fishing do so on a full-time basis with no alternative livelihood activities or social security arrangements. Fishermen are considered by many to be vulnerable.
- Some vessel owners may employ crew which typically consists of Syrian nationals, Bangladeshis and, to a lesser extent, Egyptian nationals.
- Fishermen are experiencing a decline in fish stocks and reduced incomes. Invasive species have reportedly become more common in coastal areas.
- Aquaculture is limited in Lebanon with only one shrimp farm located along the north coast in Akkar Governorate.

Though the fisheries sector is mostly small scale and artisanal, it constitutes a key livelihood for vulnerable people who have few or no other alternatives for work. Given that the project will have a relatively short duration, the sensitivity of the fishing industry to the project is rated as low (2).

Tourism and recreation

The AOI for tourism is the immediate vicinity of Beirut Port and Airport, as routine events, such as helicopter transfers from Beirut Airport, and the physical presence of the MODU, are only likely to have an effect on tourist facilities in these areas. The study area is the Lebanese coastline north of Beirut (including Beirut itself) and information has been provided at a national level to provide context.

National level

Lebanon's tourism sector has historically been an important contributor to the Lebanese economy and remains, to date, a major source of revenue. In 2017, Lebanon ranked second in the Middle East in terms of the total contribution of the tourism sector to GDP (estimated at 9.3 billion USD or 18% of GDP). In 2016, there were an estimated 338,600 tourism-related jobs, demonstrating the importance of this sector for income generation and employment (GFA *et al*., 2019).

The growth of the tourism sector has been facilitated by various factors including decreasing international concerns over security and safety and improvements in infrastructure. The current expansion of Beirut Rafic Hariri International Airport aims to increase the airport's annual capacity from its current level of around 6 million passengers to 20 million by 2030 (Raidy, 2018).

In recent decades, visitors from the Arab countries have formed the mainstay of Lebanon's tourism industry. However, the Syrian conflict has brought a dramatic decline in Arab visitors (declining from 41% in 2010 to 29% in 2018) in the wake of a political boycott on travel to Lebanon from the GCC countries.

Three different types of tourism can be distinguished:

- nature-based and adventure tourism, including beach recreation, visits to nature reserves, camping, caving, cycling, hiking and trekking, mountain climbing, skiing and winter sports
- cultural tourism, including archaeology, historic buildings, industrial heritage (silk industry, soap industry, glass industry), festivals and traditional crafts (pottery, weaving, leather production and glass blowing)
- religious tourism, predominantly geared towards members of the Lebanese Christian Diaspora (Pasquier, 2012; Monroe, 2016) and mostly comprises Christian and Islamic worship sites.

Several recreational activities take place in the coastal zone, including sea angling which is a popular activity carried out along the entire Lebanese coastline in all seasons of the year. Sea angling is most common during the summer months when the sea is warm and the number of species more plentiful. Men, women and children enjoy the activity. Gear consists of single rods (often telescopic), hooks and fish traps. Some sea anglers fish in deeper waters with fibre glass boats, using global positioning system (GPS) and sonar equipment.

Governorate and local level

Tourism in the coastal zone represents a major contributor to the local economy. However, tourism has suffered as a result of regional political instability following the onset of the Syrian conflict and has struggled to return to pre-2010 levels.

At the time of writing, Beirut hosts the majority of tourists in Lebanon; the capital accounted for 80% of all tourist expenditures in 2017 (BLOMINVEST, 2018). Leisure, business and nightlife tourism constitute the main kinds of tourism, with Hamra, Downtown Beirut and Gemmayzeh representing the most popular areas for visitors.

The beach resorts located in the sample communities are illustrated in Figure 5.88: Beach resorts in the sample communities for Block 4. Resort sizes vary, though most employ between 30 and 120 staff. Most resorts operate all year round; however, they are busiest during the summer, at weekends and during Eid.

Tourist beaches are also prominent in the AOI and are located in Tripoli, Anfeh, Chekka, Batroun, Byblos, Jounieh, and Beirut. Additional diving locations include Batroun, Byblos, Safra, Jounieh and Beirut.

The recreational and tourist sites along the coast are utilised by local and foreign visitors and are significant sensitive receptors for the project, both culturally and economically. There are beaches, bathing sites, recreational sailing marinas and scuba-diving sites. Although tourism is mostly seasonal, many people’s livelihoods depend on the sector.

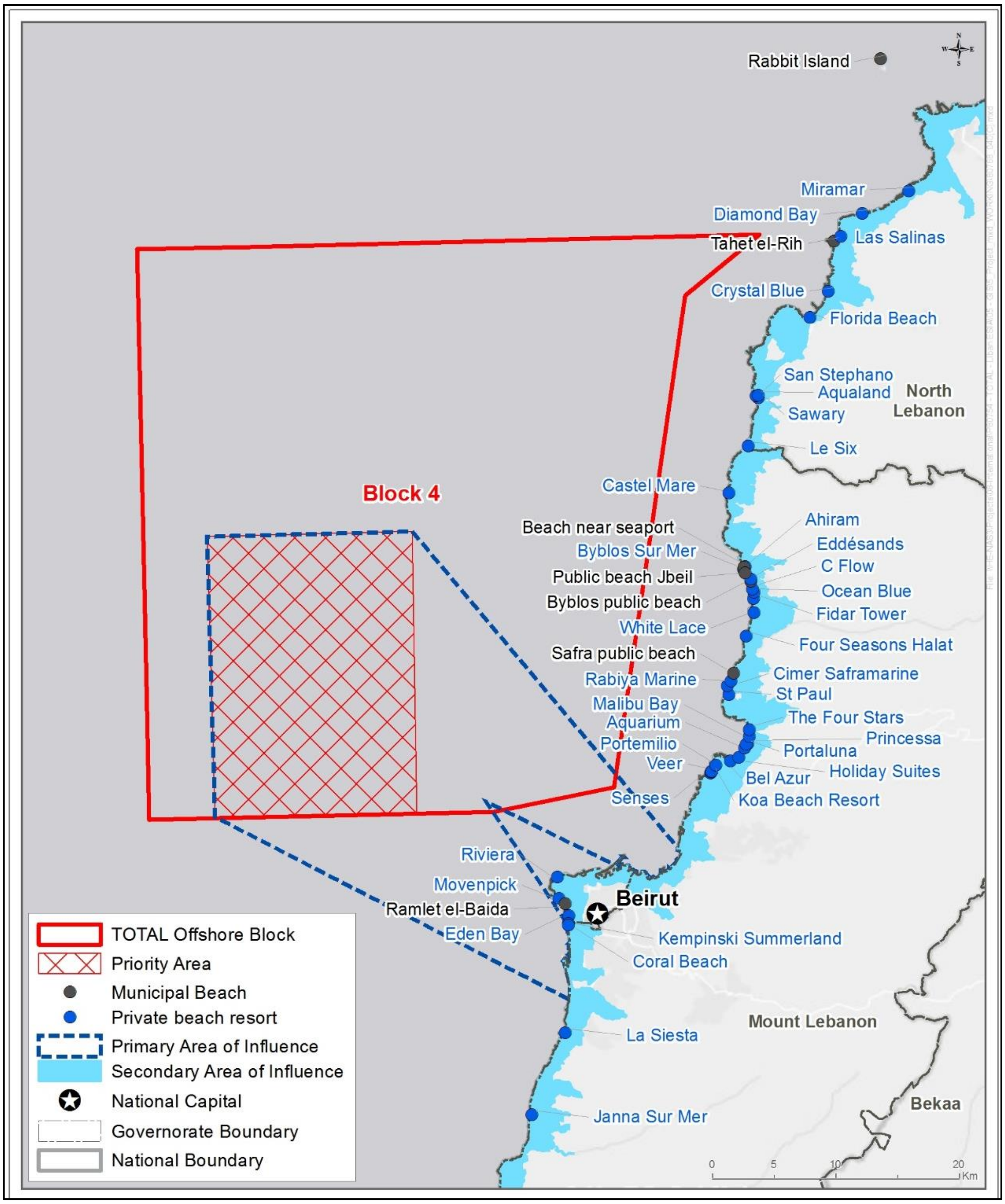

Figure 5.88: Beach resorts in the sample communities for Block 4

Source: Adapted from Rahhal (2018)

The Palm Islands Nature Reserve is located northwest of Tripoli. The islands of Sanani, Ramkine and Palm, together with their surrounding sea, form the Nature Reserve, which has several designations: it is a Mediterranean Specially Protected Area under the Barcelona Convention, an Important Bird Area by Birdlife Convention and a Wetland of Special International Importance. It also harbours some endangered reptile species, including the green turtle and loggerhead turtle. Parts of the reserve are also used during the summer months for swimming and snorkelling.

The most prominent cultural tourism sites in the sample communities include:

- Tripoli's historical port quarter, Al Mina, which boasts well-preserved sites and monuments dating back to the beginning of the Crusades and the Islamic Empire. The 12^{th}-century citadel of Raymond de Saint Gilles includes a museum and excellent views from the ramparts.
- The city of Byblos, one of the five United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Sites (WHS) in Lebanon, which hosts an expansive archaeological site, including Persian fortress from the 5th century BC, a Crusader castle, medieval city walls and an Obelisk temple that dates back to the ancient Egyptians.

Sea angling is a popular hobby which is undertaken throughout the coastal zone, including along Beirut corniche. Fish caught are consumed by the households; excess is frozen or shared. Anglers who use boats are reportedly prepared to travel distances up to 16 nm to reach locations but most fished along the shoreline.

Key trends and sensitivities

- Nature-based and adventure tourism, cultural tourism and religious tourism are the main kinds of tourism in Lebanon. Nature-based and adventure tourism includes coastal tourism and there are in excess of 40 beach resorts located along the coastline in the AOI.
- Tourism has suffered as a result of regional political instability following the onset of the Syrian conflict and has struggled to return to pre-2010 levels. The Syrian conflict has brought a dramatic decline in Arab visitors (declining from 41% in 2010 to 29% in 2018).
- Beirut hosts the majority of tourists in Lebanon; the capital accounted for 80% of all tourist expenditures in 2017.
- Although coastal tourism is seasonal, with the summer months being the busiest, many people's livelihoods depend on the sector.
- Sea angling is a popular recreational activity, particularly in the summer months.

The tourism sector is a key contributor to the national and local economy and includes people and businesses that have few or no other alternatives for work. Given that the project will have a relatively short duration, the sensitivity of tourism is ranked as medium (3).

5.5.3.6 Infrastructure

The direct footprint of the project is relatively small in terms of use of existing infrastructure (Port of Beirut (utilities within the port), airport, shipping lanes, some existing road transport links around the port and some capacity within a waste facility), there is also a risk of offshore infrastructure (seabed cables and pipelines) being accidentally impacted. On this basis, the AOI is determined to be the direct footprint of the well site (including any anchoring), the route between the port and well site, and the logistics base. To give context to the infrastructure in the AOI, the study area has been broadened to include the whole country of Lebanon.

National level

Although Lebanon has a relatively extensive infrastructure network comprising roads, ports, electricity and telecommunications services, a growing population and the influx of displaced persons have placed pressure on already stressed and ageing infrastructure.

A World Bank report (2016) identified several infrastructure gaps which have negatively affected the economic development of the country and its population's well-being.

Despite improvements, the road system is in poor condition and congestion, especially in Beirut, remains a problem. The road infrastructure in rural regions is basic. The country's rail network is currently unusable due to damages sustained during the civil war. The main airport in Lebanon is the Beirut Rafic Hariri International Airport.

There are four main ports in Lebanon, Beirut, Tripoli, Sidon and Tyre, which are managed by public entities (BankMed, 2015). Most maritime traffic is handled by the ports of Beirut and Tripoli, with the former port being the major handler of imported and exported goods (Dar, 2018). Apart from being a national import/export gateway, the Port of Beirut serves traffic to Iraq, Turkey, Syria, Egypt and other eastern Mediterranean countries (European Commission, 2009). These ports are further discussed at governorate and local level.

Lebanon has three submarine cables: The Breytar cable, the CADMOS cable and the India-Middle East-Western Europe (IMEWE) cable. The Kirkuk submarine pipeline, which is used for pumping crude oil between Iraq and Lebanon, lands in Tripoli. The pipeline ceased operation in 1982 following the outbreak of the Iran-Iraq war. Discussions are currently underway to bring it back into service.

Electricity, which is generated primarily from thermal power, is provided by the state-owned electricity company, EdL. This, however, is seasonal and relies on the availability of water resources (Dar, 2018).

At the time of writing, water supply is being rationed due to water resource shortages, power failures and excessive power bills associated with the operation of pump stations. Moreover, surface and groundwater resources are heavily polluted due to current wastewater discharge practices (World Bank, 2016).

Lebanon has been experiencing a waste management crisis for a number of years due to inadequate management and insufficient landfills. Table 5.33 summarises the municipal solid waste (MSW) management facilities in Lebanon.

Table 5.33: MSW management facilities in Lebanon

Region	Existing facilities	Potential/planned facilities
Beirut and Mount Lebanon	Amroussieh sorting facility Karantina sorting facility Costa Brava (Choueifat) sanitary landfill Bourj Hammoud sanitary landfill Hbaline sorting facility Chouf Swayjani sorting and composting facility	Costa Brava (Choueifat) sanitary landfill extension Costa Brava composting Plant Upgrade of Bourj Hammoud sewage treatment Incineration plant by Beirut Municipality and the CDR Hbaline sorting facility extension with a capacity of 150 tons per day (t/d) Hbaline landfill rehabilitation

Region	Existing facilities	Potential/planned facilities
North Lebanon	Tripoli sorting and composting facility Tripoli controlled dumpsite Minieh-Dannieh sorting and composting facility Mechmech sorting and composting facility	Closure of Tripoli controlled dumpsite/construction of alternative sanitary landfill Srar (Akkar) sorting and compositing facility and sanitary landfill Zgharta sorting and composting facility with a capacity of 120 t/d Al Dannieh sorting and composting facility Koura sorting and composting facility with a capacity of 80 t/d Batroun sorting and composting facility Bcharreh sorting and composting facility

Source: MoE et al. (2017). Note: Some of these facilities are not operating at full capacity, operated for a limited period or were never even operational.

As shown in Table 5.33, the management of MSW in Lebanon involves many sorting and composting facilities and a small number of landfill sites (namely Costa Brava, Bourj Mammoud and Zahle). Approximately 35% of the country's waste is disposed of in these three landfill sites, whilst approximately 15% of waste is treated in the sorting and composting facilities. The country's remaining waste – approximately 50% - is directly disposed of in open and uncontrolled dumpsites (MoEW, 2019).

At the beginning of 2018, the Lebanese Government approved the Integrated Solid Waste Management (ISWM) Policy.

Ports

The Port of Beirut is situated within the capital city Beirut and is considered the largest port of the eastern Mediterranean and an important international trading station with the surrounding Arab countries. It constitutes the main contributor to sea transport, accounting for 91% of total seaborne imports in 2014 (BankMed, 2015). In addition, the port exported 87% of Lebanon's exports in the same year. The Port of Beirut received over nearly 3000 ships in 2015 and handled over 8 million MT/year of general cargo. In the month of July 2019 alone, a total of 78 container ships and 58 general cargo vessels arrived at the port (Port of Beirut, 2019). The container terminal operations of the Port of Beirut are subcontracted to the private Beirut Container Terminal Consortium (BCTC), operating the terminal since 2005 (DLCA, 2017).

Governorate and local level

An overview of the infrastructure in the coastal governorates is provided in Figure 5.89.

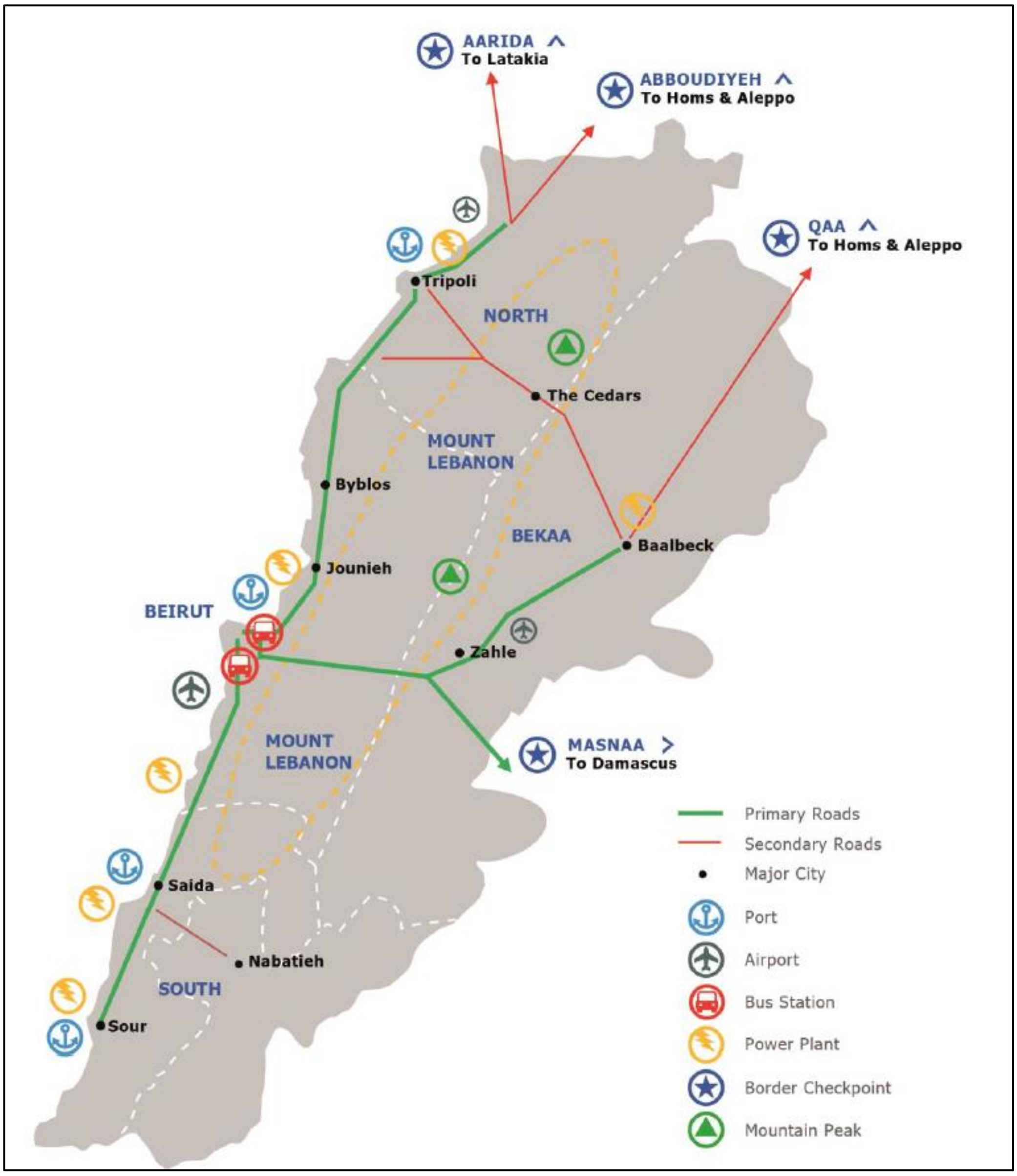

Figure 5.89: Infrastructure map for the coastal governorates

Source: IDAL (2019b)

The port is managed by Beirut Port Authority and shipping movements are overseen by the MoPWT, Directorate General of Land and Maritime Transport. The port covers an area of approximately 1.2 million m² and has four basins, 16 quays and a new container terminal capable of holding approximately one million twenty-foot equivalent units (TEUs) each year. Additional shipping activities in the coastal zone resulting from the Project will add to the already busy shipping lanes and port facility (see Figure 5.33 for shipping lanes).

The Port of Tripoli is considered the second most important port in Lebanon with a total area of approximately 3 million m^2, including a land area of 320,000 m^2 and a dumping area of 420,000 m^2. At the time of writing, the Port of Tripoli is upgrading its container terminal facilities. A concession to invest in and operate the terminal has been awarded to Gulftainer (IDAL, 2019c). Most of the terminal upgrades have either already been completed or are nearing completion (Dar, 2018).

Road network

The north of Lebanon is served by a two-way, 83-km coastal route that passes through major cities such as Jounieh and Byblos leading to Tripoli. At the time of writing, the main coastal highway connecting Tripoli and Akkar is still under construction (Amine, 2018).

Secondary roads in the sample communities are narrow but sealed and generally in good condition. Only in the sample community of Kfar Abida were road conditions described as extremely poor. The transport networks in Al-Mina (North Lebanon) and Bebnine (Akkar) were reportedly underdeveloped and insufficient beyond the main coastal towns.

Airports

Rene Mouawad Air Base (Kleyate Airport) is located north of Bebnine in the governorate of Akkar. The airport is currently non-operational. The Hamat Air Base is located in North Lebanon. The airport has never been used as a civilian airport and is not currently used as an airbase or airport.

Submarine cables

The Breytar telecommunications cable runs the length of the 134-km coastline, stretching from Tartous in Syria, with landing points at Tripoli and Beirut. It is an important communication facility for the country. The IMEWE cable lands in Tripoli.

Fibre-optic cable is currently being installed in the sample communities as part of a four-year, 300 million USD programme, the Nationwide Fiber Optics Project. The project will upgrade the country's existing and outdated copper wire infrastructure with fibre-optic cables, connecting schools, businesses and residential areas to the country's fibre optic backbone. The project is being run by Oregro, the state-run operator of Lebanon's fixed telecom network (Lebanon Opportunities, 2018).

Fibre-optic cable will be installed in stages, with the suburbs of Beirut, Dbayeh and Kesrouan. At the time of writing, fibre-optic cable is being installed in Chekka and Byblos. This will not interfere with Project activities.

Access to clean water

Access to the public piped water network varies. 96% of the population in Beirut is connected to the public water supply, whereas less than 55% of the population in North Lebanon is connected to the public water supply. However, mayors engaged with in the sample communities in the north considered the quality of the water they had access to as 'good', with the exception of Bebnine and Byblos where allegedly excessive use of chemicals and pesticides in cultivated areas has led to poor water quality (Fransabank, 2018).

Table 5.34 shows the completed, ongoing and planned wastewater projects in the sample communities in the coastal zone. The project will not interfere with any of these wastewater projects.

Table 5.34: Wastewater sector projects in the sample communities

Community	Description	Status
Bebnine (Akkar)	Construction of new sewerage networks and a treatment plant with sea outfall	Estimated completion date: November 2020
Tripoli, North Lebanon	Wastewater treatment plant to serve Tripoli coastal area, Al Qalamun, some sections of Koura and Zgharta district, coastal areas of Beddaoui, Deir Aamer and Minnieh Northern wastewater coastal collector (includes lifting stations, main secondary and subsidiary sewer lines connected to the main collector, serving more than 100,000 residents) Southern wastewater coastal collector extending over the coast of Tripoli, serving regions of Koura and Tripoli	Completed
Chekka-Anfeh	Wastewater treatment plant	Completed in 2005
	Project for the construction of wastewater networks and pumping/lifting stations in the villages and towns of coastal Chekka-Anfeh	Ongoing
Batroun	Wastewater treatment plant.	Completed in 2005
	Installation of wastewater networks and pumping/lifting stations in villages and towns in Batroun region	Ongoing
Byblos	Wastewater treatment plant	Completed in 2011
Jounieh	Rehabilitation of wastewater pumping station and the construction of sewer networks and channels	Completed in 2015
Northern Beirut (Daoura)	Beirut coastal wastewater collection project. Northern section includes 17 km coastline extending from Dbayeh to Dora and from Ras Beirut to Dora, serving 1.5 million residents	Completed in 2000
	Wastewater collection and treatment project in northern coastal area of Beirut serving 1.3 million residents, including villages in the district of Metn	Ongoing (90% complete)
	Construction of additional sewerage networks and preliminary treatment plant in Beirut River area	Estimated completion date: December 2020
Jiyeh	Wastewater treatment plant in Ras Nabi Younes	Completed in 2006
	Construction of wastewater networks and pumping/lifting stations in the villages and towns of coastal Chouf	Completed in 2016

Source: CDR, 2017. Note: The table only includes wastewater sector projects for which data was available.

Waste management

At the time of writing, Lebanon produces about 6,500 tonnes of municipal solid waste (MSW) per day, of which approximately 50% is disposed of in uncontrolled dumpsites;

approximately 35% is disposed of in sanitary landfills, and approximately 15% is sorted into recyclable or reusable materials, or converted into organic soil enhancers (MoEW, 2018). Lebanon produces about 50,000 tonnes of hazardous solid waste per year (MoEW, 2018). Environmentally sound treatment of hazardous solid wastes is non-existent as most are disposed in a haphazard manner (MoEW, 2018).

Dumping and burning of waste in public areas is prevalent in the coastal zone and was observed in most of the sample communities, but particularly in Al-Mina, Anfeh and Bebnine. However, the Mayors of Batroun and Fidar stated that waste management facilities in their municipalities were excellent, and no problems were experienced.

Key trends and sensitivities

- Despite improvements, the road system is in poor condition and congestion, especially in Beirut, remains a problem. High vehicle ownership and low car occupancy rate create heavy congestion during peak hours, especially surrounding the entries to and exits from Beirut. Road accidents are common.
- Electricity supply struggles to meet demand. Lebanon has been suffering from power shortages for the past 30 years and this has constrained the business and investment environment.
- Surface and groundwater resources are heavily polluted due to current wastewater discharge practices (World Bank, 2016).
- In recent years, Lebanon has been experiencing a waste management crisis which has resulted in ineffective waste disposal with serious consequences for public health, the economy and the environment (Abbas et al., 2017). Lebanon generates approximately 50,000 t of potentially hazardous waste per year. Some of this is disposed of haphazardly (MoEW, 2018).
- The Breytar cable is an important communication facility in Lebanon and has landing points at Tripoli and Beirut. At the time of writing, fibre-optic cable is being installed in Chekka and Byblos.

The direct project footprint is relatively small in terms of use of existing infrastructure (limited onshore traffic movements and vessel movements in the port area that will not add markedly to existing port operational levels). While it is acknowledged that waste management needs attention in Lebanon, wastes arising from the exploration drilling programme will be managed under TEP Liban's Waste Management Plan. Waste streams with no in-country treatment facilities (e.g. NADF cuttings) will be transferred to Cyprus for treatment and disposal, therefore the sensitivity of infrastructure is considered low (2).

5.5.3.7 Shipping

The AOI for shipping is the transportation corridor from the logistics base to the wells. Routine events (e.g., vessels transiting from the port to the well site) are only likely to have an effect in the near vicinity of the Port of Beirut. To provide context, the study area has been broadened to include the country as a whole.

As a coastal country to the east of the Mediterranean, Lebanon has long benefited from its strategic location, (BankMed, 2015). Many foreign registered ships enter Lebanese waters and maritime transport is concentrated near Beirut, which has significant commercial shipping throughput and apart from being a national import/export gateway, it serves transit traffic to Iraq as well as transhipment traffic to/from Turkey, Syria, Egypt and other eastern Mediterranean countries (European Commission, 2009).

As outlined in Section 5.5.3.6, the Port of Beirut is an important international trading station with surrounding Arab countries and is among the top ten seaports in the Mediterranean Sea. Over 3000 ships entered the Port of Beirut in 2015, delivering more than 8 million MT/year of general cargo. In July 2019 alone, 78 container ships and 58 general cargo vessels arrived at the port (Port of Beirut, 2019). In 2018, more than 665 ships entered the Port of Tripoli (IDAL, 2019c).

Shipping routes in proximity to the Block 4 AOI are shown in Figure 5.33.

Trends and sensitivities

- The shipping that comes through the Port of Beirut is of critical importance to the Lebanese economy.
- The project supply vessels are expected to have up to 10 return trips per week from Beirut Port to the MODU (Chapter 4, project description).
- While project activities will not add markedly to existing port operational levels, the port of Beirut is considered critical infrastructure for the country and, as such, further analysis of potential impacts has been undertaken in this EIA.

The sensitivity of shipping is considered medium (3).

5.5.3.8 Public health

The AOI for public health is the area near the Port of Beirut, as any impacts are related to air and noise emissions. Routine activities are only likely to affect the immediate vicinity. To provide context, the study area has been broadened to include the country as a whole.

National level

The right to health and an adequate standard of living (including the right to the necessary social services, such as health facilities) are rights enshrined in the UDHR.

Lebanon's main health indicators, which are presented in Table 5.35, are relatively good.

Table 5.35: Key health indicators for Lebanon

Indicator	Result
Life expectancy at birth	74.9 years
Infant mortality rate (IMR)	Total: 7.1 deaths/1000 live births Male: 7.3 deaths/1000 live births Female: 6.8 deaths/1000 live births
Under-5 mortality rate	8.3 per 1000 live births
Maternal mortality rate	15 deaths/100,000 live births
Under-1 immunisation coverage (including pneumococcal and rota virus)	OPV3: 90% PENTA3: 91% MCV1: 91% Information on pneumococcal vaccines (PCV13, PPSV23) and rota virus (RV5,

Indicator	Result
	RV1) are not available because the MoPH do not provide such vaccines.
Total health expenditure	6.4% of GDP
Public health care expenditure (as a percentage of total health expenditure)	N/A
Total public sector expenditure on public health care expenditure	Less than 10%

Source: WHO, 2017

Lebanon, like many countries in the Middle East, is undergoing an epidemiological transition marked by an increasingly ageing population suffering from chronic and non-communicable diseases (NCDs). According to the Institute for Health Metrics and Evaluation (IHME), the main health problems and causes of premature death amongst Lebanese citizens are as follows:

- ischemic heart disease
- neonatal disorders
- stroke
- diabetes
- lung cancer
- road injuries
- breast cancer
- conflict and terror
- interpersonal violence.

Although the number of water-borne diseases (e.g., dysentery, typhoid and viral hepatitis) are decreasing, water pollution is still a public health concern.

Mental health is an increasing concern in Lebanon with approximately 25% of the population experiencing at least one mental illness at some stage in their lives (MoPH, 2015). Mental illnesses amongst displaced Syrian persons are more prevalent than among Lebanese nationals and the numbers are reportedly increasing, reaching more than 1 million in 2016 (Karam et al., 2016).

Public health in Lebanon is managed by the General Directorate of Public Health in the MoPH.

The Syrian crisis and resulting influx of displaced Syrian persons has increased the demand for health care services and significantly increased government costs in order to meet the increased demand. The conflict has also led to

- the overcrowding of hospitals, which is in return compromising access to health care for host communities and exacerbating medicine shortages
- an over-stretched public health care system and rising public health care expenditure
- shortages of health care workers (e.g., specialists and nurses)
- an increase in communicable diseases and the appearance of new diseases (e.g., leishmaniasis).

Governorate and local level

A wide range and large number of health care facilities were identified in the sample communities. These include hospitals, clinics and dispensaries (pharmacies), affiliated with both the public and private sector.

A larger greater number of hospitals, clinics and dispensaries were identified in the larger urbanised settlements (e.g., Beirut, Al-Mina and Saida) compared to the smaller and less densely populated settlements (e.g., Anfeh and Okaiba). Communities in rural areas need to travel further for medical treatment.

Trends and sensitivities

- Lebanon, like many countries in the Middle East, is undergoing an epidemiological transition marked by an increasingly ageing population suffering from chronic and non-communicable diseases (NCDs).
- The increase in displaced persons since the onset of the Syrian crisis in 2011 has prompted an increase in a number of health issues in certain areas, including communicable diseases, sanitation-related diseases, increased risk of epidemics (e.g., measles) and traffic accidents. Water pollution is still a public health concern.
- Mental health is an increasing concern in the country.
- Only 50.1% of the Lebanese population (predominantly the middle and upper classes) are reported to have health insurance.

Baseline information on other impacts that could affect health are discussed separately where relevant (such as air pollution, Section 5.3.1.1, and infrastructure, Section 5.5.3.6) but combined in the impact assessment chapter. Overall sensitivity of public health and safety to the project is considered low (2) owing to the small-scale nature of the activities (especially onshore) and their short duration.

5.5.3.9 Social conditions; public safety and security

The AOI for social conditions: public safety and security consists of the areas in the immediate vicinity of Beirut Port and Airport. Routine events (such as vessel movements or helicopter transfers from Beirut Airport) and unplanned events including road traffic accidents are only likely to have an effect on these areas. To provide context, the study area has been broadened to include the country as a whole.

National level

Safety and security

Many areas in Lebanon are relatively safe but some security issues remain, particularly ad-hoc terrorism threats, armed clashes, kidnapping and outbreaks of violence. Security hot spots exist near Lebanon’s borders with Syria and Occupied Palestine, parts of metropolitan Beirut, Tripoli, northern and southern Lebanon and displaced persons/refugee settlements (FCO, 2019).

According to the Government National Statistics Office, some crimes have decreased whilst others have increased. Some crime statistics are presented in Table 5.36.

Table 5.36: Crime statistics for Lebanon

Crime	Year	
	2008	2015
Homicide	183	235
Motor vehicle theft (per 100,000)	7528	8896
Abduction	899	991
Assault	9100	7769
Robbery	5	2330
Rape	101	192

Source: WDA (2019)

Road accidents are prevalent in Lebanon and the poor quality of road infrastructure, the high volume of vehicles and lack of policing contribute towards a lack of road safety. According to traffic police reports, the number of fatalities in 2012 reached 595 and, according to the Red Cross, 6700 persons were injured. These figures are considered to be under-reported with the WHO (2012) estimating a higher number of fatalities (at 950 rather than 595).

Gender and vulnerable groups

According to Lebanese law and the Lebanese Constitution, men and women enjoy equal rights in social and economic life (UNSF, 2017). Despite this, Lebanon had a Global Gender Gap score of 0.595 in 2018, ranking 140 out of 149 countries on the Global Gender Gap Index (World Economic Forum, 2018)[12]. Lack of female political participation is a long-standing issue (The Borgen Project, 2017). This can be attributed to complexities associated with legal, social, financial and political barriers, which reflect the patriarchal nature of Lebanese society and discriminate against women entering the public and political sphere (AUB, 2019). Despite efforts to raise awareness, the incidence of GBV and domestic violence (DV) in Lebanon remains high (Intalert, 2014)[13]. DV affects an estimated 48% of women nationally (Civil Society Knowledge Centre 2017).

Vulnerable groups identified by United Nations (UN) agencies in Lebanon are the elderly, single-headed households and socially marginalised groups, such as the chronically ill (especially those living with Human Immunodeficiency Virus (HIV) and Acquired Immunodeficiency Syndrome (AIDS)), children (particularly in displaced persons/refugee settlements, at school, in low-income areas and in detention facilities), separated women, widowed women, unaccompanied minors, orphans, pregnant women and girls married before the age of 18, refugees and displaced persons (a large proportion of whom are women and youths). In addition, in 2018, the United Nations High Commissioner for Refugees (UNHCR) identified Lebanon as a human trafficking route via boats from coastal locations on the Lebanese shore to Cyprus (Europe) (UNHCR, 2018). The large

12 The Global Gender Gap Index is an index designed to measure gender inequality. The assessment of gender inequality across countries, as per the index, is undertaken by the World Economic Forum. The findings of the assessment are published in an annual Global Gender Gap Report.

13 Men can also be subject to GBV and DV. However, pressures to conform to social ideals of masculinity in Lebanon can deter men from reporting these incidences.

number of displaced Syrian persons currently residing in Lebanon are deemed particularly vulnerable to trafficking. In addition to those mentioned above, fishermen and those involved in the fisheries supply chain and coastal natural resource users are also deemed vulnerable.

Governorate and local level

Crime levels were reported to be very low or virtually non-existent in the sample communities, and where they do occur, they are typically reported to the relevant municipality. The municipal police were said to be primarily responsible for ensuring the safety of citizens.

Whilst there is a good network of road infrastructure in the coastal Governorates, road safety remains hazardous. Table 5.37 sets out the number of road accidents per governorate. The table shows that Mount Lebanon has the highest number of road accidents followed by North Lebanon. This is possibly due to the higher population in these two governorates.

Table 5.37: Road accidents in governorates, 2010

Governorate	Road accidents	Injured	Killed
Beirut	616	743	22
Mount Lebanon	1,958	2,827	238
North Lebanon	668	920	102

Source: WHO (2012)

Across the sample communities, the following groups were identified as vulnerable: unemployed persons, fishermen, low-income families, elderly and youth (see Table 5.38).

Table 5.38: Main vulnerable groups and reasons behind vulnerability

Vulnerable group	Reasons for vulnerability
Unemployed persons	Inability to satisfy basic needs (e.g. health care)
Fishermen	Have to borrow money to undertake livelihood (thus trapped in debt cycle) Incomes insufficient to sustain adequate standard of living Inconsistent income generation (affected by seasonality) Lack of social security Lack of legal support and protections Lack of extension services (e.g. facilitated loans, basic fishing gear and equipment) Threats to the offshore environment (e.g. pollution), leading to a decline in fish stocks Lack of alternative income-generating opportunities
Low-income families	Inability to satisfy basic needs Lack of employment opportunities
Farmers	Decline in agricultural land due to urbanisation

Vulnerable group	Reasons for vulnerability
Elderly	Lack of social security
Women	Lack of enjoyment of basic human rights Exclusion from politics, decision-making processes
Youth	Limited participation in politics Lack of employment opportunities

Source: KII with mayors of municipalities and human rights agencies, FGD with fishermen and farmers

The vulnerability of fishermen was raised in all sample communities in the coastal zone. The reasons for their vulnerability are set out in Table 5.38 above but the main factor was lack of social security.

People with disabilities (PWDs) and widows were also identified as vulnerable groups but to a much lesser extent. Refugees and displaced people were barely recognised as being vulnerable across the sample communities; instead, this category of the population were blamed for deficiencies in over-stretched services in the country.

Key trends and sensitivities

- Many areas of Lebanon are considered safe and the incidence of many types of crimes have decreased in recent years. However, security threats, including threats of terrorism, armed clashes, kidnapping and outbreaks of violence still remain.
- Road accidents are prevalent in Lebanon and the poor quality of road infrastructure, the high volume of vehicles and lack of policing contribute towards a lack of road safety.
- Gaps in gender equality remain, particularly in the areas of political empowerment and labour market participation.
- Despite efforts to raise awareness, the incidence of GBV and DV remains high.
- Vulnerable people include Lebanese youth, the poor, persons with disabilities and women (UNSF, 2017).

The project is not expected to require a large number of onshore workers, and most are expected to be Lebanese. There will not be an influx of foreign workers onshore. Most vulnerable groups will experience no impact or negligible impact from the project, although fishermen may experience indirect negative impacts. The sensitivity of social conditions to the project is therefore rated as low (2).

5.5.3.10 Archaeology and cultural resources

The AOI for archaeology and cultural resources is the coastal and offshore areas in the immediate vicinity of the well site and in the vicinity of Beirut Port. To provide context, the study area has been broadened to include the country as a whole.

National level

Lebanon boasts a rich diversity of cultural heritage sites, ranging from temple ruins to castles, statues, monuments and shipwrecks. Furthermore, five Lebanese cities have been classified as UNESCO WHS, one of which (Byblos) is located in the AOI.

Lebanon has a rich intangible culture stemming from its history and diverse religions which are reflected in the festivals, music, literature and cuisine (Stokes, 2009).

Governorate and local level

A number of cultural heritage sites with significant historical importance were identified in the coastal zone, including on the sea edge. A study as part of the Environmental Resources Monitoring in Lebanon (ERML) project identified 14 coastal cultural heritage sites (see Table 5.39 and Figure 5.90). These include: the crusader castle of Saint Gilles, the ancient southern port quay and necropolis in Tripoli, Ras Enfeh, the Salinas wall promenade and Our Lady of Natour monastery in Anfeh, the historical centre and fishing harbour, and the great Phoenician wall and roman amphitheatre in Batroun (see Table 5.39). The site at El Keib River estuary, the Nahr Ibrahim River estuary, the Bay of Jounieh and the Khaldeh archaeology site are in closest proximity to the proposed well location in Block 4 (Table 5.39).

Table 5.39: Natural and cultural heritage sites, ranked by priority

Ranking	Site Name	Priority	Distance From Block 4	Distance From Priority Area	Distance From Proposed Well Location
1	Ras Enfeh	High	6.5 km	41.9 km	51.4 km
3	Historical centre and fishing harbour of Batroun	High	7.0 km	30.3 km	38.4 km
5	El Keib River historical site and estuary	High	6.8 km	22.7 km	26.4 km
6	Promontory cape and cliffs of Ras Shaqaa and Saydet El Nouriyeh Monastery	High	6.2 km	39.2 km	45.0 km
11	Salinas wall promenade and Our Lady of Natour Monastery	Medium	6.8 km	42.9 km	52.7 km
14	Bay of Jounieh	Medium	8.3 km	24.9 km	27.5 km

Source: IoE UoB, 2012

Offshore antiquities, including underwater cities, ancient breakwaters and Phoenician walls are present in Batroun and Anfeh (North Lebanon) and in Aamchit (Mount Lebanon), which are near the Block 4 boundary (Figure 5.90). The antiquities at Aamchit are the closest offshore site to the Block 4 priority area (25.5 km) and proposed well location (29.5 km), although the site at Anfeh is closest to the Block 4 boundary (4.9 km; Figure 5.90). Efforts are ongoing to uncover underwater coastal antiquities in Bebnine and Chekka.

Additionally, the coastal waters of Lebanon have some shipwrecks sites considered of great value (MoEW, 2019). It is likely that future studies of shipwrecks and nearshore underwater sites in the coastal regions will unveil more significant offshore archaeological artefacts.

Several cultural festivals take place in the sample communities, including

- Batroun International Festival, 1–25 July
- Jounieh International Festival, 1–18 July
- Byblos International Festival, 1–24 August.

Key trends and sensitivities

- Lebanon has a rich diversity of cultural heritage.
- At the time of writing, the DGA is conducting a survey to identify and locate features of archaeological interest along the coastline to enable their protection.
- Offshore antiquities, including underwater cities, ancient breakwaters and Phoenician walls are also present in the sample communities and can be found in Batroun and Anfeh (North Lebanon), Aamchit (Mount Lebanon). Efforts are currently ongoing to uncover underwater coastal antiquities in Bebnine and Chekka.
- No objects of archaeological interest were found during EBS offshore surveys in March 2019.

No archaeological or cultural site will be directly affected by routine project activities, but accidental impacts are possible and the sites themselves are of national or international importance. The sensitivity of the cultural resources and archaeology to the project is assessed as medium (3).

5.6 Sensitivity assessment

The sensitivities of all the receptors in the SEA report (MoEW, 2019) and identified in this EIA are listed in Table 5.40 based on the criteria in Chapter 1. Where appropriate the location of the receiver is split between coastal and offshore, however where the sensitivity score for both is considered the same, a single sensitivity ranking is provided. These sensitivity rankings are used in the impact assessment chapter to help define the severity of the impacts.

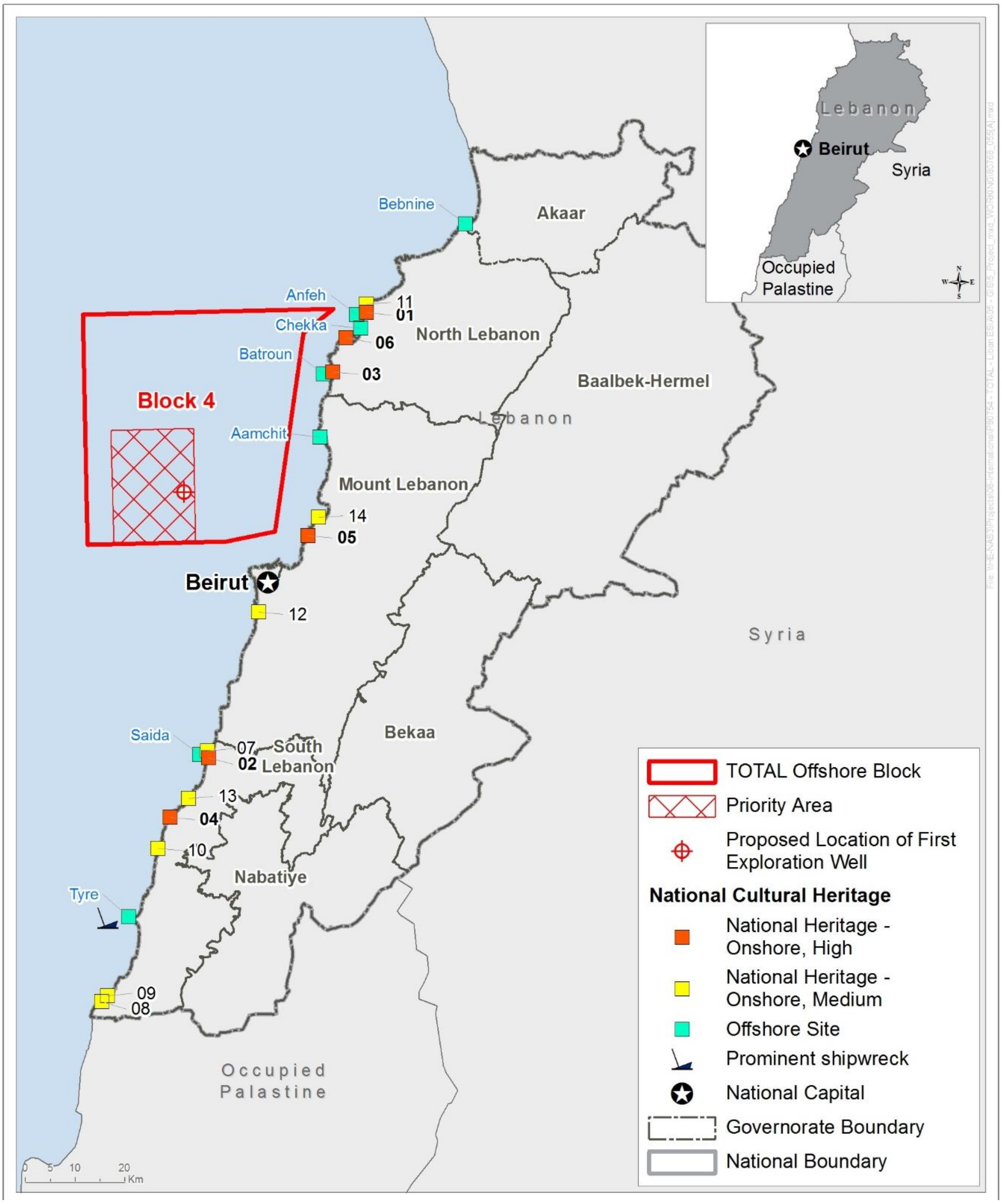

Figure 5.90: Priority and ranking of culturally sensitive sites in Lebanon

Source: Adapted from information in IoE UoB, 2012

Table 5.40: Sensitivity of receptors

Receptor	Coastal	Offshore	Offshore and coastal (or onshore)
Air quality			2
Climate change			3
Water quality	2	3	2-3
Sediment quality / composition			2
Benthos*			2
Sensitive marine habitats (offshore)** [14]			4
Coastal habitats***			4
Plankton*			2
Fish			3
Cetaceans****			4
Seals****			4
Turtles****			4
Seabirds			3
Protected/threatened species*****			4
Terrestrial ecology***			1
Education and training			2
General economy/industry			2
Fisheries			2
Tourism			3
Infrastructure			2
Shipping			3
Public health			2
Social conditions			2
Archaeological and cultural resources			3

* The SEA refers to ‘Phyto- and zoo benthos’**,** however within this EIA the receptors are split into ‘benthos’ or ‘plankton'.
** The SEA uses the terminology ‘Sensitive Marine Habitats’ however for this EIA the term used is ‘Sensitive Marine Habitats (Offshore)’.
*** The SEA uses the term ‘Terrestrial Ecology and Coastal Habitats’ however for this EIA the receptor is split into ‘Coastal Habitats’ and ‘Terrestrial Ecology.’
**** The SEA considers this one receptor however for this EIA this receptor group is split into three different receptor types.

***** Protected/threatened species are considered a receptor in their own right, due to their higher sensitivity to impacts than the majority of the faunal assemblage.

[14] Sensitive marine habitats (offshore) includes areas of high sensitivity seabed habitat identified in the Block 4 EBS and offshore sites identified for conservation by OCEANA.

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6 POTENTIAL IMPACTS OF THE PROJECT

6.1 Introduction

This chapter presents the potential impacts of the project on environmental, social and cultural heritage receptors from routine activities and potential non-routine/accidental events related to the Block 4 exploration drilling campaign.

Impact assessment with respect to drilling activities covers all phases of drilling, from mobilisation of the mobile offshore drilling unit (MODU) to the proposed well site; installation, drilling, logging, and plug and abandon; and MODU demobilisation at the end of the campaign. The impact evaluation of onshore support activities only covers the operational phase of the logistics base (the period when drilling is taking place offshore).

This chapter is structured as follows:

- outline of preliminary impacts identified at scoping stage, Section 6.2
- environmental impacts from routine operations, Section 6.3
- social and cultural heritage impacts from routine operations, Section 6.4
- potential accidental, cumulative and transboundary impacts, Section 6.5.

Sections 6.3 and 6.4 discuss the impacts by project activity.

The methodology for assessing environmental and social impacts is provided in Section 1.8.7 of this EIA.

This impact assessment refers to the B4-1 well specifically. However, it is also written to cover a secondary exploration well and a potential appraisal well in Block 4.

6.2 Impact identification matrix

Preliminary impacts were identified as part of the Block 4 scoping in line with the impact identification matrix in the ‘Update for Strategic Environmental Assessment (SEA) for Exploration and Production Activities Offshore Lebanon’ (MoEW, 2019). The SEA preliminary impacts were generated from a range of receptors and project activities that are typical for exploration drilling operations. Appendix 6.1 reviews the SEA preliminary impacts and presents reasons why certain impacts have been screened out of the impact assessment for the Block 4 exploration drilling programme.

Appendix 6.1 also provides an explanation of how the impact sources presented in this EIA correspond with the project activities that were included in the SEA preliminary impacts matrix.

Table 6.1 summarises impacts that have been screened into the impact assessment and are considered in this chapter. The matrix identifies which receptors have the potential to be impacted by the project activities. The chapter expands on this initial assessment and carries out significance scoring of potential and residual impacts.

Table 6.1: Block 4 exploration drilling impact identification matrix

Activity code	Activity	Air quality	Climate change	Sediment quality/ composition	Water quality	Benthos	Fish*	Plankton	Seabirds*	Cetaceans, turtles and seals	Sensitive marine habitats	Coastal habitats	Terrestrial ecology	Archaeological and cultural resources	Infrastructure	Social conditions (security/safety)	Education and training	General economy	Fisheries	Shipping	Tourism	Public health
Routine activities																						
MAE01 & MAS01	MODU mobilisation, installation, plug and abandonment and demobilisation	X	X	X	X	X	X	X		X	X			X					X	X		
MAE02 & MAS02	Cuttings discharge during drilling Option 1 – use of NADF in lower-hole sections Discharge of drill cuttings and WBDFs from riserless upper-hole sections (top-hole and next section) only (option selected for well B4-1 and option for possible future exploration / appraisal wells in Block 4)			X	X	X	X				X			X	X				X	X	X	
MAE03 & MAS02	Cuttings discharge during drilling Option 2 – use of a HPWBDF in lower-hole sections Discharge of drill cuttings and WBDFs from riserless upper-hole sections (top-hole and next section) and discharge of HPWBDF cuttings from lower-hole sections (option for possible future exploration / appraisal wells in Block 4)			X	X	X	X	X		X	X								X	X	X	
MAE04, MAS02 & MAS03	Ship to shore of NADF cuttings and fluids (only applicable to Option 1 above)	X	X												X				X	X	X	
MAE05 & MAS02	Cementing discharges during drilling			X		X																

Activity code	Activity	Air quality	Climate change	Sediment quality/ composition	Water quality	Benthos	Fish*	Plankton	Seabirds*	Cetaceans, turtles and seals	Sensitive marine habitats	Coastal habitats	Terrestrial ecology	Archaeological and cultural resources	Infrastructure	Social conditions (security/safety)	Education and training	General economy	Fisheries	Shipping	Tourism	Public health
MAE06 & MAS02	Pipe dope discharges during drilling				X		X	X											X			
MAE07 & MAS02	Blowout preventer testing discharges during drilling				X		X	X											X			
MAE08, MAS02 & MAS03	Discharge of sanitary waste from MODU and support/supply vessels				X		X	X											X			
MAE09, MAS02 & MAS03	Discharge of food waste from MODU and support/supply vessels No discharge permitted for B4-1 well as < 12 nm from land. Discharge permitted for possible future exploration / appraisal wells if > 12 nm from land				X		X	X											X			
MAE10, MAS02 & MAS03	Desalination unit discharges from MODU				X		X	X											X			
MAE11, MAS02 & MAS03	Discharge of drainage water (deck drainage, fire water, bilge water and slop water) from MODU and support/supply vessels				X		X	X											X			
MAE12, MAS02 & MAS03	Uplift and discharge of cooling water from MODU				X		X	X											X			
MAE13, MAS02 & MAS03	Discharge of ballast from MODU and support/supply vessels				X		X	X											X			

Activity code	Activity	Air quality	Climate change	Sediment quality/ composition	Water quality	Benthos	Fish*	Plankton	Seabirds*	Cetaceans, turtles and seals	Sensitive marine habitats	Coastal habitats	Terrestrial ecology	Archaeological and cultural resources	Infrastructure	Social conditions (security/safety)	Education and training	General economy	Fisheries	Shipping	Tourism	Public health
MAE14, MAS02 & MAS03	Generation of solid waste on MODU and support/supply vessels	None providing waste managed properly																				
MAE15	Operation of incinerator onboard MODU Not applicable to well B4-1 as no incinerator on MODU, may be applicable to possible future exploration / appraisal wells depending on MODU selection	X	X																			
MAE16	MODU and support/supply vessel power generation resulting in air emissions	X	X																			
MAE17	Well test of possible future appraisal well Not applicable to well B4-1	X	X																			
MAE18, MAS02 & MAS03	Underwater noise from vertical seismic profile (VSP) activities						X			X									X			
MAE19 & MAS02	Underwater noise from MODU and support/supply vessel operations						X			X									X			
MAS03	Support activities (movement of support vessels)														X				X	X	X	
MAE20 & MAS02	Light spill from MODU						X		X	X											X	
MAE21 & MAS03	Chemicals use and storage	None providing chemicals managed properly																				

Activity code	Activity	Air quality	Climate change	Sediment quality/ composition	Water quality	Benthos	Fish*	Plankton	Seabirds*	Cetaceans, turtles and seals	Sensitive marine habitats	Coastal habitats	Terrestrial ecology	Archaeological and cultural resources	Infrastructure	Social conditions (security/safety)	Education and training	General economy	Fisheries	Shipping	Tourism	Public health
MAE22	Logging using radioactive sealed sources (also applicable to onshore storage and transport of radioactive sealed sources)	None under normal operations																				
OAS01	Logistics base operation														X	X	X	X			X	X
OAE01 & OAS01	Logistics base operation - emissions to air	X	X																			X
OAE02	Logistics base operation - discharge of drainage water				X								X		X							
OAE03 & OAS01	Logistics base operation - noise generation												X								X	X
OAE04, OAS01 & OAS02	Logistics base operation – waste management	None providing waste managed properly													X	X						X
OAE05, OAS01 & OAS02	Logistics base operation – chemicals management	None providing chemicals managed properly																				
OAE06 & OAS03	Helicopter transfers to Beirut International Airport								X			X	X		X						X	X
Potential accidental event scenarios																						
AE1	Dropped object from MODU (lifting)			X		X																
AE2	Loss of chemical containment onboard MODU			X	X	X	X	X											X			
AE3	Radioactive source lost in hole			X																		
AE4	Riser rupture, release of drilling fluid to sea			X	X	X	X	X											X			

Activity code	Activity	Air quality	Climate change	Sediment quality/ composition	Water quality	Benthos	Fish*	Plankton	Seabirds*	Cetaceans, turtles and seals	Sensitive marine habitats	Coastal habitats	Terrestrial ecology	Archaeological and cultural resources	Infrastructure	Social conditions (security/safety)	Education and training	General economy	Fisheries	Shipping	Tourism	Public health
AE5	Shallow gas blowout, release of gas into water column	X		X	X	X	X												X	X		
AE6	Blowout – release of condensate and gas	X			X		X	X	X	X		X		X	X	X		X	X	X	X	X
AE7	Collision of third-party ship with MODU – release of third-party fuel inventory, possible damage to MODU and riser				X		X	X	X	X	X								X	X		
AE8	Helicopter crash on MODU deck – release of aviation fuel to sea				X			X														
AE9	Loss of containment during offshore materials transfer to MODU – release of drilling fluids or marine diesel to sea			X	X	X	X	X											X			
AE10	Loss of rig stability (rig capsize) due to severe metocean conditions with release of fuel inventory				X		X	X	X	X	X	X		X	X	X		X	X	X	X	X
AE11	Earthquake resulting in loss of well integrity and release of hydrocarbons to sea				X		X	X	X	X	X	X		X	X	X		X	X	X	X	X
AE12	Loss of containment during materials transfer to supply vessels at logistics base quay side – release of drilling fluids/diesel to sea				X																X	

Notes: Source of impact codes: MAE - marine activities environment; MAS – marine activities social; OAE – onshore activities environment; OAS – onshore activities social; AE – accidental events.

6.3 Environmental impact assessment – routine activities

This section evaluates environmental impacts that may arise from planned/routine activities related to the Block 4 exploration drilling campaign.

The activities outlined in the project description (Chapter 4), environmental sensitivities in the study area (Chapter 5), input from public participation (Chapter 3) and modelling studies (cuttings dispersion modelling and underwater noise modelling) have been used to provide input into the evaluation.

For each project aspect, potential impacts are presented followed by proposed mitigation measures. The residual impact, taking the mitigation into consideration, is then assessed. Within the subsections for each project aspect, single or multiple codes are provided, e.g., MAE01. These codes cross-reference to the environmental impact summary table at the end of this section (Table 6.9).

Impacts to social and cultural heritage receptors from routine project activities are presented in Section 6.4.

6.3.1 Marine activities

6.3.1.1 Drill rig mobilisation, installation, plug and abandonment (P&A) and demobilisation (MAE01)

TEP Liban proposes to use a dynamically positioned drillship to carry out the drilling of the first well in Block 4. For any further exploration or appraisal wells, a drillship or a semi-submersible drilling unit could be used to undertake the works.

Drillships move using their own power. If a semi-submersible rig is used, it may be towed into position using tugboats or move to the drilling position using its own propulsion system.

Impacts from routine operational discharges during MODU mobilisation and demobilisation are included in Sections 6.3.1.6 to 6.3.1.11; air emissions during mobilisation and demobilisation are included in Section 6.3.1.12; and underwater noise during mobilisation and demobilisation is included in Section 0.

Impacts of mobilisation, installation, P&A and demobilisation on sediments and benthic communities

Potential impacts

Where conventional moored semi-submersibles are used, seafloor sediments and benthic communities can be physically disturbed by anchors and cables. Where dynamically positioned drillships are used, there are no anchoring impacts. This is discussed in more detail in Chapter 7, Analysis of Project Alternatives.

Before the departure of the MODU at the end of each well, bottom sediments will be disturbed within the AOI during well abandonment operations due to the removal of the blowout preventer (BOP) and cement plugging operations. The area of disturbed seafloor will be small (i.e., several tens of square metres) from these activities.

Block 4 is within the East Levantine Canyons ecologically and biologically significant area (EBSA), a system composed of deep canyons, hydrothermal vents and submarine freshwater springs that is of particular biological importance. Potential pockmark areas, identified from geophysical data, were deliberately targeted for remotely operated vehicle (ROV) survey during the offshore environmental baseline survey (EBS) of Block 4 in March–April 2019. The footage indicated the presence of deep-water biodiversity hotspots where potential cold-gas-seep areas have created elevated hard relief above the surrounding seabed with higher numbers of epifaunal species. These features were observed on transects B4-VT07 and B4-VT13 during the EBS, see Figure 5.60 in Chapter 5. It should be noted that there were no observations of such within the AOI (1.5 km radius) around the B4-1 well site. However, it may be the case that a second exploration well or an appraisal well would be located closer to the recorded features. The offshore EBS indicated that much of the deep-water areas of Block 4 (and in the area of the B4-1 well site) is either open bathyal plain seabed or seafloor canyons comprising muddy sediments with a relatively impoverished benthic fauna dominated by polychaetes and, to a lesser degree, small bivalve mollusc, and amphipods. The benthic infaunal communities are considered typical of those throughout the deep water Eastern Mediterranean region.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1): the geographic extent is immediate, the impact duration is very short term and the activities associated with the mobilisation, installation, plug and abandonment and demobilisation of the MODU causes disturbance to individuals of a species that is similar in effect to the random changes in population due to normal environmental variation. The seabed and associated benthic community are considered to be of low sensitivity (2) in the AOI of the first exploration well. However, future wells may be located closer to sensitive seabed habitats (4).

<table>
<tr><th>Receptor sensitivity</th><th>Potential impact intensity</th><th>Potential impact significance</th><th>Cross-reference to Table 6.9</th></tr>
<tr><td>Sediment quality/ composition and benthos – low (2)</td><td rowspan="2">Very low (1)</td><td>Negligible (2)</td><td rowspan="2">MAE01</td></tr>
<tr><td>Sensitive seabed habitats – high (4)</td><td>Minor (4)</td></tr>
</table>

Mitigation

Anchoring impacts will not be an issue for well B4-1 as a drillship has been selected for the drilling programme and will use dynamic positioning.

If a semi-submersible is selected for future exploration / appraisal wells, impacts will be minimised by ROV survey of the seabed to select optimum anchor positions that avoid any sensitive seabed features.

A plugging and abandonment programme will be submitted to respective authorities as part of the advanced drilling plan before project start-up (for each well), and an ROV site clearance survey will be conducted after drilling operations to provide the status of the seafloor condition around the well site.

Residual impacts

The table below summarises residual impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1): the geographic extent and impact duration remains the same and the activities are considered to have very limited disturbance effects due to the implementation of the above mitigation measures. Residual impacts anticipated to be negligible to minor.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.9
Sediment quality/ composition and benthos – low (2)	Very low (1)	Negligible (2)	MAE01
Sensitive seabed habitats – high (4)		Minor (4)	

6.3.1.2 *Drill cuttings and fluid discharge (MAE02 and MAE03)*

Cuttings and drilling fluids modelling and risk assessment

In order to assess the impact of cuttings and drilling fluids discharge on the marine environment from the Block 4 wells, TEP Liban modelled drilling discharges using the SINTEF DREAM/ParTrack model (TEP Liban, 2019a). The DREAM (Dose Related Risk and Effect Assessment Model) is a three-dimensional particle model for assessing the consequences of regular planned releases to the marine environment. DREAM helps visualise and analyse releases occurring over extended time periods in the water column. The ParTrack model includes releases of drill fluids and cuttings. Additional environmental risk calculations for bottom sediments, particle stress in the water column and chemicals stress both in the water column and the sediments were also carried out using predicted environmental concentration (PEC) and predicted no effect concentration (PNEC) analysis. The PEC is calculated by the model based on the drilling fluids composition, product characteristics and environmental conditions. This PEC is then compared to the PNECs to characterise whether the anticipated concentration is expected to have a significant impact risk on the habitat. The PNECs used in the risk calculations were derived from toxic thresholds provided by the supplier of the drilling fluid components, following the methodology recommended by OSPAR (i.e., applying conservative safety factors up to 1000 times the toxic thresholds[1]). Owing to the safety factors used, this approach is very conservative.

For physical parameters, the PNECs used were the ones available in the model derived from field studies and benchmark studies available in the literature.

The risk in the model could be displayed as the result of the PEC/PNEC calculation or as a percentage (percentage of communities in the ecosystem potentially impacted). A significant risk corresponds to a calculated concentration in the environment (PEC) exceeding the predicted no effect concentration (PNEC = toxic threshold value/safety

[1] PNEC calculations have been derived from toxicity test thresholds using safety factors as recommended by OSPAR and REACH. This safety factor (1000) is very conservative to account for a series of uncertainties including species representativeness. The PNECs can therefore be applied to Mediterranean waters.

factor for chemical stressors) to a level likely to potentially impact 5% of species in a typical ecosystem. In other words, a significant risk would occur for a PEC/PNEC ratio >1 corresponding to a potential risk for 5% of the species in the ecosystem. The greater the PEC/PNEC ratio, the greater the percentage of species potentially impacted.

Risk stressors can be physical or chemical phenomenon; the following were considered in the cuttings modelling and assessment study:

- burial of organisms in the sediment:
  - PEC is the total thickness, in mm, of the added layer caused by the deposition on the seafloor.
  - PNEC is the threshold value of thickness accepted by benthos; PNEC thickness is 6.5 mm. This value is derived from the statistical description of the variation in sensitivity (species sensitivity distributions, SSD).
- change in the sediment structure - grain size:
  - PEC represents the change, in percentage, of the median grain size in the sediment, averaged over the upper 3 cm of the sediment layer.
  - PNEC is the maximal change between the natural sediment grain size (model parameters fixed to 150 µm) and the grain size after the release. PNEC grain size=+/- 52.7 µm. This value is derived from the statistical description of the variation in sensitivity (SSD).
- oxygen depletion in the sediment:
  - PEC is the reduction of the oxygen content (%) in the sediment layer due to the discharge, integrated over the layer where bioturbation is taking place (about 10 cm).
  - PNEC is the threshold level for hypoxia: PNEC oxygen = 20% of initial rate of O_2.
- toxicity of chemicals in the water column:
  - PEC is the concentration, expressed in ppm, of the released substance, calculated in the water column after its dispersion in the marine environment.
  - PNEC is the maximum concentration, expressed in ppm or mg/l, causing no harm to the ecosystem. According to European recommendations, PNEC is obtained from ecotoxicological values (LC_{50}, NOEC, etc.) adjusted with safety factors. For several typical discharges implying of the basic compounds (lead, barium, etc.) the PNEC values are integrated into the model MEMW.
- physical effects of suspended matter in the water column:
  - The ratio PEC/PNEC will be superior to 1 (potential risk) when the suspended matter is superior to the threshold value accepted by the marine organisms.
- toxicity of chemicals in sediment:
  - PEC is the calculated concentration of the substance in the sediment, expressed in in ppm averaged over the upper 3 cm of the sediment layer.
  - PNEC is the maximum concentration accepted in the sediment with no impact for the ecosystem. The toxicity of the substances are calculated based on partitioning (that is, only the part of the chemical that dissolves into the pore water is assumed to be bioavailable, and therefore toxic). For HOCNF chemicals, the partition coefficient is assumed to be given by the log Pow coefficient.

Metocean data was obtained from SATOCEAN whose ocean current modelling is based on HYCOM (Hybrid Coordinate Ocean Model; Bleck, 2001). Data used are based on 13 months of datasets and comprise 3D currents and associated 2D winds from the continuous current hindcast at each grid point, as follows:

- 3D currents:
  - NetCDF format (OSCAR compatible)
  - 13 months of data (1 December 2014–31 December 2015)
  - spatial resolution at least 1/32°
  - vertical resolution 32 layers
  - time step 3 hours
- associated 2D winds:
  - NetCDF format (OSCAR compatible)
  - 13 months of data (1 December 2014–31 December 2015)
  - time step 3 hours.

Statistical data for wind speed was obtained from METEOGROUP for one location in Block 4. Current statistics were obtained from a combination of CYCOFOS data from 2009 to 2016 and the CSFR worldwide atmospheric model from 1998 to 2018. Current data from the sea surface (5–10 m) and the seabed (1500–1700 m) was used in the modelling.

Bathymetry data in the MEMW software was used in the modelling, and water column characteristics were obtained from the offshore EBS of Block 4 carried out in March–April 2019.

The limitations of the model are as follows:

- This model is a simplification of real operations and, as such, it cannot take into account every single parameter in order to allow reasonable/achievable time for processing and the size of files generated. For this reason, results might vary depending on how the model has been parameterised.
- All the results presented in this report are based on historical metocean databases and are used to better understand the fate of the drill cutting discharges and how it may impact the ecosystem. Because these results are based on a historical database, it cannot guarantee an accurate prediction of what may happen in the future.

Modelling has been carried out for two well options; the two well options are described in Section 4.4.4.2 of the Project Description:

- Option 1 use of NADFs in lower-hole sections– cuttings and seawater, gel sweeps and pad mud discharged to the seabed during riserless drilling of the 36-in. and 26-in. upper-hole sections (top-hole and next section). NADF and cuttings from the lower-hole sections of the well will be transported to shore for treatment and disposal (no offshore discharge).
- Option 2 use of HPWBDFs in lower-hole sections – cuttings and seawater, gel sweeps and pad mud discharged to the seabed during riserless drilling of the 36-in. and 26-in. upper-hole sections (top-hole and next section), then high-performance WBDF cuttings discharged from the rig (following separation of drilling fluids on the MODU) for the 17½-in., 12¼-in. and 8½-in. hole sections.

Option 1 has been selected for the first well (B4-1). For any future exploration/appraisal wells in Block 4, Option 1 or 2 will be used depending on the experience gained from drilling B4-1.

The sections below summarise the findings.

Impacts of drill cuttings and fluid discharge on seabed - sediments and benthic communities

Potential impacts

Discharged drilling fluids and cuttings will accumulate on the seafloor within the AOI, resulting in changes to seabed contours, grain size, barium concentrations and potentially concentrations of other metals. These changes generally occur primarily within a few hundred metres around a well site and may persist for several years (Continental Shelf Associates, Inc., 2006).

The effects of drilling discharges on benthic communities have been reviewed extensively by the NRC (1983), Neff (1987) and Hinwood et al. (1994). Owing to the low toxicity of most drilling fluids, the main mechanism of impact to benthic communities within the AOI is increased sedimentation, possibly resulting in burial or smothering. Monitoring programmes have shown that benthic impacts of drilling are minor and localised within a few hundred metres of the well site (EG&G Environmental Consultants, 1982; NRC, 1983; Neff, 1987; Continental Shelf Associates, Inc., 2006).

With respect to impacts on sediments and benthic communities the following environmental risks were evaluated:

- burial of organisms – study of the thickness of the residual deposit
- oxygen variation – study of the oxygen rate change
- change in the sediment structure – study of the grain size change
- chemical concentrations – effluent concentrations on the superficial sediments.

Option 1

As stated above, Option 1 involves the use of NADFs in the lower-hole sections. The cuttings modelling takes into account discharge of cuttings and seawater, gel sweeps and pad mud discharged to the seabed during riserless drilling of the 36-in. and 26-in. upper-hole sections only (top-hole and next section). NADF and cuttings from the lower-hole sections of the well will be transported to shore for treatment and disposal (no offshore discharge). This option has been selected for well B4-1. For any future exploration/appraisal wells in Block 4, Option 1 or 2 will be used depending on experience gained from drilling of the first well.

Option 1: Burial of organisms

At the end of the drilling activities, deposition of cuttings can be seen in a north/northeast direction from the discharge point due to the seabed currents (see Figure 6.1).

The maximum thickness of deposits is 31 mm, with sediment deposits very localised around the discharge point (less than 100 m from it).

The thickness of the deposit varies very slowly over time with deposit thickness still about 30 mm after 10 years and only a small fraction dispersed.

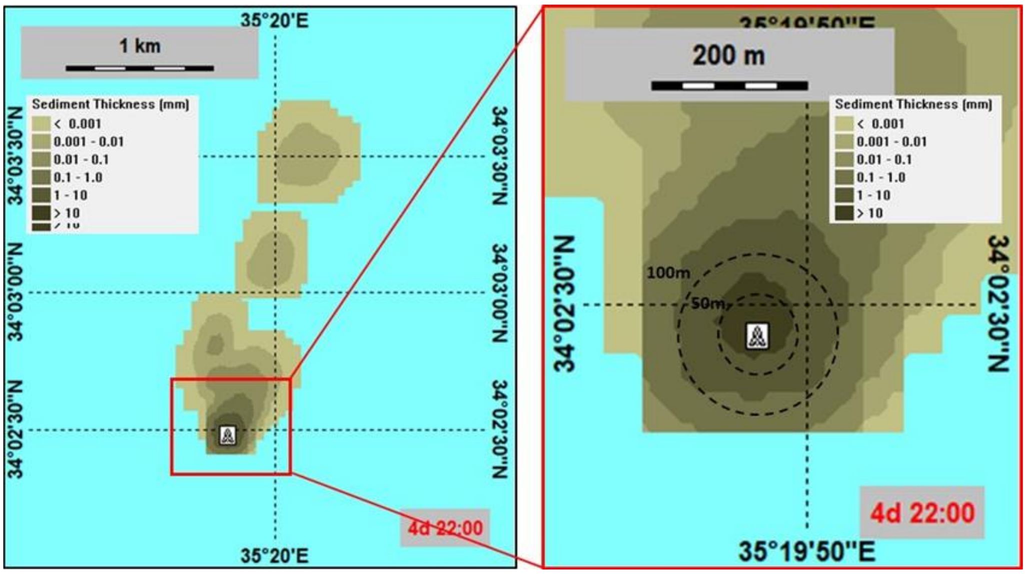

Figure 6.1: Cuttings thickness deposit after drilling operations (Option 1)

Source: TEP Liban (2019a)

Option 1: Oxygen variation

Figure 6.2 shows oxygen variation on the superficial sediments during drilling operations. The area with a potential risk associated with oxygen variation is mainly centralised around the discharge point and along an axis to the north.

The maximum oxygen variation observed was up to 195% less than 125 m around the discharge point.

The modelling results show that oxygen variation changes rapidly over the time, less than 100 days after the end of drilling activity oxygen in the top layer of sediments is back to pre-discharge levels.

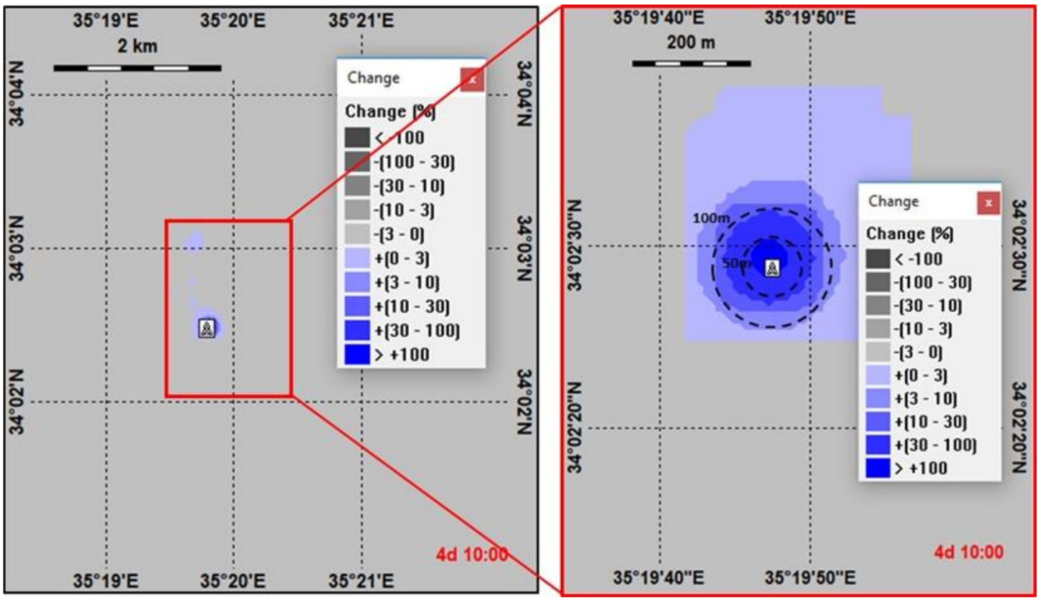

Figure 6.2: Oxygen variation in superficial seabed sediments after drilling operations (Option 1)

Source: TEP Liban (2019a)

Option 1: Change in sediment structure

Figure 6.3 shows the grain size variation on the sediments at the end of the 26-in. drilling operations. The area with sediment grain size changes observed is mainly centralised around the discharge point and along an axis to the north. The maximum grain size variation observed was up to 110% less than 100 m around the discharge point.

Grain size variation changes very slowly over the time. Ten years after the end of drilling activity, nothing has changed with regards to this parameter.

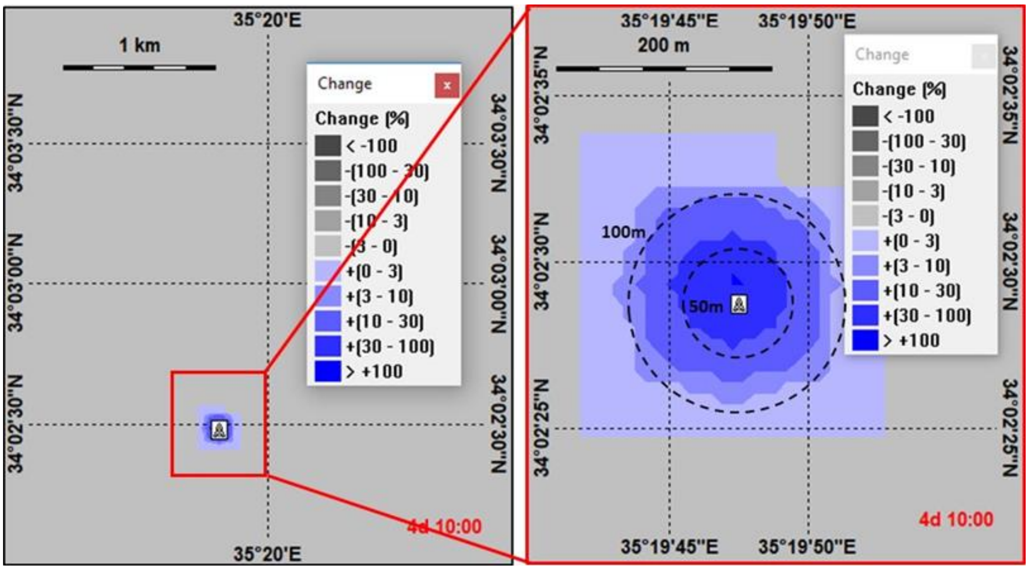

Figure 6.3: Grain size variations after drilling operations (Option 1)

Source: TEP Liban (2019a)

Option 1: Chemical concentrations

The modelling results for the discharge of drilling fluids from Option 1 did not predict any risk to the sediments. Therefore, the impact to the sediment from the drilling fluids is anticipated to be minimal.

Option 1: Maximum sediment risk and main contributors

The outcomes of the model for the maximum risk associated with the drilling discharge operations on sediments for Option 1 is presented in Figure 6.4. The total potential risk presents a cumulative picture of all stressors contributing to the risk to the sediments.

These figures show that a significant potential risk (above 5%) is observed around the well site. A maximum risk of 27.5% has been calculated, although the spatial risk is relatively limited. The area at risk is not centralised around the discharge point but is orientated along an axis starting from the discharge point towards north.

Figure 6.5 shows that a significant potential risk is observed up to 155 m away from the discharge point (and mostly within 100 m of the discharge point). The sensitive seabed area determined from the EBS in Block 4 (see Figure 5.60) will not be affected by these discharges, as it is located about 9 km north-northwest of the well site.

Risk decreases over time in the sediments at the discharge point after the end of the drilling operations. Figure 6.5 clearly shows that the area of sediments impacted decreases to nothing around the discharge point 10 years after the end of the drilling operations.

The main contributors to total risk in the sediments are sediment thickness (50%) and sediment grain size (50%).

Figure 6.6 shows that the contribution of the two stressors to total risk remains consistent over time.

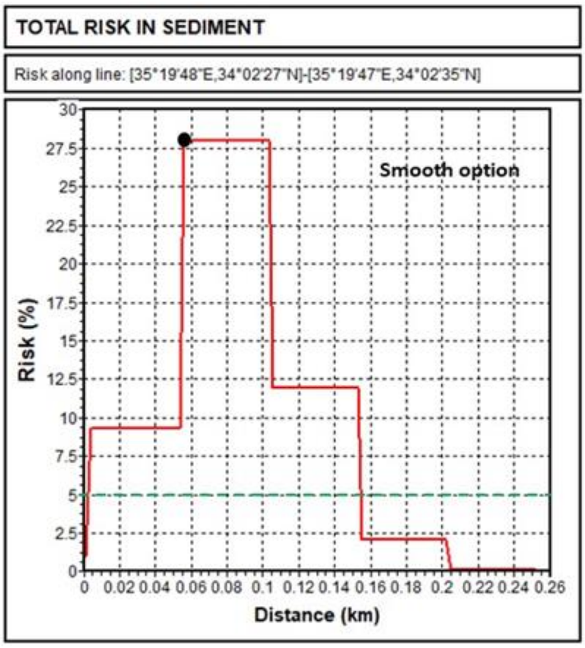

Figure 6.4: Maximum risk of drilling operation on the sediments against distance from the discharge location (Option 1)

Black dot symbolises discharge point. Source: TEP Liban (2019a)

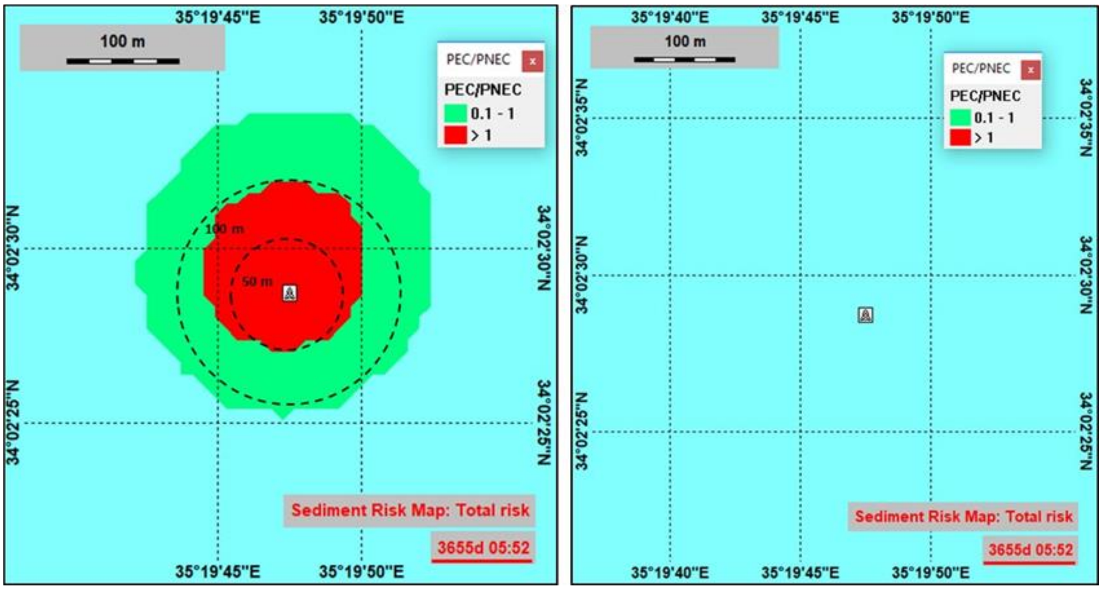

Figure 6.5: Maximum potential risk of drilling operation on the sediments at end of drilling and after 10 years (Option 1)

Source: TEP Liban (2019a)

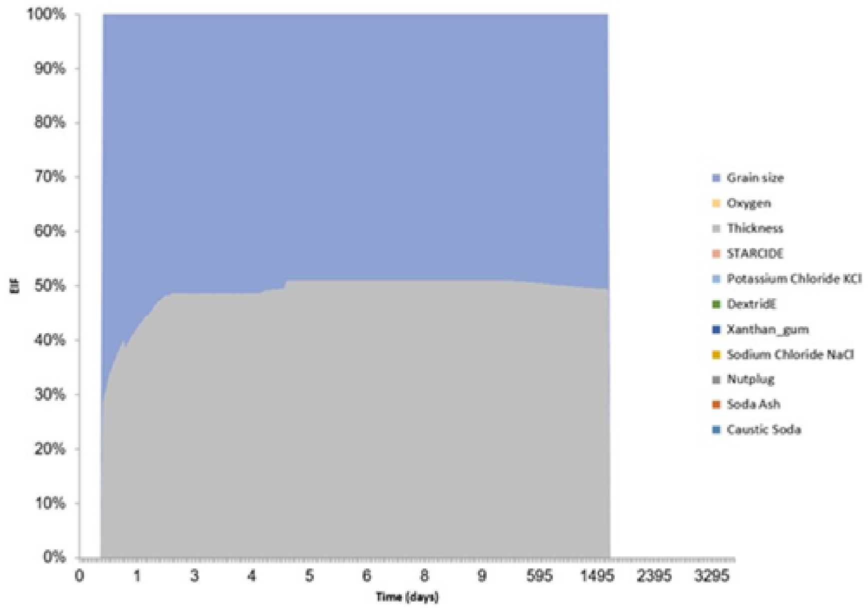

Figure 6.6: Main contributors to risk of drilling operations over time (Option 1)
Source: TEP Liban (2019a)

Option 2

As stated above, Option 2 involves the use of HPWBDFs in the lower-hole sections. The cuttings modelling takes into account cuttings and seawater, gel sweeps and pad mud discharged to the seabed during riserless drilling of the 36-in. and 26-in. upper-hole sections (top-hole and next section), then high-performance WBDF cuttings discharged from the rig from the 17½-in., 12¼-in. and 8½-in. hole sections. For any future exploration/appraisal wells in Block 4, Option 1 or 2 will be used depending on experience gained from drilling of the first well.

Option 2: Burial of organisms

At the end of the drilling activities (~31 days), deposition of cuttings can be seen in a north/northeast direction from the discharge point, due to the seabed currents (see Figure 6.7).

The maximum thickness of deposits is 26 mm, with sediment deposits very localised around the discharge point (less than 75 m from it).

The thickness of the deposit varies very slowly over time with deposit thickness still around 25 mm after 10 years and only a small fraction dispersed.

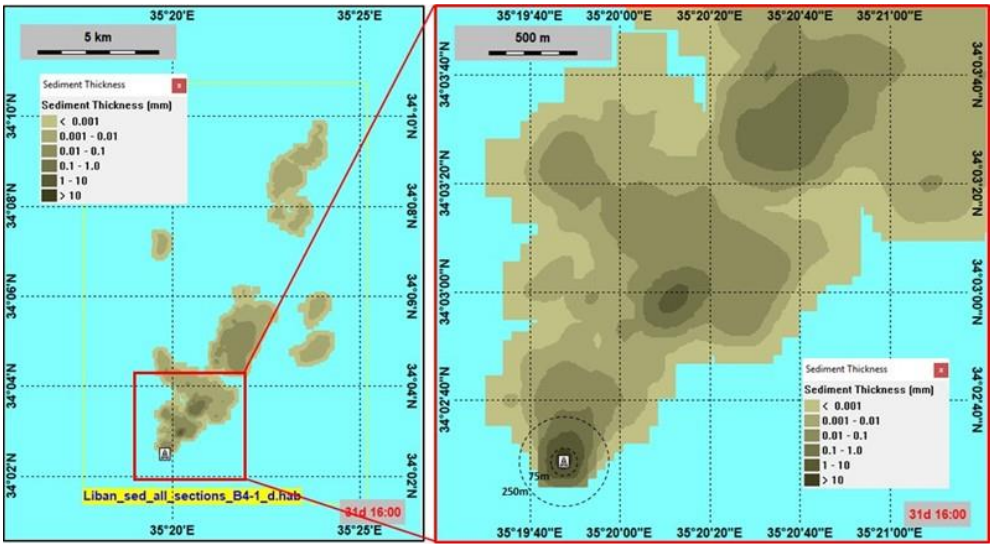

Figure 6.7: Cuttings thickness deposit after drilling operations (Option 2)

Source: TEP Liban (2019a)

Option 2: Oxygen variation

Figure 6.8 shows oxygen variation on the superficial sediments during drilling operations. The area with a potential risk associated to oxygen variation is mainly centralised around the discharge point with some additional patches along an axis to the north and northeast.

The maximum oxygen variation observed was up to 175% within a 100-m radius around the discharge point. The highest oxygen variation in the sediments is due to the discharge of the upper-hole sections (36-in. and 26-in.). For the other sections (17½ in., 12¼ in. and 8½ in.) discharged 10 m below sea surface, the cuttings are dispersed and more spread towards the north and northeast leading to lower oxygen variation in the sediments at the seabed.

The modelling results show that oxygen variation changes rapidly over the time, less than 100 days after the end of drilling activity oxygen in the top layer of sediments will have returned to pre-discharge levels.

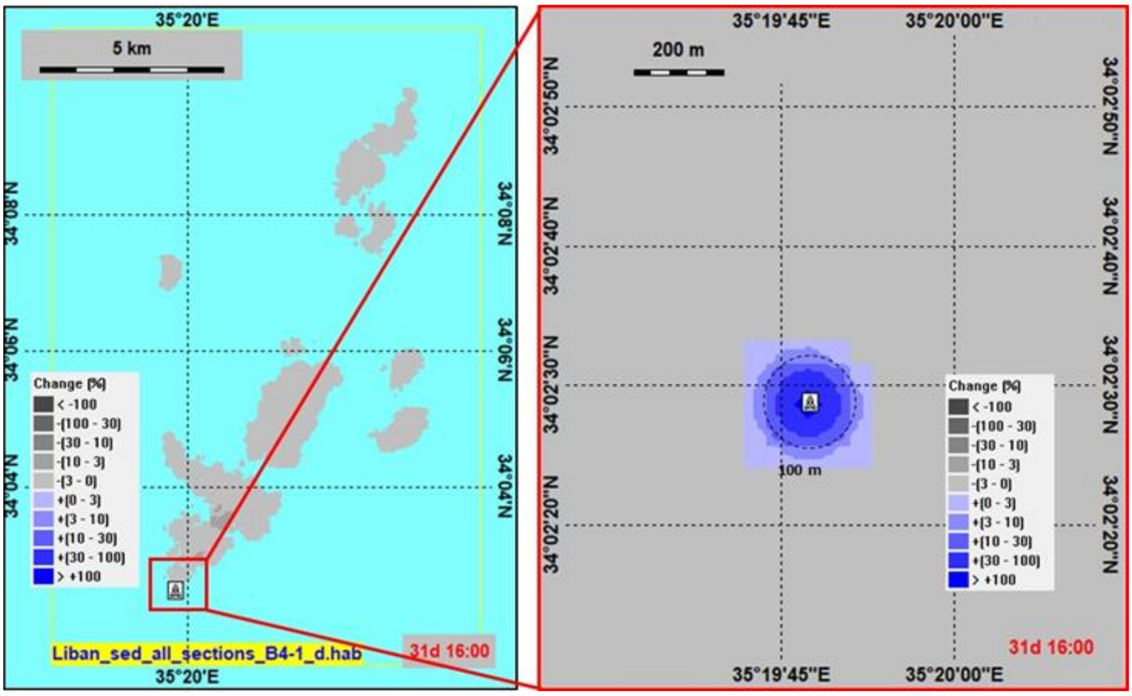

Figure 6.8: Oxygen variation in superficial seabed sediments after drilling operations (Option 2)

Source: TEP Liban (2019a)

Option 2: Change in sediment structure

Figure 6.9 shows grain size variation in the sediments at the end of the 8½-in. drilling operations. Two main areas with sediment grain size changes are observed:

One patch centralised around the discharge mainly due to the discharge of the 36-in. and 26-in. sections. The maximum grain size variation observed was up to 170% within a 125-m radius around the discharge point.

A second significant patch, further to the northeast, is mainly due to the discharge of the 17½-in., 12¼-in. and 8½-in. sections with some additional patches along the same axis. The maximum grain size variation observed was up to 112% within a 1.5-km radius around the discharge point.

Grain size variation changes very slowly over the time. Ten years after the end of drilling activity, almost nothing has changed with regards to this parameter.

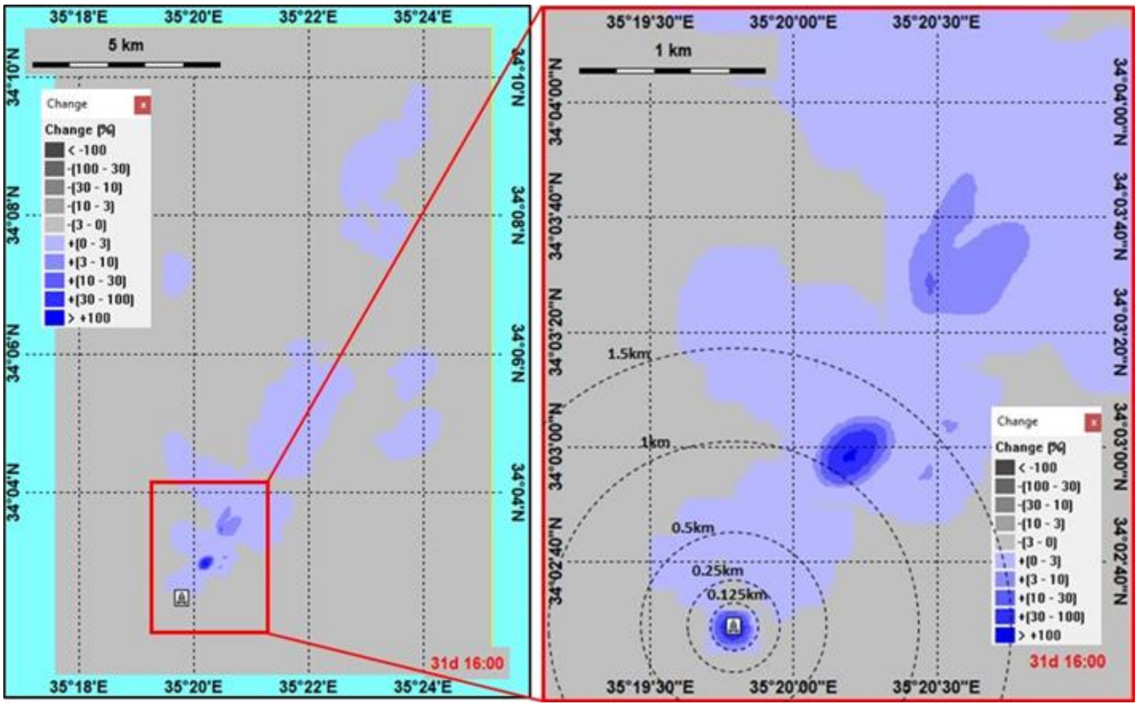

Figure 6.9: Grain size variations after drilling operations (Option 2)

Source: TEP Liban (2019a)

Option 2: Chemical concentrations

Figure 6.10 shows the total effluent (discharge) concentrations on the superficial sediments during drilling operations. Relatively high concentrations of effluent are observed in the sediments; however, barite and bentonite (non-soluble chemicals) account mainly for total concentrations of effluent in sediments. Other trace concentrations of PAC-L, BARAZAN D, hydro-treated light petroleum distillate, ethoxylated alcohol (from the CLAY GRABBER), RADIAGREEN EME salt and BARACARB were also detected in the sediments.

The area with a potential risk associated to discharge concentration is not centralised around the discharge point but is orientated along an axis starting from the discharge point towards the north–northeast.

The maximum discharge concentration observed was up to 911 g/l around the discharge point. However, discharge is spread up to 15 km away from the discharge point towards the northeast.

Effluent concentration varies slowly over time, with total effluent concentrations still high in the top layer of sediments 10 years after the end of drilling activity.

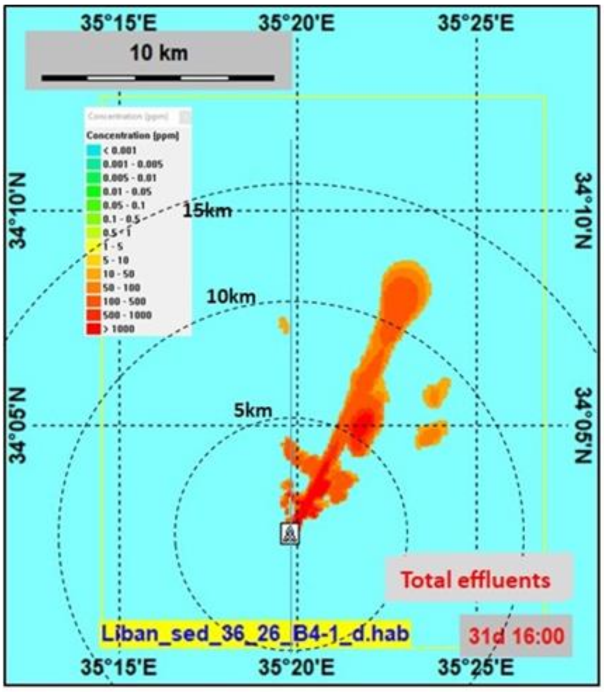

Figure 6.10: Concentrations of chemicals in superficial sediments after drilling operations (Option 2)

Source: TEP Liban (2019a)

Option 2: Maximum sediment risk and main contributors

The outcomes of the model for the maximum potential risk associated with the drilling discharge operations on sediments for Option 2 are presented in Figure 6.11. The total risk presents a cumulative picture of all stressors contributing to the risk to the sediments.

These figures show that a significant potential risk (above 5%) is observed around the well site. A maximum risk of 34% has been calculated, although the spatial risk is relatively limited. A significant risk (above 5%) has been calculated in an area of up to 1.5-km radius around the discharge point at the end of the drilling operations. The area at risk is not centralised around the discharge point but is orientated along an axis starting from the discharge point towards the north–northeast. The second peak on Figure 6.11 reflects the cuttings distribution with the currents resulting in a separate area of increased risk to the northeast of the well site, probably associated with finer material.

Figure 6.12 shows that a significant potential risk (above 5%) is observed up to 1.45 km away from the discharge point. The sensitive seabed area determined from the EBS in Block 4 (see Figure 5.60) will not be affected by these discharges, as it is located about 9 km north–northwest of the well site.

The main contributors to total risk in the sediments are the sediment grain size (74%), thickness (10%) and chemicals (16%).

Risk slightly decreases over the time in the sediments 10 years after the end of the drilling operations. Risk remains high predominantly owing to the physical parameters of sediment grain size and cuttings thickness (see Figure 6.13). These changes in sediment structure are explained by the difference in grain size between the cuttings discharged and the fine sediment present at such depths in the eastern Mediterranean. Once the cuttings have settled out, only the finest particles will continue to be carried by the seabed currents, which are usually of low magnitude. Therefore, risk remains associated with these physical parameters.

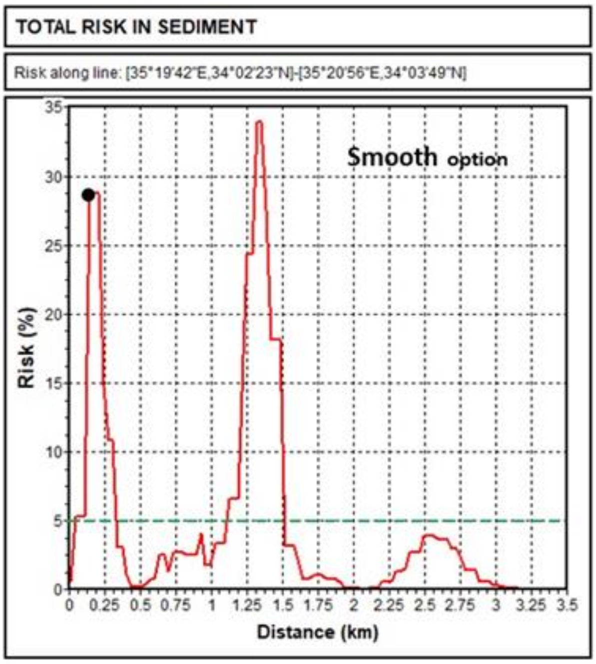

Figure 6.11: Maximum potential risk of drilling operation on the sediments against distance from the discharge location (Option 2)

Black dot symbolises discharge point. Source: TEP Liban (2019a)

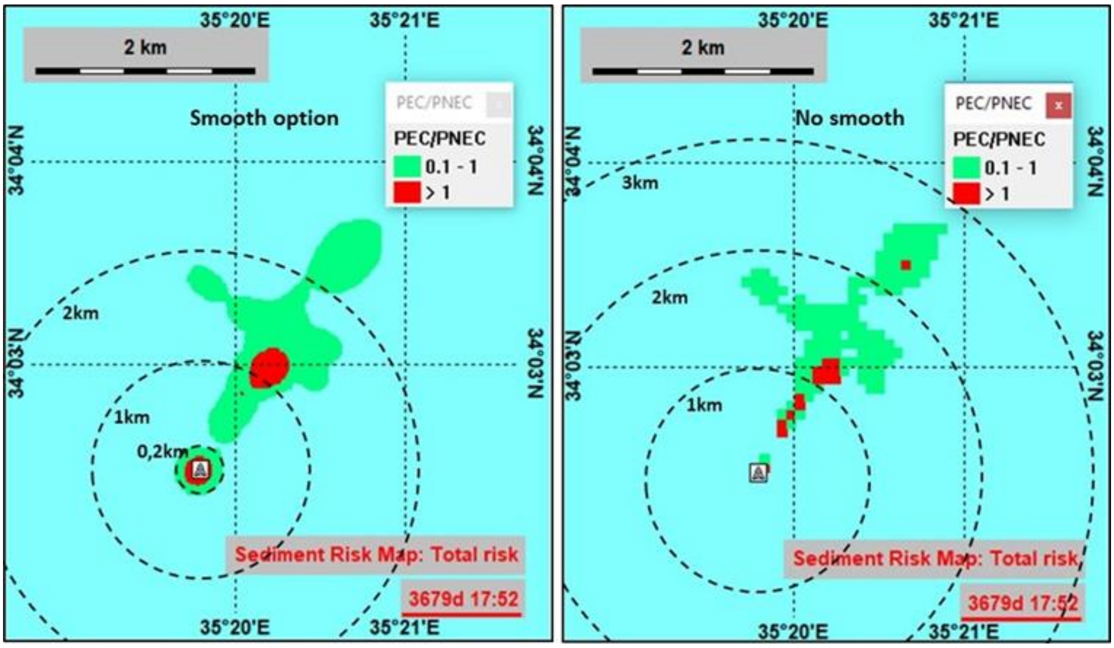

Figure 6.12: Maximum potential risk of drilling operation on the sediments at end of drilling and after 10 years (Option 2)

Source: TEP Liban (2019a)

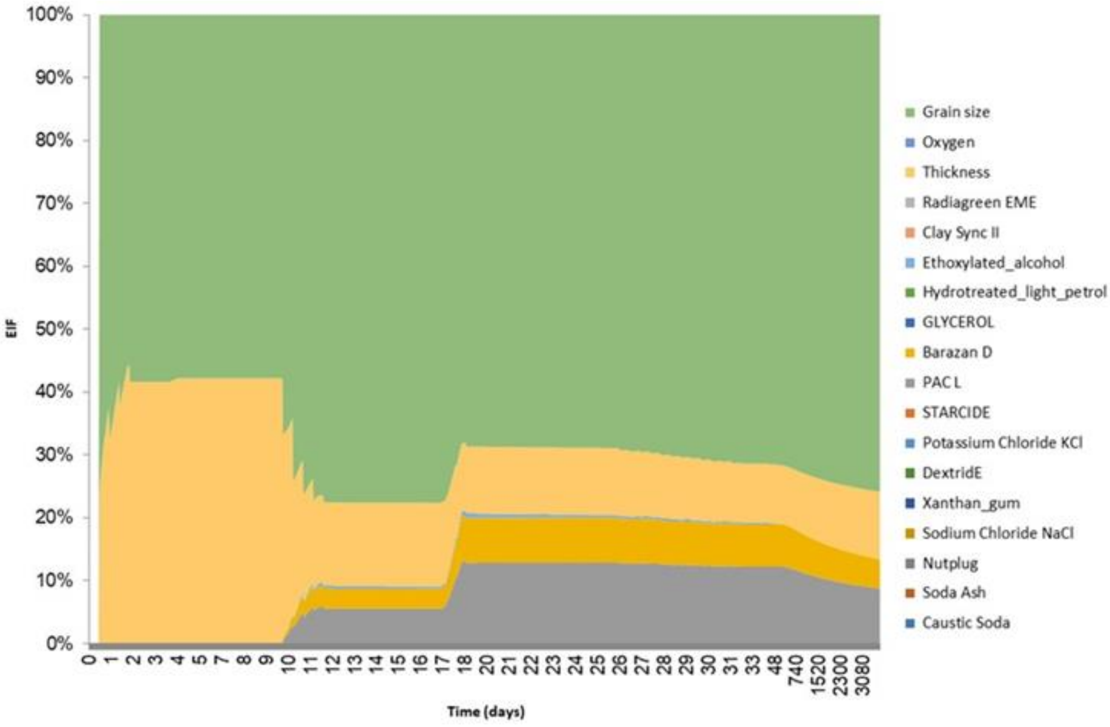

Figure 6.13: Main contributors to risk of drilling operations over time (Option 2)

Source: TEP Liban (2019a)

Note: Increase in chemical contribution at day 9 associated with the 17½-in. hole section discharge

The text and table below summarises pre-mitigation impact analysis for sediments and benthic communities.

For Option 1 - discharge of drill cuttings and WBDFs from the riserless upper-hole sections (top-hole and next section) of the well only (option selected for well B4-1 and could be selected for future exploration / appraisal wells in Block 4) (MAE02 in Table 6.9), the impact intensity has been scored in accordance with a combination of factors from Table 1.2 as low (2): although the impact duration is medium term (risk anticipated to have reduced considerably after 5 years, with no risk remaining 10 years after the end of drilling) the geographic extent is immediate, with disturbance of a habitat on a local scale with restoration requiring minimal or no intervention. The localised short term disturbance of individuals of the benthic community will not affect other trophic levels or the integrity of the population.

For Option 2 – discharge of drill cuttings and WBDFs from the riserless upper-hole sections (top-hole and next section) of the well and discharge of HPWBDF cuttings from the lower well sections (this option could be selected for future exploration / appraisal wells in Block 4) (MAE03 in Table 6.9), the impact intensity has been scored in accordance with a combination of factors from Table 1.2 as medium (3): although the impact duration is long term (risk remains 10 years after drilling), the geographic extent is local and the risk is associated with the physical parameters of grain size and sediment thickness rather than chemical effects. Physical impacts on the benthic community anticipated to be limited to disturbance of a population of species resulting in a change of abundance over one or more generations in the immediate area, but that does not change the integrity of the population of the species, or populations of dependent species.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.9
Sediment quality/ composition and benthos – low (2)	Option 1 - Discharge of drill cuttings and WBDFs from drilling riserless upper-hole sections – low (2)	Minor (4)	MAE02
Sediment quality/ composition and benthos – low (2)	Option 2 - Discharge of drill cuttings and WBDFs from drilling riserless upper-hole sections, plus discharge of drill cuttings and HPWBDF cuttings from drilling lower-hole sections – medium (3)	Moderate (6)	MAE03

Mitigation

Use and discharge of drilling fluids and cuttings will be subject to TEP Liban's chemicals management plan (see Section 8.5.2). Tables 4.3 to 4.6 in Chapter 4 show that the proposed water-based drilling fluids maximise the use of chemicals with low toxicity, high biodegradability and low bioaccumulation potential, with the majority of constituent chemicals ranked as PLONOR, HQ Band 'Gold', or OCNS Group E (see Section 2.10.2.3 in Chapter 2 for an explanation of chemical ranking). Seawater will be used for drilling the first 36-in. top-hole section.

Barite consists of barium sulphate, an insoluble, chemically inert mineral powder that can contain measurable concentrations of trace metals. The barite used for the Block 4 exploration drilling campaign will meet the applicable heavy metal concentration standards of <1 mg/kg for mercury, and <3 mg/kg for cadmium dry weight (World Bank, 2015).

The drilling fluids and cuttings from the lower-hole sections will be returned to the rig and separated using the onboard solids control equipment (shale shakers and centrifuges). The separated drilling fluids will be re-used and the separated cuttings will be discharged to sea. The cuttings discharge chute will be 10 m below the sea surface to aid dispersion of the solids.

Residual impacts

All of the above mitigation measures were taken into account in the modelling, therefore the residual impact scores are the same as the pre-mitigation scores. Residual impacts anticipated to range from minor to moderate.

With respect to possible future exploration / appraisal wells in Block 4, impact interactions on sediments and benthic communities could be possible if the wells were separated by less than 3 km. This additive risk will be taken into account when planning future well locations within the Block.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.9
Sediment quality/ composition and benthos – low (2)	Option 1 - Discharge of drill cuttings and WBDFs from drilling riserless upper-hole sections – low (2)	Minor (4)	MAE02
Sediment quality/ composition and benthos – low (2)	Option 2 - Discharge of drill cuttings and WBDFs from drilling riserless upper-hole sections, plus discharge of drill cuttings and HPWBDF cuttings from drilling lower-hole sections – medium (3)	Moderate (6)	MAE03

Impacts of drill cuttings and fluid discharge on water column - water quality, plankton, fish, sensitive seabed habitats

Potential impacts

Discharges of drill fluids and cuttings produce a visible plume that moves with the currents as these materials are diluted, dispersed and settle to the seafloor. Modelling of the impact of cuttings and drilling fluid discharge on the water column, along with an assessment of risk has been conducted. The results presented below summarise the impacts to the water column from Option 1 discharge of cuttings and water-based fluids from the upper-hole riserless sections only (top-hole and next section), and Option 2 discharge of cuttings and water based fluids from the upper-hole riserless sections (top-hole and next section) and then discharge of high-performance WBDF cuttings from the lower-hole sections.

Option 1 has been selected for the first well (B4-1). For any future exploration/appraisal wells in Block 4, Option 1 or 2 will be used depending on experience gained from drilling B4-1.

Option 1 modelling results

Figure 6.14 shows that risk is mainly limited to the seabed between 1560 m and 1595 m. The maximum risk calculated is up to 100%, very close to the discharge point. A significant risk has been calculated in an area extending up to 25 km from the discharge point. This area is not centralised around the discharge point and is orientated along an axis starting from the discharge point towards the north–northeast following the current.

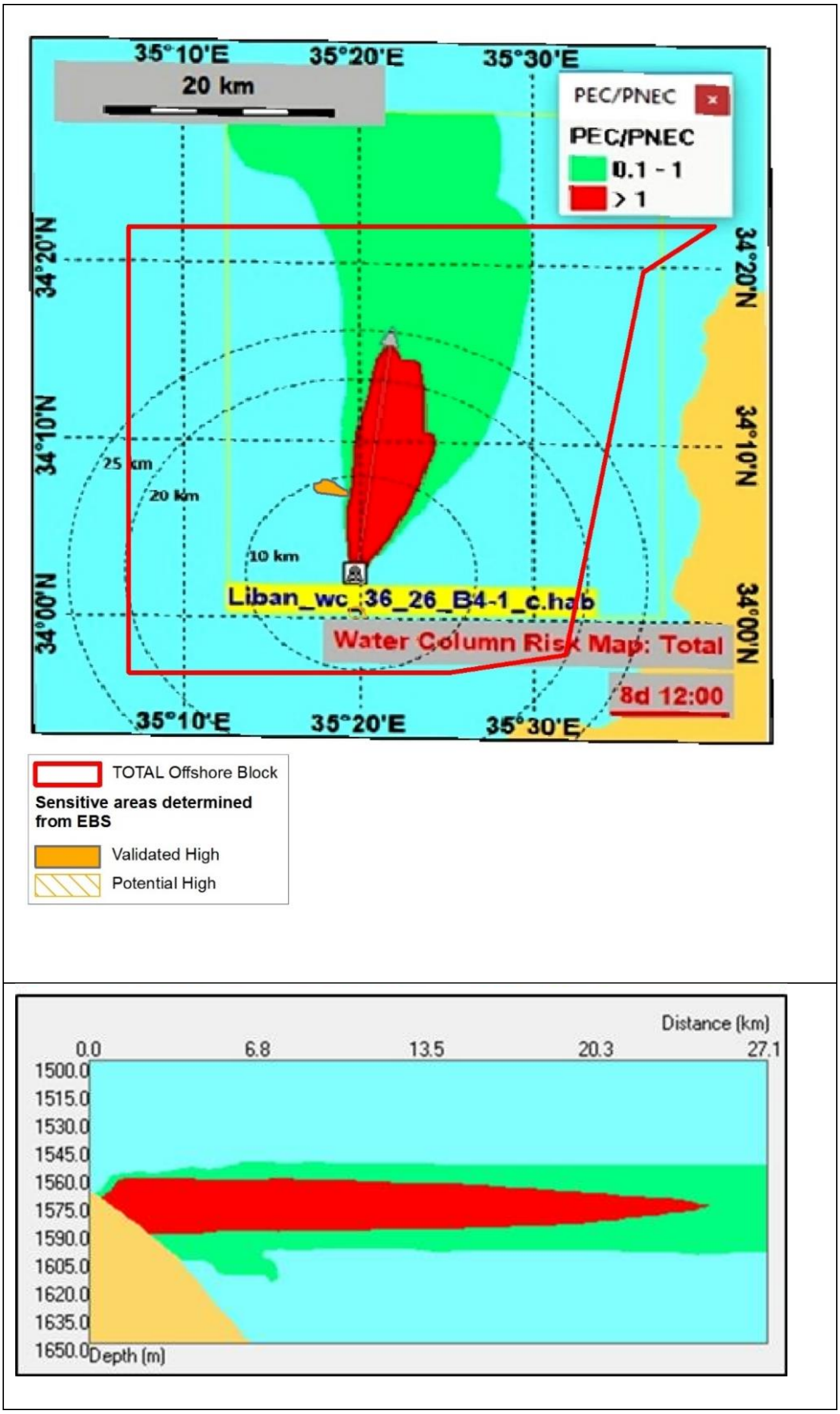

Figure 6.14: Maximum risk of drilling operation on the water column (Option 1)

Source: TEP Liban (2019a)

Figure 6.15 clearly shows that the risk to the water column is not constant throughout the drilling operations with three distinct periods clearly observed:

- The first corresponds to the discharge of the 36-in. section at the very beginning of the operations. Figure 6.14 shows that this does not lead to any significant risk to the environment.
- A second period with significant risk (up to 46%) calculated during the discharge of the drilling fluids and the cuttings corresponding to the 26-in. section. A potential significant risk has been calculated throughout all the duration of the drilling and discharge of the 26-in. section.
- A third period with a significant risk (up to 41%) calculated during the discharge of the drilling fluids and the cuttings corresponding to the 26-in. section washout.

Figure 6.15 shows that the impact of the discharge of the 36-in. and 26-in. sections on the water column is very short term. Risk is not detected anymore in the water column right after the end of the washout period (4.4 days).

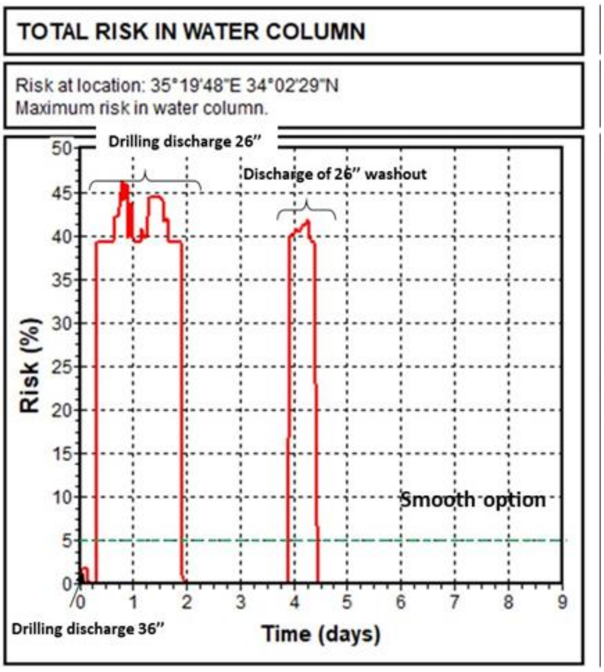

Figure 6.15: Maximum risk of drilling discharges on the water column over time (Option 1)

Source: TEP Liban (2019a)

The main contributors to the risk in the water column are bentonite (41%), barite (32%) and caustic soda (17%). Bentonite and barite are high risk owing to the quantities used.

Figure 6.16 shows the concentrations of the total discharge in the plume around the discharge point, including cuttings and chemicals. The maximum concentration observed was up to 116 ppm. Figure 6.16 shows that the higher concentrations are observed at the seabed, close to the discharge point.

Option 1 modelling results impact summary

For Option 1, the risk to the water column from cuttings and drilling fluid discharge is very short term (<5 days) with the plume remaining near the seabed but extending 25 km from the site. The risk to the water column is driven by the bentonite, which is an inert clay with low environmental toxicity. The bentonite will decrease water quality by adding turbidity.

Impacts to benthic communities from increased turbidity include clogging of gill and feeding structures and direct smothering. The benthic community in the well site area is dominated by polychaetes, which are not filter feeders, and smothering impacts are not anticipated owing to the fineness of the particles (bentonite clay particles < 2 µm) that would be carried by currents and settle in a very thin layer on the seabed. The turbidity plume is anticipated to pass to the east of the sensitive seabed area identified in the EBS, see Figure 6.14.

Prolonged exposure to increased turbidity in the water column can affect fish by clogging of gills and asphyxiation. However, the short term increase in turbidity of the water column associated with the cuttings and drilling fluid discharge (<5 days) is unlikely to result in such effects. Marine fish species closely associated with the seabed (benthic species) can generally withstand high suspended sediment levels (Wilber and Clarke, 2001). As the plume remains near the seabed in this case plankton communities and pelagic fish species are not anticipated to be impacted.

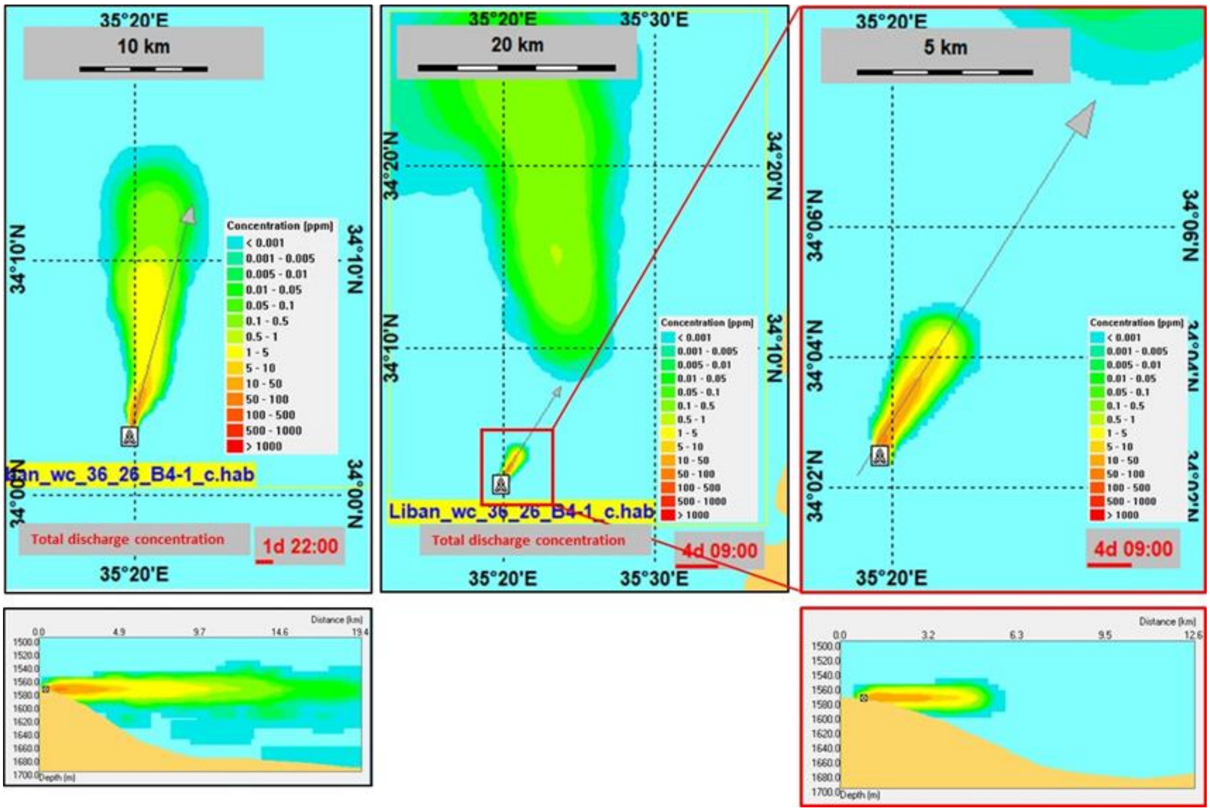

Figure 6.16: Discharge concentration at end of drilling operations (Option 1)

Source: TEP Liban (2019a)

Option 2 modelling results

Figure 6.17 shows that the risk to the water column is due to the discharge from the 36-in. and 26-in. riserless sections at the seabed and the discharge from the lower-hole sections (17½ in., 12¼ in. and 8½ in.) with discharges from the MODU cuttings chute 10 m below the sea surface.

The risk associated with the discharge of the riserless sections is limited mainly to the seabed and has already been described in the Option 1 scenario. The risk associated with the discharges from the lower-hole sections is located mainly between the sea surface and 900 m water depth; however, patches were also observed below 900 m.

For the sections drilled with a riser, a maximum potential risk of up to 18% was observed very close to the discharge point just below the sea surface and significant risk was observed up to 12.5 km away. This area is not centralised around the discharge point but is orientated along an axis starting from the discharge point towards the north–northeast.

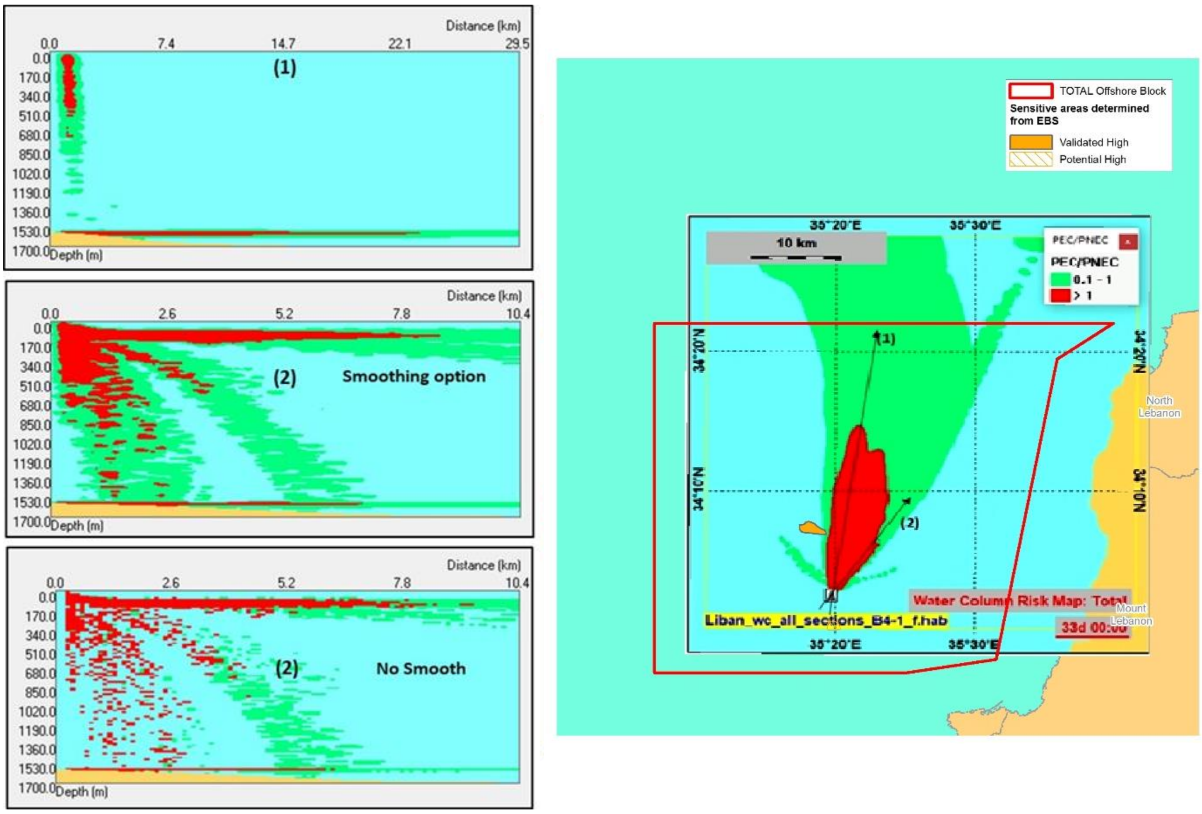

Figure 6.17: Maximum risk of drilling operation on the water column (Option 2)
Source: TEP Liban (2019a)

Figure 6.18 shows that the risk to the water column is not constant throughout the drilling operations with six distinct periods observed:

- the first three periods correspond to the discharge of the 36-in., 26-in. and 26-in. washout sections as described in Option 1
- a fourth period with a maximum risk of 18% from the 17½-in. section
- a fifth period with a maximum risk of 13% from the 12¼-in. section
- a sixth period with a maximum risk of 8% from the 8½-in. section.

Figure 6.18 shows that the impact of the discharge from all sections on the water column is short term. Risk is not detected in the water column immediately following the end of the drilling operation.

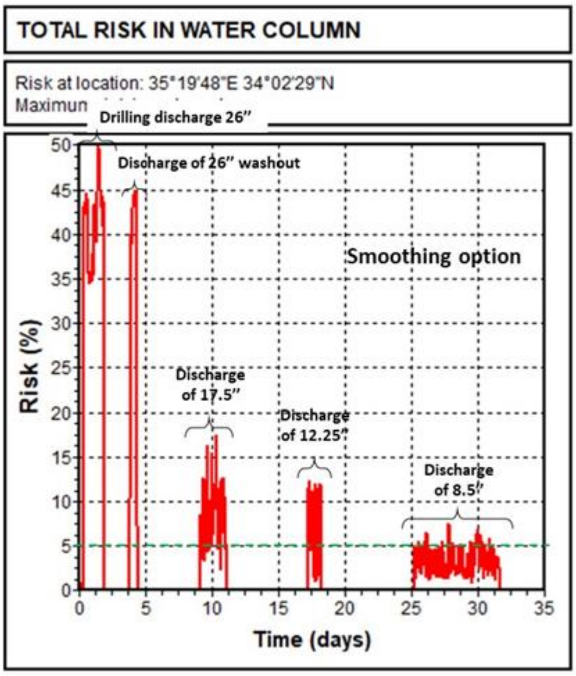

Figure 6.18: Maximum risk of drilling discharges on the water column over time (Option 2)

Source: TEP Liban (2019a)

Figure 6.19 shows the discharge concentrations in the plume around the discharge point when drilling the 17½-in., 12¼-in. and 8½-in. lower-hole sections. The maximum concentration observed was up to 116 ppm during drilling of the 26-in. section. The discharge concentrations for the remaining sections were

- 17½-in. section: up to 3 ppm
- 12¼-in. section: up to 1.5 ppm
- 8½-in. section: up to ≤1 ppm.

The main risk contributors to the water column are barite (38%), bentonite (34%) and caustic soda (14%). Bentonite is the main contributor to the total risk in the water column during the discharge of the upper-hole sections discussed in Option 1. Beginning at the 17½-in. section until the 8½-in. section, barite is the main contributor to total risk owing to the quantity used.

Option 2 modelling results impact summary

For Option 2 (impacts are in addition to those from Option 1), the risk to the water column from cuttings and drilling fluid discharge from the MODU cuttings chute is considered short term. The extent of the plume is generally limited to surface and mid-depth waters and extends 12.5 km from the site. The risk to the water column is driven by barite which is considered to have low toxicity to marine fauna. The barite will decrease water quality by adding turbidity.

Impacts to benthic communities from this discharge will be very limited as the plume is generally limited to surface and mid-depths. The turbidity plume is anticipated to pass to the east of the sensitive seabed area identified in the EBS, see Figure 6.17.

Impacts to planktonic communities from turbidity are generally associated with the scattering and absorption of light from the suspended solids in the water column and a reduction in photosynthesis, with a knock-on effect to phytoplankton and zooplankton communities. The short term nature of the increased turbidity levels associated with this discharge however (see Figure 6.18) are unlikely to have significant impacts on the plankton population at the well site. Effects are anticipated to be short term owing to the fast growth rates of planktonic organisms and the dispersal and mixing of plankton and zooplankton from both inside and outside the affected area.

As stated earlier, prolonged exposure to increased turbidity in the water column can affect fish by clogging of gills and asphyxiation. However, the short term increase in turbidity of the water column associated with the cuttings and drilling fluid discharge (see Figure 6.18) is unlikely to result in such effects. Pelagic fish are highly mobile and have the ability to temporarily leave the affected area.

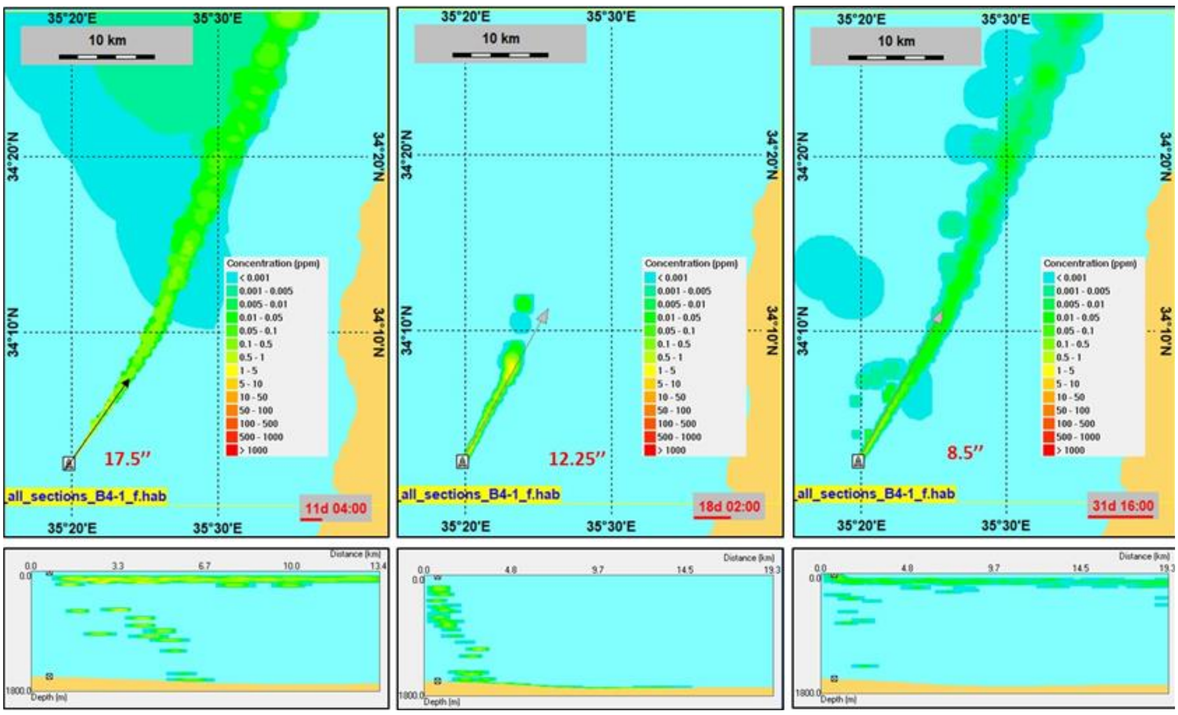

Figure 6.19: Discharge concentration at end of drilling the 17½-in., 12¼-in. and 8½-in. lower-hole sections (Option 2 – potentially selected for future exploration / appraisal wells)

Source: TEP Liban (2019a)

The text and table below summarises pre-mitigation impact analysis.

For Option 1 the risk to the water column from cuttings and drilling fluid discharge is very short term (<5 days) with the plume remaining near the seabed but extending 25 km from the site. The risk to the water column is driven by the bentonite, which is an inert clay with low environmental toxicity. The bentonite will decrease water quality by adding turbidity, however significant impacts on highly mobile fish species not anticipated. The clay particles are very small (< 2 µm) and will stay in suspension for a long period of time so may pass over the sensitive marine habitat to the north of the drilling site, or more likely pass to the east of this area (see Figure 6.14). When these particles do settle out of suspension, they will deposit on the sea floor but in a very fine layer that will not have an impact on the benthic community.

The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as low (2) for water quality: although the geographical extent is regional, the duration is very short term and risk is associated with inert bentonite clay particles. Impact intensity for indirect effects on fish and protected/threatened fish species from this very short-term increase in water column turbidity close to the seabed has been scored as very low (1). Impact intensity for indirect effects on sensitive seabed habitats has been scored as very low (1) as they are not anticipated to be affected by the fine layer of inert bentonite particles when they settle out. Impacts on plankton are not assessed as the cuttings plume stays close to the seabed.

For Option 2 (impacts are in addition to those from Option 1), the risk to the water column from cuttings and drilling fluid discharge from the MODU cuttings chute is considered very short term. The extent of the plume is generally limited to surface and mid-depth waters and extends 12.5 km from the site. The risk to the water column is driven by barite which is considered to have low toxicity to marine fauna. These discharges into the water column dissipate rapidly.

The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as low (2) for water quality: although the geographical extent is regional, the impact duration is very short term and risk is associated with inert, insoluble barite particles. Impact intensity for indirect effects on fish and protected/threatened fish species from this very short-term increase in water column turbidity has been scored as very low (1). Impact intensity on sensitive seabed habitats have been scored as very low (1) as the plume is limited to the surface and mid-depth waters and will not impact the seabed.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.9
Water quality – medium (3)	Option 1 - Discharge of drill cuttings and WBDFs from drilling riserless upper-hole sections – low (2)	Moderate (6)	MAE02
Fish – medium (3)	Option 1 - Discharge of drill cuttings and WBDFs from drilling riserless upper-hole sections – very low (1)	Minor (3)	
Protected/ threatened species (fish) – high (4)		Minor (4)	
Sensitive seabed habitats – high (4)		Minor (4)	
Water quality – medium (3)	Option 2 - Discharge of drill cuttings and WBDFs from drilling riserless upper-hole sections, plus discharge of drill cuttings and	Moderate (6)	MAE03

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.9
	HPWBDF cuttings from drilling lower-hole sections – low (2)		
Plankton (2)	Option 2 - Discharge of drill cuttings and WBDFs from drilling riserless upper-hole sections, plus discharge of drill cuttings and HPWBDF cuttings from drilling lower-hole sections – very low (1)	Negligible (2)	
Fish – medium (3)		Minor (3)	
Protected/ threatened species (fish) – high (4)		Minor (4)	
Sensitive seabed habitats – high (4)		Minor (4)	

Mitigation

The mitigation measures presented to reduce impacts to the sediment and benthic communities are also applicable to the water column.

Residual impacts

The mitigation measures referred to above were taken into account in the modelling, therefore the residual impact scores are the same as the pre-mitigation scores. Residual impacts anticipated to range from minor to moderate.

With respect to possible future exploration / appraisal wells within Block 4, impact interactions on the water column are not anticipated as the elevated turbidity levels associated with discharge of cuttings and drilling fluids are short lived and limited to the duration of the discharge period.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.9
Water quality – medium (3)	Option 1 - Discharge of drill cuttings and WBDFs from drilling riserless upper-hole sections – low (2)	Moderate (6)	MAE02 (Option 1)
Fish – medium (3)	Option 1 - Discharge of drill cuttings and WBDFs from drilling riserless upper-hole sections – very low (1)	Minor (3)	
Protected/ threatened species (fish) – high (4)		Minor (4)	
Sensitive seabed habitats – high (4)		Minor (4)	
Water quality – medium (3)	Option 2 - Discharge of drill cuttings and WBDFs from drilling riserless upper-hole	Moderate (6)	MAE03 (Option 2)

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.9
	sections, plus discharge of drill cuttings and HPWBDF cuttings from drilling lower-hole sections – low (2)		
Plankton - low (2)	Option 2 - Discharge of drill cuttings and WBDFs from drilling riserless upper-hole sections, plus discharge of drill cuttings and HPWBDF cuttings from drilling lower-hole sections – very low (1)	Negligible (2)	
Fish – medium (3)		Minor (3)	
Protected/ threatened species (fish) – high (4)		Minor (4)	
Sensitive seabed habitats – high (4)		Minor (4)	

6.3.1.3 *Cementing discharges (MAE05)*

Impacts of cement discharge on sediments and benthic communities

Potential impacts

After drilling each hole section, cement is pumped down the casing and up the annulus formed between the casing and the well bore. During this process, some excess cement may be displaced into the water column and onto the seabed within the AOI. Estimated quantities of cement discharged for well B4-1, and for a possible 3 well drilling programme, are presented in Section 4.6.2.2.

The table below summarises pre-mitigation impact analysis. The potential impact intensity has been scored in accordance with a combination of factors from Table 1.2 as low (2): the geographic extent is local; the impact duration is short term and volumes of cementing discharge are relatively small causing disturbance to habitats on a local scale and not affecting the integrity of species' populations.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.9
Sediment quality/ composition and benthos – low (2)	Low (2)	Minor (4)	MAE05

Mitigation

Table 4.7 (Chapter 4) shows that the cement formulation selected maximises the use of chemicals with low toxicity, high biodegradability and low bioaccumulation potential, with all constituent chemicals ranked as PLONOR, HQ Band 'Gold' or OCNS Group 'E' (see Section 2.10.2.3 for an explanation of chemical ranking).

Cement will only be discharged from the 20-in. well casing. During cementing, ROV monitoring will be carried out to ensure that cement discharges are kept at a minimum.

Residual impacts

The table below summarises residual impact analysis. The impact intensity for sediment and benthos has been scored in accordance with a combination of factors from Table 1.2 as very low (1): the geographic extent is immediate as cement will only be discharged from the 20-in. casing, and the impact duration is very short term as once set the chemicals will be bound into the matrix of the cement and will not be bioavailable. This results in a negligible residual impact.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.9
Sediment quality/ composition and benthos – low (2)	Very low (1)	Negligible (2)	MAE05

6.3.1.4 Pipe dope discharges (MAE06)

Impacts of pipe dope discharge on water quality, plankton and fish

Potential impacts

Before drilling activities, the rig crew will apply pipe dope to the drilling equipment joints to prevent thread damage. A small amount of this lubricating grease will enter the water column during drilling. The main environmental concerns regarding pipe dope are related to its heavy metal content, with some forms of pipe dope containing lead.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as low (2) for water quality and very low (1) for plankton and fish (including protected/threatened species): the geographic extent is local, the impact duration is very short term and only small amounts of pipe dope will be released into the marine environment.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.9
Water quality – medium (3)	Low (2)	Moderate (6)	MAE06
Plankton – low (2)	Very low (1)	Negligible (2)	
Fish – medium (3)		Minor (3)	
Protected/ threatened species (fish) – high (4)		Minor (4)	

Mitigation

A heavy metal free pipe dope will be used for the Block 4 exploration drilling programme. For well B4-1 the pipe dope Kopr-Kote (OCNS Category B) will be used. This product does not contain lead or zinc and has low bioaccumulation potential.

Residual impacts

The table below summarises residual impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1) for water quality, plankton and fish (including protected/threatened species): the geographic extent and the impact duration remain the same and only small amounts of heavy metal free pipe dope product will be released into the marine environment, with rapid dilution and dispersion. Residual impacts are anticipated to be negligible to minor.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.9
Water quality – medium (3)	Very low (1)	Minor (3)	MAE06
Plankton – low (2)		Negligible (2)	
Fish – medium (3)		Minor (3)	
Protected/ threatened species (fish) – high (4)		Minor (4)	

6.3.1.5 BOP testing discharges (MAE07)

Impacts of BOP testing discharges on water quality, plankton and fish

Potential impacts

BOP testing will be carried out weekly for safety reasons, resulting in the discharge of small volumes of BOP testing fluid (99% water, 1% Stack Magic) close to the seabed within the AOI. Estimated quantities of BOP fluids discharged for well B4-1, and for a possible 3 well drilling programme, are presented in Section 4.6.2.4.

Stack Magic has been formulated to meet the current CEFAS OSPAR requirements and is classified as OCNS Category E. Stack Magic is a biodegradable water glycol hydraulic control fluid.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1) for water quality, plankton and fish: the geographic extent is immediate, the impact duration is very short term and only small volumes of low toxicity BOP testing fluid will be released into the marine environment with rapid dilution and dispersion.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.9
Water quality – medium (3)	Very low (1)	Minor (3)	MAE07
Plankton – low (2)		Negligible (2)	
Fish – medium (3)		Minor (3)	
Protected/ threatened species (fish) – high (4)		Minor (4)	

Mitigation

None required. The safety and environmental benefits of regular testing of the BOP system outweigh the potential environmental impacts of BOP testing fluid release.

Residual impacts

The table below summarises residual impact analysis. The impact intensity remains very low (1), no mitigation is required. Residual impacts are anticipated to be negligible to minor.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.9
Water quality – medium (3)	Very low (1)	Minor (3)	MAE07
Plankton – low (2)		Negligible (2)	
Fish – medium (3)		Minor (3)	
Protected/ threatened species (fish) – high (4)		Minor (4)	

6.3.1.6 *Sanitary waste and food waste discharges (MAE08 and MAE09)*

Impacts of sanitary and food waste discharges on water quality, plankton and fish

Potential impacts

Sanitary waste and food waste from the MODU and support/supply vessels have the potential to affect concentrations of suspended solids, nutrients and chlorine, as well as generating biological oxygen demand (BOD). Estimated quantities of sanitary waste discharged for well B4-1, and for a possible three well drilling programme, are presented in Section 4.6.3.1.

The table below summarises pre-mitigation impact analysis. The impact intensity for water quality, plankton and fish (including protected/threatened species) has been scored in accordance with a combination of factors from Table 1.2 as low (2): the geographic extent is local, the impact duration is short term and discharges from the MODU in offshore Block 4 are likely to be rapidly diluted and dispersed, with minimal impact on water quality and marine life.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.9
Water quality – medium (3)	Low (2)	Moderate (6)	MAE08 and MAE09
Plankton – low (2)		Minor (4)	
Fish – medium (3)		Moderate (6)	
Protected/ threatened species (fish) – high (4)		Moderate (8)	

Mitigation

Sanitary waste from the MODU and the support/supply vessels will be discharged in accordance with MARPOL 73/78 Annex IV. Grey water will be discharged to sea (without treatment) as long as no floating matter or sheen is observable. If sheen is observed, the discharge would be halted, and source of the sheen investigated. Black water will either be contained onboard for transfer to shore and disposal or treated in accordance with MARPOL 73/78 Annex IV before discharge (approved sewage treatment plant discharge requirements provided in Table 2.10). Both the MODU and support/supply vessels will have an International Sewage Pollution Prevention Certificate in line with MARPOL 73/78 Annex IV (the certificate for the Tungsten Explorer MODU is included in Appendix 4.3).

Discharge of food waste from the MODU and support/supply vessels will only be carried out more than 12 nm from the nearest land and all food waste will be ground up in order to pass through a 25-mm mesh before discharge, in line with MARPOL 73/78 Annex V (Mediterranean Sea ‘special area’ requirement). B4-1 well is 11 nm from land hence macerated food waste will not be discharged and will be shipped to shore for treatment and disposal. If at any time the support / supply vessels or MODU are outside 12 nm from nearest land during the B4-1 drilling programme they will be permitted to discharge food waste in accordance with MARPOL Annex V. If future Block 4 wells are located further than 12 nm from shoreline, discharge of macerated food waste will be permitted, and discharge of wastes to sea will be recorded in the MODU’s garbage record book.

Residual impacts

The table below summarises residual impact analysis. The impact intensity for water quality, plankton and fish (including protected/threatened species) has been scored in accordance with a combination of factors from Table 1.2 as very low (1): the geographic extent and impact duration remain the same, however the implementation of mitigation measures presented above and compliance with international standards reduce impact intensity. Residual impacts are anticipated to be negligible to minor.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.9
Water quality – medium (3)	Very low (1)	Minor (3)	MAE08 and MAE09
Plankton – low (2)		Negligible (2)	
Fish – medium (3)		Minor (3)	
Protected/ threatened species (fish) – high (4)		Minor (4)	

6.3.1.7 *Desalination unit discharges (MAE10)*

Impacts of desalination unit discharges on water quality, plankton and fish

Potential impacts

Impacts associated with desalination units are concerned mainly with the discharge of concentrated high salinity water, alterations to temperature, and discharge of anti-scaling chemicals resulting in a reduction in water quality and impacts on marine organisms. It is estimated that about 750 m^3/day of higher salinity water will be discharged from the MODU for well B4-1 (the same applies to the possible 3 well drilling programme). The system will be dosed with the anti-scaling chemical 'HDC-ASI-ECO', which is an environmentally sound all-organic product based on biodegradable compounds.

The table below summarises pre-mitigation impact analysis. The impact intensity for water quality, plankton and fish (including protected/threatened species) has been scored in accordance with a combination of factors from Table 1.2 as very low (1): the geographic extent is local, but the impact duration is very short term and the higher salinity waters are likely to be rapidly diluted and dispersed in this offshore environment. Based on the EBS findings, temperature sensitive species, such as corals, are not anticipated in Block 4.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.9
Water quality – medium (3)	Very low (1)	Minor (3)	MAE10
Plankton – low (2)		Negligible (2)	
Fish – medium (3)		Minor (3)	
Protected/ threatened species (fish) – high (4)		Minor (4)	

Mitigation

No mitigation is suggested, as the dispersion of higher salinity water will be rapid in the offshore location of the well site. It is likely to sink through the water column owing to its increased density, dispersing and diluting as it goes.

Residual impacts

The table below summarises residual impact analysis. The impact intensity remains as very low (1), no mitigation is required. Residual impacts are anticipated to be negligible to minor.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.9
Water quality – medium (3)	Very low (1)	Minor (3)	MAE10
Plankton – low (2)		Negligible (2)	
Fish – medium (3)		Minor (3)	
Protected/ threatened species (fish) – high (4)		Minor (4)	

6.3.1.8 Drainage discharge (including deck drainage, bilge water, slop water and fire water) (MAE11)

Impacts of drainage discharges on water quality, plankton and fish

Potential impacts

Deck drainage consists of wastewater resulting from rainfall, sea spray, rig washing, deck and equipment cleaning, and fire drills. Estimated quantities for well B4-1, and a possible 3 well drilling programme, are provided in Section 4.6.3.4.

Bilge water is defined in MARPOL 73/78 Annex I as water that may be contaminated by oil resulting from issues such as leakage or maintenance work in machinery spaces. Any liquid entering the bilge system including bilge wells, bilge piping, tank top or bilge holding tanks is considered oily bilge water.

Slop water is made up of contaminated drilling and completion fluids, cleaning residue from the rig pits, tanks, pipes and decking and contaminated rain and wash water.

Discharge of oily water to the marine environment can impact water quality and the function of marine organisms.

The MODU will be equipped with a firewater distribution system, and the firewater pumps will be tested on a weekly basis. A foam concentrate system may be in place to enhance the effectiveness of the fire system's deluge water spray and supplemented with carbon dioxide and dry powder extinguishers.

The table below summarises pre-mitigation impact analysis. The impact intensity for water quality, plankton and fish (including protected/threatened species) has been scored in accordance with a combination of factors from Table 1.2 as low (2); the geographic extent is local, the impact duration is short term and drainage discharges are anticipated to be of relatively low volume and will disperse rapidly in the offshore environment.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.9
Water quality – medium (3)	Low (2)	Moderate (6)	MAE11
Plankton – low (2)		Minor (4)	
Fish – medium (3)		Moderate (6)	
Protected/ threatened species (fish) – high (4)		Moderate (8)	

Mitigation

MODUs and support/supply vessels are designed to contain runoff and prevent oily drainage from being released to the environment. The flow is diverted to separate systems depending on the area where the runoff was collected. Drainage water from process areas that could be contaminated with oil goes to closed drains, and drainage water from non-process areas to open drains.

On the MODU, the clean drain tank will collect clean water from the deck drains, scuppers and tops of deck houses. This will only be discharged to sea as long as no visible sheen is observable (sea surface monitored during discharge). A contaminated bilge tank will collect dirty water from the bilge system and machinery space deck drains for treatment in oily water separators. These wastewater discharges will be monitored automatically to ensure that oil in water discharges are less than 15 ppm in accordance with MARPOL 73/78 Annex I. A monitor will check the oil in water content and if this exceeds 15 ppm, the gravity overboard valve from the drain tank will close and another valve will open so that the water can be recirculated back to the oily water separators[2]. Oily waste and sludge from separation processes will be transported to shore for treatment and disposal. Residual oil (sludge) will be collected and maintained onboard, if there is a requirement to empty the sludge tanks (if they are full) sludge will be transported to shore for treatment by a company approved by the competent authorities.

Slop water will be treated onboard the MODU in a slop treatment unit. The treatment unit will be equipped with a control valve that measures the oil content as the treated water is going through it. If the oil content meets the requirement of 15 ppm, the treated slop water will be discharged to sea. If the system detects an output near the discharge limits, it will automatically divert the water back to the feed tank for re-processing. If liquid slops can't meet the 15 ppm after treatment, they will be transferred to Cyprus with the drill cuttings for treatment.

The MODU and support/supply vessels (more than 400 gross tonnage) will have an International Oil Pollution Prevention Certificate (the certificate for the Tungsten Explorer MODU is included in Appendix 4.3), maintain an oil record nook and have an approved shipboard oil pollution emergency plan (SOPEP) in accordance with MARPOL 73/78 Annex I.

The foam concentrate system, carbon dioxide firefighting equipment and dry powder extinguishers will only be discharged in emergency situations.

Residual impacts

The table below summarises residual impact analysis. The impact intensity for water quality, plankton and fish (including protected/threatened species) has been scored in accordance with a combination of factors from Table 1.2 as very low (1): the geographic extent and impact duration remain the same but the implementation of mitigation measures presented above reduces impact intensity with discharges to international standards and rapid dispersion. Residual impacts are anticipated to be negligible to minor.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.9
Water quality – medium (3)	Very low (1)	Minor (3)	MAE11
Plankton – low (2)		Negligible (2)	
Fish – medium (3)		Minor (3)	
Protected/ threatened species (fish) – high (4)		Minor (4)	

[2] MARPOL 73/78 Annex I requirement that discharge automatically stopped if effluent exceeds limit (Mediterranean Sea 'special area' requirement for ships > 400 gross tonnage).

6.3.1.9 Cooling water discharge (MAE12)

Impacts of cooling water discharge on water quality, plankton and fish

Potential impacts

Seawater will be used for equipment and plant cooling on the MODU. It will be uplifted and discharged below the sea surface at an estimated rate of around 105,000 m^3/day for well B4-1 (the same applies to the possible 3 well drilling programme).

The key concerns associated with cooling water uptake and discharge are issues relating to the thermal plume on the marine environment (potential effects on the physiology of marine organisms) and discharge of antifouling chemicals.

The antifouling system will be a marine growth prevention system (MGPS), which supplies an impressed current to a copper anode. No antifouling chemicals will be used in the cooling water system.

The table below summarises pre-mitigation impact analysis. The impact intensity for water quality, plankton and fish (including protected/threatened species) has been scored in accordance with a combination of factors from Table 1.2 as low (2): the geographic extent is local, the impact duration is short term and dilution and dispersion of the cooling water discharge is rapid owing to the offshore location of the MODU. Based on the EBS findings, temperature sensitive species, such as corals, are not anticipated in Block 4.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.9
Water quality – medium (3)	Low (2)	Moderate (6)	MAE12
Plankton – low (2)		Minor (4)	
Fish – medium (3)		Moderate (6)	
Protected/ threatened species (fish) – high (4)		Moderate (8)	

Mitigation

Discharge of cooling water will comply with allowable limits in Decision No. 8/1/2001 (maximum temperature of wastewater discharge to sea 35 °C) and TOTAL/World Bank temperature requirements (temperature increase will not exceed 3°C above ambient 100 m away from discharge point[3]).

There will be no discharge of antifouling chemicals in the cooling water. The antifouling system will be an MGPS, see Section 4.6.3.5.

Residual impacts

The table below summarises residual impact analysis. The impact intensity for water quality, plankton and fish (including protected/threatened species) has been scored in accordance with a combination of factors from Table 1.2 as very low (1): the geographic

[3] Seawater surface temperatures range from 17.3°C in January to 28.9°C in August in Eastern Mediterranean, see Section 5.3.1.5.

extent and impact duration remain the same, however the predicted rapid dilution and dispersion of cooling water discharges in the offshore environment of Block 4 and implementation of mitigation presented above will reduce impact intensity. Residual impacts anticipated to be negligible to minor.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.9
Water quality – medium (3)	Very low (1)	Minor (3)	MAE12
Plankton – low (2)		Negligible (2)	
Fish – medium (3)		Minor (3)	
Protected/ threatened species (fish) – high (4)		Minor (4)	

6.3.1.10 Ballast water exchange (MAE13)

Impacts of ballast water discharge on water quality, plankton and fish (potential for effects on whole ecosystem)

Potential impacts

Discharged ballast water can contain invasive non-native marine animals and plants. This introduction of non-native species is considered one of the five major threats to marine biodiversity identified in the 1992 Convention on Biological Diversity. The introduction of non-native species from ships' ballast water, in addition to other sources, is causing increasing concern and is a potentially serious but highly unpredictable problem in all coastal marine ecosystems (Carlton, 1996).

The effects of introducing new animal and plants can be almost undetectable or, conversely, can completely dominate and displace native communities. A severe example of the impact of introduced non-native organisms in ballast is the introduction of the comb jelly (*Mnemiopsis leidyi*) into the Black Sea, causing significant impacts on plankton populations, and the near extinction of anchovy and sprat fisheries.

The recent connection of the Mediterranean with the Red Sea via the Suez Canal has resulted in a direct pathway for the introduction of species of Indo-Pacific origin. Inward migration of species from the Red Sea into the eastern Mediterranean, known as Lessepsian migration, has had implications for the marine ecosystem of the eastern Mediterranean. It is estimated that there are around 775 marine invasive species in the eastern Mediterranean (Zenetos et al*.,* 2012), which comprise several groups including fish, plankton and benthic species.

The drillship for well B4-1 will be mobilised from within the Mediterranean. However, for possible future wells in Block 4, the MODU may be mobilised from outside the Mediterranean Sea and the support/supply vessels may be mobilised from other ports in the Mediterranean area. The potential for introduction of invasive species therefore needs to be considered.

The table below summarises pre-mitigation impact analysis. The impact intensity for water quality, plankton and fish (including protected/threatened species) has been scored in accordance with a combination of factors from Table 1.2 as medium (3): the geographic extent could be regional if invasive species are introduced and the impact duration medium term.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.9
Water quality – medium (3)	Medium (3)	Moderate (9)	MAE13
Plankton – low (2)		Moderate (6)	
Fish – medium (3)		Moderate (9)	
Protected/ threatened species (fish) – high (4)		Major (12)	

Mitigation

The key mitigation to reduce the risk of introduction of invasive species is compliance with the International Convention for the Control and Management of Ships' Ballast Water and Sediments 2014, which specifies ballast water exchange requirements in order to meet ballast water performance standards (see Section 2.10.2.2). This Convention also requires that vessels have an onboard ballast water management plan, keep a record of all ballast water exchange operations in a ballast water record book and have an International Ballast Water Management Certificate (the certificate for the Tungsten Explorer is included in Appendix 4.3).

It should be noted that the MODU will carry out internal ballasting for a large proportion of its operations with no discharge of ballast to sea.

Ballast water on the MODU and support/supply vessels will be segregated and not come into contact with oil or chemicals.

Residual impacts

The table below summarises residual impact analysis. The impact intensity for water quality, plankton and fish (including protected/threatened species) has been scored in accordance with a combination of factors from Table 1.2 as very low (1) this is due to the mitigation measures significantly reducing the likelihood of invasive species introduction. Residual impacts anticipated to be negligible to minor.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.9
Water quality – medium (3)	Very low (1)	Minor (3)	MAE13
Plankton – low (2)		Negligible (2)	
Fish – medium (3)		Minor (3)	
Protected/ threatened species (fish) – high (4)		Minor (4)	

6.3.1.11 Generation of solid wastes (MAE14)

Impacts limited under normal operations

Potential impacts

Offshore oil and gas operations generate several solid waste streams, as detailed in Section 4.6.5.

Before mitigation, no impacts are anticipated if waste is managed in line with international best practice. However, waste materials accidentally lost overboard can entangle marine fauna or cause injury through ingestion. Leatherback turtles are especially attracted to floating debris, particularly plastic bags, because it resembles their preferred food of jellyfish. Ingestion of plastic can result in drowning, lacerations, digestive orders or blockages, and reduced mobility (Maritime Communication Services Inc. et al., 2008). Marine debris can also injure or kill birds that ingest or become entangled in it.

Mitigation

Disposal of plastics and all other garbage including paper products, rags, glass, metal, bottles, crockery, dunnage, lining and packing material to sea is prohibited under MARPOL 73/78 Annex V (Mediterranean Sea 'special area' requirement). Solid wastes (hazardous and non-hazardous) generated by the Block 4 exploration drilling programme will be transported to shore for recycling/treatment/disposal (with the exception of water-based drill cuttings, see MAE02 and MAE03). For future exploration / appraisal wells there may be the option for onboard incineration of solid waste (dependent on the MODU selected). There is no incinerator onboard the Tungsten Explorer MODU for well B4-1 drilling programme.

Onboard the MODU and support/supply vessels, waste will be segregated at source and coded according to the appropriate waste coding and waste receptacles will be designed to prevent release of wind-borne waste. Waste transfer notes will provide an auditable trail of the waste management process and TEP Liban has developed a waste management plan that will be implemented by its contractors (see Section 8.5.1). Waste management awareness will be raised among personnel through site inductions, toolbox talks, performance reports and general waste management awareness campaigns (e.g., posters, brochures).

Hazardous waste will be transported, stored and treated/disposed of in line with applicable national regulations in force (including reporting requirements, etc).

As discussed in MAE01, a site clearance survey will be conducted after the B4-1 drilling operations are complete to ensure that there is no marine debris from drilling activities deposited on the seafloor around the well site. If marine debris is located, option for removal by ROV would be considered. Any floating waste lost from MODU would be collected by the support or supply vessels.

Residual impacts

As all solid waste streams generated by the Block 4 exploration drilling campaign will be shipped to shore for recycling / treatment / disposal (with the exception of water-based drill cuttings, see MAE02 and MAE03), impacts on marine receptors are not anticipated; see MAE14, Table 6.9.

Potential accidental impacts from objects dropped overboard from the MODU are discussed in Section 6.5.1 (Table 6.11, AE1).

6.3.1.12 Air emissions (MAE04, MAE15, MAE16 and MAE17)

Impacts of air emissions on air quality and climate change

Potential impacts

The MODU will emit air pollutants including CO, NO_x, SO_x, VOCs, PM_{10} and greenhouse gases (GHGs) such as CO_2, CH_4 and N_2O from engine exhaust emissions and operation of the onboard incinerator. Support/supply vessels and helicopters will also emit air pollutants from combustion of diesel and aviation fuel.

Environmental issues associated with air pollutant emissions include

- CO – contributes indirectly to global warming by enhancing low-level ozone production, poisonous at high concentrations and can potentially enhance photochemical smog
- NO_x – can form ozone at ground level by reacting with volatile organic compounds (VOC) in the presence of sunlight. Ground-level ozone at elevated concentrations is harmful to people, animals and plants.
- SO_x – contributes to acid deposition (wet and dry), which affects freshwater and terrestrial ecosystems. Respiratory illness is a potential direct health effect.
- VOCs – contribute to the generation of ground-level ozone in the presence of NOx and are associated with the generation of photochemical smog. Direct health effects include eye irritation and coughing; some are carcinogenic.
- CO_2, CH_4 and N_2O – GHGs that contribute to global warming.

Air pollutant emissions and greenhouse gas emissions for well B4-1, and the possible 3 well drilling programme, are presented in Tables 4.9 and 4.10.

The estimated GHG emissions for the B4-1 drilling programme (13692 t CO_2 equivalent for both offshore and onshore activities, see Table 4.12) represent about 0.06% of Lebanon's annual emissions. Estimated GHG emissions for a possible 3 well programme, including well test, (50249 t CO_2 equivalent) represent about 0.2% of Lebanon's annual emissions. Lebanon's total GHG emissions in 2012 were 24.34 million Mt CO_2 equivalent (Climatelinks, 2019).

It should be noted that for well B4-1, transportation of cuttings to Cyprus for treatment and disposal represents 8% of the total emissions for this well (MAE04).

The table below summarises pre-mitigation impact analysis. The impact intensity for all air emission impacts has been scored in accordance with a combination of factors from Table 1.2 as low (2): the geographic extent is local; the impact duration is short term and relatively small quantities of pollutants are emitted. Dilution and dispersion of pollutants is rapid in the offshore atmosphere, and the distance of activities from the shore is considerable.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.9
Air quality – low (2)	Ship to shore transportation of NADF cuttings – low (2)	Minor (4)	MAE04
Climate change – medium (3)		Moderate (6)	
Air quality – low (2)	Operation of incinerator onboard MODU – low (2)	Minor (4)	MAE15
Climate change – medium (3)		Moderate (6)	
Air quality – low (2)	MODU and support/ supply vessel/ helicopter transfer/ plant operation – low (2)	Minor (4)	MAE16
Climate change – medium (3)		Moderate (6)	
Air quality – low (2)	Well test of possible future appraisal well – low (2)	Minor (4)	MAE17
Climate change – medium (3)		Moderate (6)	

Mitigation

The MODU and support/supply vessels will comply with MARPOL 73/78 Annex VI, which sets out SO_x[4] and NO_x emissions from ship exhausts and prohibits deliberate emissions of ozone-depleting substances including halons and chlorofluorocarbons. MARPOL also sets limits on emissions of NO_x from diesel engines. The MODU and support/supply vessels (more than 400 gross tonnage) will obtain an International Air Pollution Prevention Certificate in accordance with MARPOL 73/78 Annex VI (the certificate for the Tungsten Explorer MODU is included in Appendix 4.3).

In addition, all machinery, equipment and installations will comply with generally accepted standards in the international petroleum industry, will be of proper construction and kept in good working order. Any ozone-depleting substances and all products listed in the Montreal Protocol, i.e., CFCs, HCFCs and halons, will be prohibited except for essential use, under derogation.

There will be no incinerator onboard the MODU for well B4-1. If future exploration / appraisal wells are drilled using a MODU with onboard incinerator TEP Liban will inform the MoE for environmental clearance. Any onboard incineration for future wells will be carried out in compliance with the requirements of MARPOL 73/78 Annex XI Chapter 3, regulation 16, which relates to shipboard incineration.

Fuel efficiency measures were taken into account in the selection of the MODU and support/supply vessel and helicopters transfers to the MODU will be optimised. To minimise engine use, the support vessel will drift around the MODU while carrying out its safety and security duties.

With respect to air emissions from cuttings transportation to Cyprus (MAE04), effective separation of non-aqueous drilling fluids from the cuttings on the drilling rig will minimise volumes requiring transportation (it is estimated that the solids control equipment on the

[4] The sulphur content of marine fuel oil used on-board ships must not exceed 0.5% by mass in line with MARPOL 2020. Alternatively, ships must fit an exhaust gas cleaning system or use any other technological method to limit SO_x emissions.

MODU will be capable of recovering around 95% of drilling fluids from cuttings). The use of HPWBFs and cuttings discharge to sea will be considered for future wells in Block 4.

Should a well test of an appraisal well (MAE17) take place in the future, management and mitigation measures specified in TOTAL's corporate requirements will be followed. Alternatives to flaring of produced hydrocarbons (i.e., recovery) will be evaluated. If flaring is the sole option available for the disposal of test fluids, only the minimum volume of hydrocarbons required for the test will be flowed and the well test duration will be reduced to the extent practical. An efficient test flare burner head equipped with an appropriate combustion enhancement system (e.g., "evergreen burners" type) will be selected to minimise incomplete combustion, black smoke and hydrocarbon fallout to the sea.

A permit will be obtained from the Ministry of Energy and Water for flaring during well test and TEP Liban will inform the MoE for environmental clearance. Air emissions data, including GHG information, from project activities will be submitted to the MoE.

Residual impacts

The table below summarises residual impact analysis. The impact intensity for all air emission impacts has been scored in accordance with a combination of factors from Table 1.2 as very low (1): the geographic extent and impact duration are the same, but the implementation of the above mitigation measures ensures emissions are to national / international standards with the majority of air emission sources at an offshore location. Residual impacts are anticipated to be negligible to minor.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.9
Air quality – low (2)	Ship to shore transportation of NADF cuttings – very low (1)	Negligible (2)	MAE04
Climate change – medium (3)		Minor (3)	
Air quality – low (2)	Operation of incinerator onboard MODU – very low (1)	Negligible (2)	MAE15
Climate change – medium (3)		Minor (3)	
Air quality – low (2)	MODU and support/ supply vessel/ helicopter transfer/ plant operation – very low (1)	Negligible (2)	MAE16
Climate change – medium (3)		Minor (3)	
Air quality – low (2)	Well test of possible future appraisal well – very low (1)	Negligible (2)	MAE17
Climate change – medium (3)		Minor (3)	

6.3.1.13 Underwater noise (MAE18 and MAE19)

Impacts of underwater noise on cetaceans and seals

Underwater noise modelling study

In order to determine potential impacts of underwater noise generated by the exploration drilling campaign on marine mammals and turtles, Xodus Group was commissioned to carry out underwater noise modelling and assessment of

- drilling operations of the MODU (continuous noise)
- vessel operations, including a support vessel on station with the MODU and visits from supply vessels (continuous noise)
- vertical seismic profile (VSP) activities – airgun array operation (impulsive noise).

Noise source data for the above are provided in Table 6.2.

Table 6.2: Noise-generating activity source data

Activity	Data source	Peak sound pressure level db re 1 μPa	Sound exposure level (SEL), dB re 1 $\mu Pa^2 s$	Root mean square (rms) sound pressure level, dB re 1 μPa
VSP	TEP Liban – Gundalf report[5]	241	229	239
Semi-submersible rig	Nedwell et al. (2001)[6]	189	186 (1 s)	186 (186.4)
Drillship (including thrusters)	Stena Forth Kyhn et al. (2011)[7]	189	186 (1 s)	186 (185.6)
Support vessel	Austin and McGillivray, 2005[8]	191	188 (1 s)	188
Supply vessel	Austin and McGillivray, 2005	191	188 (1 s)	188

Source: Xodus Group (2019)

Noise propagation modelling for the assessment was carried out using the Xodus SubsoniX noise model. This model is a semi-empirical, range dependent propagation

[5] Summary of Gundalf report for the proposed Block 4 VSP airgun array: Number of guns 4; total volume 1000 m^3; peak amplitude 11.8 bar-m at 5 m depth; peak-to-peak amplitude 21.4 bar-m at 5 m depth; zero to peak sound pressure level 241 dB re 1 μPa.

[6] Data from hydrophone measurements taken on a semi-submersible rig whilst drilling conducted, considered representative of a semi-submersible that could be used for Block 4 drilling programme. Most significant contributions to underwater noise from DP systems (thrusters).

[7] Data from measurements taken on a drillship whilst drilling conducted, considered representative of a drillship that could be used for Block 4 drilling programme. Most significant contributions to underwater noise from DP systems (thrusters).

[8] Based on measurements from offshore support vessel of about 2000 t, considered representative of the support and supply vessels utilised in the Block 4 drilling programme. Most significant contributions to underwater noise from onboard machinery, hydrodynamic flow around the hull and propeller cavitation.

model which is based on a combination of theoretical considerations and extensive experimental data.

Physicochemical characteristics of the water column and sediments in Block 4 were obtained from the Block 4 EBS. The following parameters were used in the modelling: water temperature 14°C; salinity 38.75; pH 7.9; water column depth 1450-1760 m; sediment depth 2 m (mud).

This section models and assesses the impact of underwater noise on marine mammals. Modelling and assessment of impacts on turtles are considered in the next section of the report.

To determine the consequence of received noise levels on marine mammals, it is important to have an understanding of their hearing range. Marine mammals have therefore been categorised into

- low-frequency cetaceans (LF cetaceans), i.e., marine mammal species with an estimated functional hearing range of 7 Hz–22 kHz
- mid-frequency cetaceans (MF cetaceans), i.e., marine mammal species with an estimated functional hearing range of 200 Hz–160 kHz
- high-frequency cetaceans (HF cetaceans), i.e., marine mammal species with an estimated functional hearing range of 200 Hz–180 kHz
- pinnipeds in water – a suborder of carnivorous aquatic mammals that includes seals, walruses and other similar animals having finlike flippers
- sirenians includes trichechidae (manatees) and dugongidae (dugongs) – hearing sensitivities have slightly lower upper cut-off frequencies and sensitivities compared to the mid-frequency cetaceans.

Regularly occurring cetaceans in the region include common bottlenose dolphin, striped dolphin, short-beaked common dolphin, Risso’s dolphin, Cuvier’s beaked whale and rough-toothed dolphin. Fin whales, sperm whales and false killer whales are considered visitors to the area, and humpback whales and killer whales are considered vagrant (Bariche, 2010, 2012; Kerem et al., 2012).

The Mediterranean monk seal is the only seal in the region (Karamanlidis and Dendrinos, 2015). For the purpose of the underwater noise assessment, marine mammal hearing groups corresponding to LF, MF and HF cetaceans are included together with phocid pinnipeds (seals). Most of the cetaceans listed are in the MF category; the only exceptions being the baleen whales (fin and humpback), which are in the LF cetacean hearing category.

Underwater noise has the potential to affect marine life in different ways depending on its noise level and characteristics. Richardson et al. (1995) defined four zones of noise influence that vary with distance from the source and level. These are

- zone of audibility – the area within which the animal is able to detect the sound (audibility itself does not implicitly mean that the sound will have an effect on the marine mammal)
- zone of masking – the area within which noise can interfere with detection of other sounds such as communication or echolocation clicks
- zone of responsiveness – the area within which the animal responds either behaviourally or physiologically

- zone of injury/hearing loss – the area where the sound level is high enough to cause tissue damage in the mammals hearing mechanism. This can be classified as either temporary threshold shift (TTS) or permanent threshold shift (PTS)[9].

For this study, it is the zones of injury and disturbance, i.e., responsiveness, that are of concern.

Underwater acoustic thresholds for the onset of injury/hearing loss have been assessed in accordance with the recently revised levels presented in NOAA Technical Memorandum NMFS-OPR-59, April 2018 (see Table 2.12).

Disturbance occurs when there is a risk of a group of animals incurring sustained or chronic disruption to behaviour or are displaced from an area outside their natural variation. To identify the possibility of disturbance, it is necessary to consider both the likelihood of a sound causing a disturbance and the likelihood that the marine mammals will be exposed to that sound. Underwater acoustic thresholds for disturbance have been assessed in accordance with the criteria in Table 2.13, which is based on guidance from Volume 70 of the U.S. Federal Register (Federal Register 2005) Level B harassment threshold[10] for marine mammals and disturbance ranges identified by Southall et al. (2007).

The following section presents the results of the underwater noise modelling and assessment. The distances presented are the closest (calculated) distances that a marine mammal can be to the source of the noise before the noise level exceeds the threshold for the onset of physiological damage or behavioural changes. At distances greater than those shown in the tables, it is assumed that there will be no adverse impact.

In all modelling scenarios, it is assumed that marine mammals will move away from the source of the noise at a constant rate of 1.5 m/s, although it is thought that this is likely to be a conservative estimate of swim speed for the mammals inhabiting the study area.

Potential impacts from VSP activities

Estimated ranges for injury and disturbance to marine mammals from VSP survey activities is summarised in Table 6.3.

In this case as well as calculating peak sound pressure levels (SPL) at various distances from the source, it is also necessary to calculate the sound exposure levels (SEL) for a mammal using the relevant hearing ranges described earlier and taking into account the number of pulses to which it is exposed over the course of a day. For operation of the VSP source array, the SEL sound data for a single pulse was utilised, along with the maximum number of pulses expected to be received by marine mammals to calculate cumulative exposure.

Results for VSP activities with the use of a soft-start procedure (described in more detail in mitigation below) are also included in Table 6.3.

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[9] TTS is a relatively short-term reversible loss of hearing, often resulting from cellular fatigue and metabolic changes. PTS is an irreversible loss of hearing (permanent damage) that commonly results from inner ear hair cell loss and/or severe damage or other structural damage to auditory tissues (e.g., Saunders et al., 1985; Henderson et al., 2008).

[10] Level B harassment is defined as having the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioural patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild.

For peak pressure levels, the impact is limited to a range of 162 m for HF cetaceans which are the most sensitive hearing group. For the other hearing groups and species, the radius for potential injury does not exceed 26 m. It should be noted that the majority of species in the Eastern Mediterranean basin relate to MF cetaceans that avoid injury at distances of 7 m or greater from the VSP airgun array.

The injury criteria for cumulative sound exposure for impulsive noise suggest that to avoid injury to marine mammals where the animal is moving away from the static source, the maximum radius for potential injury is 499 m for the sensitive HF cetacean hearing group. The other species avoid serious injury to their hearing if they are more than 78 m away.

With soft-start procedures for the VSP airgun array, impact distances are reduced by up to a half.

Table 6.3: Radius of marine mammal potential injury and behavioural change zones for VSP activities at well site B4-1

Situation	Radius of effect (m)			
	LF cetacean	MF cetacean	HF cetacean	Phocid pinnipeds
Peak pressure (SPL) physiological damage	23 m	7 m	162 m	26 m
Peak pressure (SPL) physiological damage with soft start	7 m	2 m	51 m	8 m
SEL of marine mammal swimming away from source	78 m	66 m	499 m	62 m
SEL of marine mammal swimming away from source with soft start	29 m	24 m	255 m	24 m
RMS behavioural change	4580 m			

SPL - sound pressure level; SEL – sound exposure level; RMS – root mean squared. Source: Xodus Group (2019)

The radius of the zone for onset of behavioural change effects, using a 160 dB re 1 μPa (rms) threshold criteria (see Table 2.13), will be about 4580 m from the VSP operations.

Behavioural changes such as moving away from an area for short periods of time, reduced surfacing time, masking of communication signals or echolocation clicks, and vocalisation changes do not necessarily imply a detrimental effect on the animals involved. In addition, the airgun pulses will be intermittent rather than a continuous sound, which will reduce the period over which sound is experienced and allow animals to echolocate and communicate between pulses. Some whales are known to continue calling in the presence of seismic pulses, as the vocalisations can be heard between pulses (e.g., Madsen et al., 2002).

It is therefore considered that the zone of behavioural change will not be a zone from which animals are necessarily excluded, but rather one in which normal behaviour might be affected across a range of potential responses, from a simple noticing of the sound, to a startle response and return to normal behaviour, through to exclusion from the area. Firing operations are unlikely to extend beyond a few hours further limiting the behavioural effects of the VSP operations.

Potential impacts from continuous noise (drilling activities and vessel operations)

The injury and disturbance ranges for drilling operations comprising a MODU and two support/supply vessels are shown in Table 6.4.

These results reflect drilling operations and dynamic positioning from a drillship or semi-submersible with a standby vessel continuously in support and a supply vessel visiting the site.

It should be noted that an 'NE' designation corresponds to an animal not being exposed to sufficiently high noise to cause injury at the closest possible distance from the source of the noise, i.e., the threshold was not exceeded at a distance of less than 1 m.

Note there are no peak noise threshold limits for continuous noise.

Table 6.4: Marine mammal modelling results MODU drilling and vessel noise

Situation	Radius of effect (m)			
	Low-frequency cetacean	Mid-frequency cetacean	High-frequency cetacean	Phocid pinnipeds
SEL of swimming mammal at 1.5 m/s	Drillship: NE Semi-sub: NE	Drillship: NE Semi-sub: NE	Drillship: NE Semi-sub: 3 m	Drillship: NE Semi-sub: NE
Strong (mild) behavioural disturbance	Drillship: 858 m (8526 m) Semi-sub: 866 m (8586 m)			

SEL – sound exposure level; NE - no effect within 1 m. Source: Xodus Group (2019)

For drillship and support vessel operations, none of the mammal hearing groups are subject to noise levels that could cause injury to their hearing, including the most sensitive group HF cetaceans. The chances marine mammals will be exposed to injurious levels of noise is therefore low and only likely at distances very close to the source.

For large sound sources such as a drillships or standby vessels, an imagined point at 1 m from the acoustic centre does not exist; rather the energy will be distributed across the surface of the source (or from specific areas of it, e.g., around DP equipment) as opposed to all emanating from a single point. The near field sound levels are therefore likely to be overstated.

Marine mammals may be expected to exhibit strong behavioural responses out to a distance of about 870 m, with mild disturbances occurring up to about 8.5 km from the centre of activity.

Owing to the similarity in source levels, the results for the semi-submersible are very similar to those of the drillship.

The table below summarises pre-mitigation impact analysis. The impact intensity for underwater noise impacts from VSP activities has been scored in accordance with a combination of factors from Table 1.2 as low (2): the geographic extent is local and the impact duration is very short term, however the VSP activities could cause potential injury to species of conservation concern in the immediate vicinity of the airgun (based on the underwater noise modelling output). The impact intensity for continuous underwater noise impacts from drilling activities and vessel operations has been scored as very low (1): the geographic extent is local and the impact duration is very short term. Injury to species of conservation concern is not predicted in this case, although there may be disturbance impacts (based on the underwater noise modelling output).

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.9
Cetaceans – high (4)	Underwater noise from VSP activities – low (2)	Moderate (8)	MAE18
Seals – high (4)		Moderate (8)	
Cetaceans – high (4)	Continuous underwater noise from drilling activities and vessel operations – very low (1)	Minor (4)	MAE19
Seals – high (4)		Minor (4)	

Mitigation

For operations taking place in the Mediterranean Sea, there is an expectation that where a potential risk of injury or disturbance to cetaceans can be demonstrated, the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS) guidance on mitigation will be followed. For operations taking place in the Mediterranean Sea, there is an expectation that where a potential risk of injury or disturbance to cetaceans can be demonstrated, the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS) guidance on mitigation will be followed.

The 2016 'ACCOBAMS Methodological Guide: Guidance on Underwater Noise Mitigation Measures' provides mitigation requirements for seismic surveys including use of a visual monitoring protocol, use of an acoustic monitoring protocol and use of a soft-start protocol. These requirements have been taken into consideration in the development of the VSP-specific mitigation measures presented below:

- minimum mitigation exclusion zone of 500 m[11]
- visual monitoring of the mitigation exclusion zone by trained marine mammal observers (MMOs)
- use of acoustic monitoring, e.g., passive acoustic monitoring (PAM), to detect the presence of marine mammals
- all observations (MMO or PAM) to be undertaken during a pre-shooting search of up to 60 minutes before using the airgun devices. This will involve a visual (during daylight hours) and/or acoustic assessment (during hours of darkness/

[11] For VSP operations with no soft start, the SEL of a marine mammal swimming away from the source is 66 m for MF cetaceans (and 499 m for HF cetaceans). As a precautionary approach, the exclusion zone will be set at a radius of 500 m.

reduced visibility) to determine if any marine mammals are within the specified 500-m mitigation exclusion zone. If marine mammals are detected during the pre-shooting search then the soft-start will be delayed until their passage results in the marine mammals being outside of the mitigation zone. Notwithstanding this, there should be a minimum of a 20-minute delay from the time of the last sighting within the mitigation exclusion zone and the commencement of the soft-start, to allow animals unavailable for detection to leave the area;

- soft start procedure to be used where airgun noise emissions begin at low power, increasing gradually until full power is reached[12]
- reporting of the results and findings of real-time mitigation practices to ACCOBAMS. Results of the first survey should be used to inform any subsequent survey applications.

From the results of the assessment, none of the continuous noise sources (MODU and associated support/supply vessels) are likely to produce significant levels of noise to cause injury to the marine mammals that are likely to be found within the development area, subsequently there is no requirement for mitigation for these activities.

Residual impacts

Offshore Block 4 area has not been identified as a significant area for marine mammals. Marine mammal sightings recorded during the offshore EBS of Block 4 in March–April 2019 were limited to two bottlenose dolphins. Sightings of the Mediterranean monk seal have occurred along the Lebanese coast in recent years, although the likelihood of its presence within the AOI is limited.

The table below summarises residual impact analysis. The impact intensity for underwater noise impacts from VSP activities and continuous underwater noise impacts from drilling activities and vessel operations has been scored in accordance with a combination of factors from Table 1.2 as very low (1): the geographic extent and impact duration remain the same, however the implementation of the above mitigation measures reduce impact intensity by decreasing the potential for injury of species of conservation concern. Residual impacts are anticipated to be minor.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.9
Cetaceans – high (4)	Underwater noise from VSP activities – very low (1)	Minor (4)	MAE18
Seals – high (4)		Minor (4)	
Cetaceans – high (4)	Continuous underwater noise from drilling activities and vessel operations – very low (1)	Minor (4)	MAE19
Seals – high (4)		Minor (4)	

[12] A 10-minute soft start is recommended in this case. The 30-minute soft start required for seismic surveys is seen as disproportionate given the limited time associated with VSP firing operations (2–3 hours in total).

Impacts of underwater noise on marine turtles

Potential impacts

The underwater noise modelling and assessment conducted by Xodus Group for marine mammals also included assessment of effects on marine turtles.

Three species of marine turtle occur in Lebanese waters, potentially within the AOI: loggerhead turtle, green turtle and leatherback turtle, all of which are threatened according to the IUCN Red List (IUCN, 2018). Nesting sites for green and loggerhead turtles are found on sandy shorelines in Lebanon, whereas the leatherback turtle is only a visitor to the Mediterranean Sea.

Marine turtles appear to hear best at 200–750 Hz and do not respond well to sounds above 1000 Hz. The opening into a sea turtle's ear is covered by thick skin and a ring of scales known as the cutaneous plate. Below this skin is a fatty (subcutaneous) layer. The thick skin and a fatty layer make it difficult for the turtle to hear well in air but provide good tissue conduction for underwater sound to the middle and inner ear.

Few studies have looked at hair cell damage in reptiles, and it is still unknown if sea turtles are able to regenerate hair cells (Warchol, 2011). There is hardly any data on the effects of intense sounds on marine turtles, so it is difficult to predict the level of damage to hearing structures. Clear avoidance reactions to seismic signals at levels between 166 and 179 dB re 1 µPa have been observed by turtles (Moein et al., 1995; McCauley et al., 2000); however, these studies were conducted in a caged environment, so the extent of avoidance could not be monitored. Furthermore, a study by Weir (2007) argues that an assessment of turtle behaviour in relation to seismic surveys is hindered by the apparent reaction of individuals to the ship and towed equipment rather than specifically to airgun sound. These reactions occurred at close range (usually <10 m) to approaching objects and appeared to be based principally on visual detection.

Clearly, more research on the behavioural and physiological responses to sound needs to be conducted before appropriate noise exposure criteria can be developed for reduced fitness, injury and death. For marine turtles, the most relevant criteria for injury are considered to be those contained in the Sound Exposure Guidelines for Fishes and Sea Turtles (Popper et al., 2014), see Table 2.14. As it is not possible to draw any conclusions on the potential disturbance effects from guidance presented in Popper et al. (2014), thresholds for behavioural reactions to pulsed sounds based on the work by McCauley et al. (2000), see Table 2.15.

Potential impacts from VSP activities

The results of the underwater noise modelling and assessment are included in Table 6.5.

These findings (radius of potential injury up to 91 m from the source) are supported by qualitative assessment conducted by Popper et al. (2014), which states there is a high risk of recoverable injury close to the seismic source but a low risk at distances described at intermediate distances (i.e., at hundreds of metres) or beyond.

A moderate to high level of disturbance is possible within about 1310 m of the VSP airgun source (see Table 6.6).

Table 6.5: Radius of sea turtle potential injury zones for VSP activities

Effect	Popper thresholds for injury (dB re 1 µPa)	Radius of potential injury
Peak pressure (SPL) physiological damage	> 207	91 m
Peak pressure (SPL) physiological damage + soft start	> 207	29 m
SEL of turtle swimming away from the source	> 210	18 m
SEL of turtle swimming away from the source + soft start	> 210	5 m

Source: Xodus Group (2019)

Table 6.6: Radius of sea turtle behavioural reaction/disturbance for VSP activities

Effect	RMS sound pressure level dB re 1 µPa	Radius of potential effect
Potential strong behavioural reaction	175	1310 m
Low level or onset of disturbance	166	3135 m

Source: Xodus Group (2019)

Potential impacts from continuous noise (drilling activities and vessel operations)

The results of the underwater noise modelling and assessment are included in Table 6.7. These findings suggest there is a risk of avoidance reaction or strong behavioural response close to the source (i.e., 15 m) but otherwise responses are low away from the source.

Table 6.7: Radius of sea turtle behavioural effects MODU drilling and vessel noise

Effect	RMS sound pressure level dB re 1 µPa	Radius of potential effect	
		Drillship and support/supply vessels	Semi-sub and support/supply vessels
Potential strong behavioural reaction	175	15 m	15 m
Low level or onset of disturbance	166	43 m	43 m

Source: Xodus Group (2019)

The table below summarises pre-mitigation impact analysis. The impact intensity for underwater noise impacts from VSP activities has been scored in accordance with a combination of factors from Table 1.2 as low (2): the geographic extent is local, the impact duration is very short term, however the VSP activities could cause potential injury to species of conservation concern in the immediate vicinity of the airgun based on the underwater noise modelling output. The impact intensity for continuous underwater noise impacts from drilling activities and vessel operations has been scored as very low (1): the geographic extent is immediate and the impact duration is short term. Injury to species of conservation concern is not predicted in this case, although there may still be disturbance impacts (based on the underwater noise modelling output).

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.9
Turtles – high (4)	Underwater noise from VSP activities – low (2)	Moderate (8)	MAE18
Turtles – high (4)	Continuous underwater noise from drilling activities and vessel operations – very low (1)	Minor (4)	MAE19

Mitigation

Mitigation measures proposed for marine mammals are considered adequate for reduction of impacts on marine turtles (i.e., soft start of the VSP airguns and monitoring of the mitigation exclusion zone for marine turtles before starting up airguns).

Residual impacts

Satellite tracking of green turtles suggests that individuals do migrate along the coast of the eastern Mediterranean, though in lower numbers than on the high-use seasonal pelagic corridor running south-west from Turkey and Cyprus to Egypt, see Figure 5.66. Foraging takes place off Tripoli, though this is likely to be quite coastal and focused on seagrass beds in the area.

The table below summarises residual impact analysis. The impact intensity for underwater noise impacts from VSP activities and continuous underwater noise impacts from drilling activities and vessel operations has been scored in accordance with a combination of factors from Table 1.2 as very low (1): the geographic extent and impact duration remain the same, however the implementation of the above mitigation measures reduce impact intensity by decreasing the potential for injury of species of conservation concern. Residual impacts are anticipated to be minor.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.9
Turtles – high (4)	Underwater noise from VSP activities – very low (1)	Minor (4)	MAE18
Turtles – high (4)	Continuous underwater noise from drilling activities and vessel operations – very low (1)	Minor (4)	MAE19

Impacts of underwater noise on fish

Potential impacts

Sound plays a major role in the lives of fish (Fay and Popper, 2000) and is important for communication, locating prey, avoiding predators and developing a general understanding of surroundings.

The impact of sound on fish is, to a large extent, determined by the physiology of fish, particularly the presence or absence of a swim bladder and the use of the swim bladder to improve hearing sensitivity and range. Detection of sound pressure and particle motion increases the hearing sensitivity and broadens the hearing bandwidth of species (Popper et al., 2014). The morphological features of fish have been used to categorise them depending on hearing sensitivity and how they might be affected by sound. These categories are

- high sensitivity fish – species in which hearing involves a swim bladder or other gas volume (e.g., species of the Clupidae family including sardine and sardinella). These species are susceptible to barotrauma (injury of a body part or organ as a result of changes in pressure) and detect sound pressure and particle motion.
- medium sensitivity fish – species with swim bladders in which hearing does not involve the swim bladder or other gas volume (e.g., groupers, tunas and other species of pelagic 'white fish'). These species are susceptible to barotrauma, although hearing only involves particle motion not sound pressure.
- low sensitivity fish – species with no swim bladder or other gas chamber (e.g., sharks, rays, flatfish). There species are less susceptible to barotrauma and only detect particle motion not sound pressure. However, some barotrauma may result from exposure to sound pressure.

Most species of fish and elasmobranchs are able to detect sound frequency from well below 50 Hz (some as low as 10 or 15 Hz) to upward of 500 to 1,000 Hz (Popper and Fay 1999; Popper et al. 2003), and consequently can detect sounds within the frequency range of most widely occurring anthropogenic noises (Vasconcelos et al. 2007; Codarin et al., 2009).

Potential impacts from VSP activities

As stated previously, the VSP activities at the well site will involve the use of an airgun array (seismic source) activated near the sea surface. The peak pressure level of the airgun array will be 241 dB re 1 uPa @ 1 m, with a cumulative sound exposure level of 229 dB re 1 $\mu Pa^2 s$ (see Table 6.2).

Popper et al. (2014) has developed guidelines derived from several data sources that summarise the impacts of seismic airguns on the different categories of fish (see Table 6.8).

It is assumed that species from all three fish hearing groups could be present in the AOI. The individual species susceptibility to underwater noise is not known, although the general table from Popper provides the best current guidelines. Based on the airgun sound levels, there is potential for mortality and recoverable injuries in the near field (tens of metres from the source), potential for TTS in the intermediate field (hundreds of metres from the source) and potential for masking and behavioural impacts in the far field (kilometres from the source).

Table 6.8: Mortality and recoverable injury guidelines for fish from seismic airguns

Hearing group	Mortality and potential mortal injury	Impairment			Behaviour
		Recoverable Injury	TTS	Masking	
Fish – no swim bladder (particle motion detection)	>219 dB SEL_{cum} or >213 dB peak	>216 dB SEL_{cum} >213 dB peak	>>186 dB SEL_{cum}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish – swim bladder is not involved in hearing (particle motion detection)	210 dB SEL_{cum} or >207 dB peak	203 dB SEL_{cum} >207 dB peak	>>186 dB SEL_{cum}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish – swim bladder is involved in hearing (primarily pressure detection)	207 dB SEL_{cum} or >207 dB peak	203 dB SEL_{cum} >207 dB peak	186 dB SEL_{cum}	(N) Low (I) Low (F) Moderate	(N) High (I) High (F) Moderate

*Near (N), intermediate (I), and far (F) distances to effects are not defined; however, “near” might be considered to be in the tens of metres from the source, “intermediate” in the hundreds of metres, and “far” in the thousands of metres. Source: Popper et al. (2014)

Potential impacts from continuous noise (drilling activities and vessel operations)

Underwater noise generated by the operations of the MODU and support/supply vessels (peak sound level around 190 dB re 1 uPa @ 1 m, with a cumulative sound exposure level of around 188 dB re 1 μPa^{2}s (see Table 6.2) does not have potential to cause mortality or injury impacts to fish, though there is the potential for TTS in the near field.

The table below summarises pre-mitigation impact analysis. The impact intensity for underwater noise impacts from VSP activities has been scored in accordance with a combination of factors from Table 1.2 as low (2): the geographic extent is local and the impact duration is very short term, however the VSP activities could cause potential injury to fish species of conservation concern in the immediate vicinity of the airgun. The impact intensity for continuous underwater noise impacts from drilling activities and vessel operations has been scored as very low (1): the geographic extent is local; the duration is very short term and the potential for permanent injury is not anticipated.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.9
Fish – medium (3)		Moderate (6)	MAE18

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.9
Protected/ threatened species (fish) – high (4)	Underwater noise from VSP activities – low (2)	Moderate (8)	
Fish – medium (3)	Continuous underwater noise from drilling activities and vessel operations – very low (1)	Minor (3)	MAE19
Protected/ threatened species (fish) – high (4)		Minor (4)	

Mitigation

A soft-start procedure will be used for the airgun source. This gradual ramping-up of power will allow fish to move away from the area before they are exposed to significant noise levels, thus minimising risk of physical injury.

None of the continuous noise sources (MODU and associated support/supply vessels) are likely to produce significant levels of noise to cause injury to fish, subsequently there is no requirement for mitigation for these activities.

Residual impacts

The table below summarises residual impact analysis. The impact intensity for underwater noise impacts from VSP activities and continuous underwater noise impacts from drilling activities and vessel operations has been scored in accordance with a combination of factors from Table 1.2 as very low (1): the geographic extent and impact duration remain the same, and the implementation of the above mitigation measures further reduce impact intensity by decreasing the potential for injury to fish. Residual impacts are anticipated to be minor.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.9
Fish – medium (3)	Underwater noise from VSP activities – very low (1)	Minor (3)	MAE18
Protected/ threatened species (fish) – high (4)		Minor (4)	
Fish – medium (3)	Continuous underwater noise from drilling activities and vessel operations – very low (1)	Minor (3)	MAE19
Protected/ threatened species (fish) – high (4)		Minor (4)	

6.3.1.14 Light emissions (MAE20)

Impacts of light emissions on seabirds, fish, and turtles

Potential impacts

The MODU and support/supply vessels will use lighting during the hours of darkness for navigation, safety and security.

Impacts on seabirds (including protected/threatened species)

It is possible that seabirds flying in the vicinity of the MODU and vessels may get disorientated. For example, nocturnal migrants can be attracted to lights inducing 'circulations' where birds seem to become trapped inside the cone of light (Russell, 2005). Circulations put birds at risk of collision with the vessel or with each other and result in non-useful expenditure of energy. Offshore/pelagic birds are the main concern for this project as they will be present in greatest numbers in Block 4. Based on the EBS, gulls were the most prevalent seabirds that were observed in the area.

Impacts on fish (including protected/threatened species)

Lighting on the MODU and support/survey vessels may attract planktonic organisms and subsequently larger marine fish. Little information is available regarding the potential impacts of lighting of offshore structures and vessels on marine communities (Marchesana, 2005); however, the increase in temporary lighting is unlikely to induce any long-term changes in feeding behaviours or population dynamics.

Impacts on turtles

Lighting impacts on turtles are mostly concerned with disorientation of hatchlings going out to sea. As the B4-1 well site is 20 km offshore (and the closest that a future Block 4 exploration/appraisal well could be to shore is 12 km) this is not considered an issue.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1): the geographic extent is immediate, the impact duration is very short term, and disturbance to individuals is similar in effect to the random changes in population due to normal environmental variation.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.9
Seabirds – medium (3)	Very low (1)	Minor (3)	MAE20
Fish – medium (3)		Minor (3)	
Protected/ threatened species (fish and seabirds) – high (4)		Minor (4)	
Cetaceans – high (4)		Minor (4)	
Turtles – high (4)		Minor (4)	
Seals – high (4)		Minor (4)	

Mitigation

Area and work lighting will be limited to the amount and intensity necessary to maintain worker safety. Directional lighting will be used to minimise light spill onto the sea.

Residual impacts

The table below summarises residual impact analysis. The impact intensity remains as very low (1), with geographic extent and impact duration remaining the same, and the implementation of mitigation measures further reducing the intensity of the light spill impact. Residual impacts are anticipated to be minor.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.9
Seabirds – medium (3)	Very low (1)	Minor (3)	MAE20
Fish – medium (3)		Minor (3)	
Protected/threatened species (fish and seabirds) – high (4)		Minor (4)	
Cetaceans – high (4)		Minor (4)	
Turtles – high (4)		Minor (4)	
Seals – high (4)		Minor (4)	

6.3.1.15 Chemicals transfer and storage (MAE21)

Impacts limited under normal operations

Potential impacts

Offshore oil and gas operations use, transfer and store several chemicals as detailed in Section 4.5.3.

No impacts, prior to mitigation, are anticipated providing chemicals are managed properly. However, if chemicals are accidentally spilled and released to sea, water quality and marine fauna may be negatively impacted.

Mitigation

A chemicals management plan has been developed by TEP Liban that will be implemented by its contractors (see Section 8.5.2).

Best practice controls for chemicals management are listed in Table 6.9 (MAE21).

All chemicals will be packaged according to manufacturer's instructions.

Residual impacts

As all chemicals will be managed in line with international best practice and contained and handled by competent, trained personnel, impacts on marine receptors are not anticipated, MAE21 Table 6.9.

Potential accidental impacts from loss of chemical containment onboard the MODU are discussed in Section 6.5.1 (Table 6.11 AE2).

6.3.1.16 Well logging (MAE22)

Impacts limited under normal operations

Potential impacts

Well logging of the Block 4 wells will be carried out in order to make a detailed evaluation (a well log) of the geologic formations penetrated by the well bore. It will be performed as described in Section 4.4.7 and will use sealed radioactive sources. Impacts to the marine environment would only result from loss/damage to radioactive seals.

Mitigation

Well logging operations will be carried out by a certified team.

Best practice controls for radioactive source management are listed in Table 6.9 (MAE22).

Residual impacts

In normal condition of use and transportation sealed radioactive sources do not represent any issues with regard to environmental impact, see MAE22 Table 6.9.

Potential accidental impacts from radioactive source being lost down hole in the well are discussed in Section 6.5.1 (Table 6.11 AE3).

6.3.2 Onshore activities

6.3.2.1 Onshore logistics base operation (OAE01, OAE02, OAE03, OAE04, OAE05)

Impacts of logistics base operation on air quality and climate change

Potential impacts

The logistics base will be connected to the electricity grid of the Port of Beirut. In addition, one 60 kV back-up generator will be on site that will only be used if the electricity grid is down and the port generators are not working.

Anticipated emissions from generator use at the logistics base is presented in Tables 4.9 and 4.10 for well B4-1, and a possible 3 well drilling programme (these emission estimates represents a worst-case scenario as this was based on one generator working for 24 hours / day). Impacts on air quality and climate change from the intermittent operation of one back-up generator will be very limited.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors in Table 1.2 as very low (1): the geographic extent is local; the impact duration is very short term and the volume of air pollutant emissions is limited.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.9
Air quality – low (2)	Very low (1)	Negligible (2)	OAE01
Climate change – medium (3)		Minor (3)	

Mitigation

The back-up generator will be operated in an energy efficient manner and low sulphur fuel will be used when possible.

Any transfer of dry bulk from the drilling fluids mixing plant dry bulk silos will be carried out with the use of a dust collector unit to minimise dust migration to the surrounding environment.

Residual impacts

The table below summarises residual impact analysis. The impact intensity remains as very low (1), with geographic extent and impact duration remaining the same and the implementation of mitigation measures further reducing the intensity of air emissions. Residual impacts are anticipated to be negligible to minor.

<table>
<tr><th>Receptor sensitivity</th><th>Residual impact intensity</th><th>Residual impact significance</th><th>Cross-reference to Table 6.9</th></tr>
<tr><td>Air quality – low (2)</td><td rowspan="2">Very low (1)</td><td>Negligible (2)</td><td rowspan="2">OAE01</td></tr>
<tr><td>Climate change – medium (3)</td><td>Minor (3)</td></tr>
</table>

Impacts of logistics base operation on water quality

Potential impacts

Discharges from the logistics base will be limited to rainwater runoff from non-contaminated areas.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors in Table 1.2 as very low (1): the geographic extent is local; the impact duration is very short term and the discharge is uncontaminated rainwater which will have no discernible effect on habitats or species.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.9
Water quality (coastal) – low (2)	Very low (1)	Negligible (2)	OAE02

Mitigation

Site drainage from the logistics base will only be permitted from clean drains such as the pipe yard, jetty, marshalling areas and the warehouse area.

Where spill potential exists containment will be in place to prevent contamination of run-off water. Section 4.6.4 provides detailed information on the containment measures for the drilling fluids mixing plant.

Residual impact

The table below summarises residual impact analysis. The impact intensity remains as very low (1), with geographic extent and impact duration remaining the same and the implementation of mitigation measures further reducing the intensity of the impact. Residual impacts are anticipated to be negligible.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.9
Water quality (coastal) – low (2)	Very low (1)	Negligible (2)	OAE02

Impacts of logistic base operation on airborne noise and terrestrial fauna

Potential impacts

Airborne noise has the potential to cause disturbance of fauna in the vicinity of the logistics base. However, environmental sensitivities in the Port of Beirut are anticipated to be low as floral and faunal diversity within the port and its immediate area is anticipated to be limited owing to the industrial nature of the surroundings and the prevalence of sealed ground cover.

Sources of noise at the logistics base will be limited to those associated with loading and unloading operations, and those from the drilling fluids mixing plant and bulk facilities (generators, pumps, agitators and air compressors). None of these are anticipated to be particularly acute noise sources, especially in the context of other existing activities taking place in the port.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors in Table 1.2 as very low (1): the geographic extent is local the impact duration is very short term and faunal receptors are anticipated to be limited.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.9
Terrestrial ecology – negligible (1)	Very low (1)	Negligible (1)	OAE03

Mitigation

Equipment at the logistics base will be well maintained and individual mitigation measures applied if noise levels are higher than maximum allowable noise levels (where feasible).

Residual impacts

The table below summarises residual impact analysis. The impact intensity remains as very low (1), with geographic extent and impact duration remaining the same and the implementation of mitigation measures further reducing the intensity of the impact. Residual impacts are anticipated to be negligible.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.9
Terrestrial ecology – negligible (1)	Very low (1)	Negligible (1)	OAE03

Impacts of logistics base waste management

Potential impacts

Offshore oil and gas operations generate several solid waste streams as detailed in Section 4.6.5.

No impacts, prior to mitigation, are anticipated providing waste is managed in line with international best practice with suitable on-site storage, rigorous duty of care provisions during waste transfer, and waste treatment/disposal carried out at licenced waste treatment facilities (that comply with national regulatory requirements and TOTAL corporate requirements).

Mitigation

A waste management plan has been developed by TEP Liban and will be implemented by contractors (see Section 8.5.1). Waste streams generated by drilling, treatment, disposal and responsible contractors are presented in Table 4.15.

Best practice controls for waste management at the logistics base are listed in Table 6.9 (OAE04).

Residual impacts

Residual impacts are not anticipated providing that waste management measures proposed are implemented.

Impacts of logistics base chemicals management

Potential impacts

Offshore oil and gas operations use, transfer and store several chemicals as detailed in Section 4.5.3.

No impacts, prior to mitigation, are anticipated providing chemicals are managed properly. However, if chemicals are accidentally spilled at the logistics base, terrestrial ecology, water quality and marine fauna may be negatively impacted.

Mitigation

A chemicals management plan has been developed by TEP Liban that will be implemented by its contractors (see Section 8.5.2).

Best practice controls for chemicals management are listed in Table 6.9 (OEA05).

The chemical storage areas will be designed to avoid leak or spillage to the environment. They will have adequate ventilation and shall be protected from rainfall and direct sunlight. The logistics base contractor will operate a dedicated hazardous materials storage area within the existing logistics base warehouse (see Section 4.5.3).

It should be noted that project drilling fluid and cementing chemicals will be stored off site at the service contractor's warehouses in Beirut Port. The drilling fluids mixing plant will have a small area dedicated to the temporary storage of chemicals to keep a small stock for mixing needs.

Residual impacts

As all chemicals will be managed in line with international best practice and contained and handled by competent, trained personnel impacts on terrestrial and marine receptors at the logistics base are not anticipated, OAE05 Table 6.9.

Potential accidental impacts from loss of chemical containment onboard the MODU are discussed in Section 6.5.1 (Table 6.11 AE2).

6.3.2.2 Helicopter transfers (OAE06)

Impacts of helicopter transfers on sensitive coastal habitats and associated fauna

Potential impacts

Helicopter transfers of personnel will take place from Beirut International Airport, with an estimated 10 return trips per week. Airborne noise from helicopter operations has the potential to disturb fauna along the flight path, particularly in coastal areas when approaching the airport.

Sensitive sites in the vicinity of the airport include

- Beirut River Valley Important Bird Area (IBA), to the east of the airport, which is internationally recognised for its species of raptors, as well as white stork and great white pelican, which have large spring populations. Several migratory species use the site in large numbers owing to its situation on a major migratory flyway.
- Beirut Coast Key Biodiversity Area (KBA), which abuts the western edge of the airport and runs along the coast in this area. This site is internationally recognised owing to its significant populations of globally threatened and endemic species known only to be found in a limited area. These species include several shark and ray species as well as loggerhead turtle and the critically endangered Mediterranean monk seal.
- Raoucheh cliffs and caves proposed MPA, to the north of the airport, which has been identified of importance for its habitat features including vermetid reefs, corraligenous formations, caves, crevices, and sandy seabed in deep waters. It is an important fish nursery, feeding and spawning ground, as well as a popular tourist site.

The total number of aircraft movements (take-off and landings) at Beirut International Airport for the period December 2018–February 2019 (B4-1 drilling programme is proposed for the same period in 2019/20) was 16,059 at an average of around 179 per day (Beirut Airport Stats, 2019). A total of 73,626 total aircraft movements took place in 2018 (Beirut Airport Stats, 2019). Beirut International Airport is also used by military helicopter traffic for the Lebanese Air Force (Beirut Air Base is situated at the western end of the airport estate).

It is not anticipated that an additional 10 return helicopter trips per week (for the Block 4 exploration drilling campaign) will be a substantial increase in aircraft traffic in the vicinity of the airport owing to the density of flight traffic already accessing the facility. In addition, it is assumed that fauna present in the coastal designated areas in the vicinity of the airport will have become habituated to the noise of aircraft flying over the area.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1): the geographic extent is local; the impact duration is very short term and there is a minimal increase in aircraft movement associated with the project in relation to the density of flight traffic already accessing Beirut International Airport.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.9
Protected areas – overall high (4) includes • sensitive coastal habitats – high (4) • terrestrial ecology – negligible (1) • seabirds – medium (3) • protected/ threatened species (seabirds) – high (4)	Very low (1)	Protected areas – overall high (4) includes • sensitive coastal habitats – minor (4) • terrestrial ecology – negligible (1) • seabirds – minor (3) • protected/ threatened species (seabirds) – minor (4)	OAE06

Mitigation

The helicopter flight path will be dependent upon meteorological conditions, air traffic and other parameters. Avoidance of low flight directly over internationally recognised and proposed conservation areas and, over local communities and popular beaches, in the vicinity of the airport, if safe and practical to do so (subject to Lebanese Air Force clearance).

Residual impact

The table below summarises residual impact analysis. The impact intensity remains as very low (1), with geographic extent and impact duration remaining the same and the implementation of mitigation measures further reducing the intensity of the impact. Residual impacts are anticipated to be negligible to minor.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.9
Protected areas – overall high (4) includes • sensitive coastal habitats – high (4) • terrestrial ecology – negligible (1) • seabirds – medium (3) • protected/ threatened species (seabirds) – high (4)	Very low (1)	Protected areas – overall high (4) includes • sensitive coastal habitats – minor (4) • terrestrial ecology – negligible (1) • seabirds – minor (3) • protected/ threatened species (seabirds) – minor (4)	OAE06

6.3.3 Summary environmental impact assessment table

A systematic assessment of the potential environmental impacts of the proposed Block 4 exploration drilling campaign routine activities is provided in Table 6.9, along with potential and residual scorings of impact severity.

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Table 6.9: Environmental impacts of the Block 4 exploration drilling campaign - routine activities

Activities/ sources of Impact	Receptors	Potential effects	Potential impact			Main protection/mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
Marine activities									
MAE01: MODU mobilisation, installation, plug and abandonment and demobilisation	Seabed quality/ composition Benthos	Physical disturbance of sediments, benthic communities and sensitive seabed habitats from anchoring and removal of the blowout preventer (BOP) and cement plugging operations.	2 (low)	1 (very low)	2 (negligible)	If a drillship is selected no anchoring impacts anticipated as it will be dynamically positioned (BIO-6).	2 (low)	1 (very low)	2 (negligible)
	Sensitive seabed habitats		4 (high)	1 (very low)	4 (minor)	Predrill well-site assessments will be completed to provide high-resolution bathymetric and 3D/2D seismic data to identify seabed geohazards, habitat and, detect archaeological sites previously not detected; to inform avoidance measures and a well site free of geohazards. (CH-2) If a semi-submersible is selected impacts will be minimised by ROV survey of the seabed to select optimum anchor positions that avoid sensitive seabed features (BIO-5). A plugging and abandonment programme will be submitted to respective authorities as part of the advanced drilling plan before drilling begins (DC-1). ROV survey will be conducted after drilling operations are complete to provide status of the seafloor condition around the well site (MR-1).	4 (high)	1 (very low)	4 (minor)
	Water quality, air quality, UW noise	Impacts on water quality, air quality and climate change and underwater noise from MODU operation (includes MODU mobilisation and demobilisation) are presented in rows below along with the potential for indirect impacts on benthos, plankton, nekton (fish), cetaceans, turtles and seals and sensitive marine habitats.							

Activities/ sources of Impact	Receptors	Potential effects	Potential impact			Main protection/mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
MAE02: Option 1 – discharge of drill cuttings and WBDFs from riserless upper-hole sections only (option selected for well B4-1 and possible option future exploration / appraisal wells in Block 4)upper-hole	Seabed quality / composition Benthos	Burial or smothering of benthic communities Oxygen depletion in sediments Changes to sediment structure and quality Changes to water quality Potential for toxicity or bioaccumulation effects Potential for indirect effects on fish Potential for direct and indirect effects on sensitive seabed habitats	2 (low)	2 (low)	4 (minor)	Seawater used for drilling the 36-in. well section (PP-1). Drilling fluids proposed for 26-in. hole section of well HQ Band Gold, OCNS Group E, or PLONOR - lowest toxicity, lowest bioaccumulation potential and highest biodegradation (CM-2).	2 (low)	2 (low)	4 (minor)
	Water quality		3 (medium)	2 (low)	6 (moderate)		3 (medium)	2 (low)	6 (moderate)
	Nekton (fish)		3 (medium)	1 (very low)	3 (minor)		3 (medium)	1 (very low)	3 (minor)
	Protected / threatened species (fish)		4 (high)	1 (very low)	4 (minor)		4 (high)	1 (very low)	4 (minor)
	Sensitive seabed habitats		4 (high)	1 (very low)	4 (minor)		4 (high)	1 (very low)	4 (minor)
MAE03: Option 2 – discharge of drill cuttings and WBDFs from riserless upper-hole sections, plus discharge of HPWBDF cuttings from lower well	Seabed quality / composition Benthos		2 (low)	3 (medium)	6 (moderate)	Drilling fluids and cuttings from the lower-hole sections will be returned to the rig and separated using the onboard solids control equipment (shale shakers and centrifuges). Separated drilling fluids will be reused and the cuttings discharged to sea (WM-1). Majority of chemicals proposed for HPWBDF HQ Band Gold, OCNS Group E, or PLONOR -	2 (low)	3 (medium)	6 (moderate)
	Water quality		3 (medium)	2 (low)	6 (moderate)		3 (medium)	2 (low)	6 (moderate)
	Plankton		2 (low)	1 (very low)	2 (negligible)		2 (low)	1 (very low)	2 (negligible)
	Nekton (fish)[13]		3 (medium)	1 (very low)	3 (minor)		3 (medium)	1 (very low)	3 (minor)

Activities/ sources of Impact	Receptors	Potential effects	Potential impact			Main protection/mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
sections (option for possible future exploration / appraisal wells in Block 4)	Protected/threatened species (fish)	Burial or smothering of benthic communities Oxygen depletion in sediments Changes to sediment structure and quality Changes to water quality Potential for toxicity or bioaccumulation effects Potential for indirect effects on plankton, fish and sensitive seabed habitats	4 (high)	1 (very low)	4 (minor)	lowest toxicity, lowest bioaccumulation potential and highest biodegradation (CM-2). Barite will meet heavy metals concentration standards, i.e., mercury <1 mg/kg and cadmium <3 mg/kg dry weight (total) (CM-1). Cuttings discharge chute will be 10 m below the sea surface to aid good dispersion of the solids (WM-2).	4 (high)	1 (very low)	4 (minor)
	Sensitive seabed habitats		4 (high)	1 (very low)	4 (minor)		4 (high)	1 (very low)	4 (minor)
MAE04: Ship to shore of NADF cuttings - ship to shore of cuttings (only applicable to Option 1 above)	Air quality	Reduction in air quality due to significant transportation requirements GHG emissions contribute to climate change	2 (low)	2 (low)	4 (minor)	Separated drilling fluids will be reused. Residual drilling fluids that no longer fulfil the product specification will be managed by the drilling well services contractor (WM-3). Cuttings skips will be certified (WM-4). Onward export of cuttings to neighbour country for treatment and disposal will be compliant with the requirements of the Basel convention **(R)** (WM-5). Mitigation measures relating to supply vessel emissions to air listed in MAE16 applicable here.	2 (low)	1 (very low)	2 (negligible)
	Climate change		3 (medium)	2 (low)	6 (moderate)		3 (medium)	1 (very low)	3 (minor)

Activities/ sources of Impact	Receptors	Potential effects	Potential impact			Main protection/mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
MAE05: Cementing discharges during drilling	Seabed quality / composition Benthos	Cement may smother seabed and change its pH Potential for toxicity or bioaccumulation effects	2 (low)	2 (low)	4 (minor)	Chemicals proposed for cement formulation are HQ Band Gold, OCNS Group E, or PLONOR - lowest toxicity, lowest bioaccumulation potential and highest biodegradation (CM-2). Discharge of cement to seabed only from 20-in. casing (PP-2). Careful monitoring of cement discharges using an ROV to ensure discharges are kept to a minimum (PP-3).	2 (low)	1 (very low)	2 (negligible)
MAE06: Pipe dope discharges during drilling	Water quality	Localised reduction in water quality Potential for indirect effects on plankton and fish	3 (medium)	2 (low)	6 (moderate)	A pipe dope product that is heavy metal free will be selected for the drilling operations (PP-4).	3 (medium)	1 (very low)	3 (minor)
	Plankton		2 (low)	1 (very low)	2 (negligible)		2 (low)	1 (very low)	2 (negligible)
	Nekton (fish)		3 (medium)	1 (very low)	3 (minor)		3 (medium)	1 (very low)	3 (minor)
	Protected/threatened species (fish)		4 (high)	1 (very low)	4 (minor)		4 (high)	1 (very low)	4 (minor)
MAE07: BOP testing discharges during drilling	Water quality	Localised reduction in water quality Potential for indirect effects on plankton and fish	3 (medium)	1 (very low)	3 (minor)	Safety and environmental benefits of regular testing of the BOP system outweigh the potential environmental impacts of BOP testing fluid release.	3 (medium)	1 (very low)	3 (minor)
	Plankton		2 (low)	1 (very low)	2 (negligible)		2 (low)	1 (very low)	2 (negligible)
	Nekton (fish)		3 (medium)	1 (very low)	3 (minor)		3 (medium)	1 (very low)	3 (minor)
	Protected/threatened species (fish)		4 (high)	1 (very low)	4 (minor)		4 (high)	1 (very low)	4 (minor)
MAE08: Discharge of sanitary waste from MODU and	Water quality	Reduction in water quality	3 (medium)	2 (low)	6 (moderate)	Sanitary waste will be managed in accordance with MARPOL 73/78 Annex IV. Grey water will be discharged to sea (without treatment) as	3 (medium)	1 (very low)	3 (minor)
	Plankton		2 (low)	2 (low)	4 (minor)		2 (low)	1 (very low)	2 (negligible)

Activities/ sources of Impact	Receptors	Potential effects	Potential impact			Main protection/mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
support/supply vessels	Nekton (fish)	Potential for indirect effects on plankton and fish	3 (medium)	2 (low)	6 (moderate)	long as no floating matter or sheen is observable. Black water will be treated in accordance with MARPOL 73/78 Annex IV prior to discharge **(R)** (WM-6). Both the MODU and support/supply vessels will have an International Sewage Pollution Prevention Certificate in line with MARPOL 73/78 Annex IV **(R)** (PP-57).	3 (medium)	1 (very low)	3 (minor)
	Protected/threatened species (fish)		4 (high)	2 (low)	8 (moderate)		4 (high)	1 (very low)	4 (minor)
MAE09: Discharge of food waste from MODU and support/supply vessels (no discharge permitted from MODU for B4-1 well as < 12 nm from land)	Water quality	Reduction in water quality Potential for indirect effects on plankton and fish	3 (medium)	2 (low)	6 (moderate)	Discharge of any food waste from the MODU and support/supply vessels will only be carried out more than 12 nm from the nearest land and all food waste will be ground up in order to pass through a 25 mm mesh before discharge, in line with MARPOL 73/78 Annex V (Mediterranean Sea 'special area' requirement) **(R)** (WM-7). Any discharges of food waste into the sea will be recorded in the Garbage Record Book of the MODU (MARPOL Annex V) **(R)** (WM-8).	3 (medium)	1 (very low)	3 (minor)
	Plankton		2 (low)	2 (low)	4 (minor)		2 (low)	1 (very low)	2 (negligible)
	Nekton (fish)		3 (medium)	2 (low)	6 (moderate)		3 (medium)	1 (very low)	3 (minor)
	Protected/threatened species (fish)		4 (high)	2 (low)	8 (moderate)		4 (high)	1 (very low)	4 (minor)
MAE10: Desalination unit discharges from MODU	Water quality	Reduction in water quality Potential for impacts on plankton and fish	3 (medium)	1 (very low)	3 (minor)	Dispersion of higher salinity water will be rapid in offshore location of well site. Anti-scaling chemical will be an environmentally sound all-organic product based on biodegradable compounds (PP-63)	3 (medium)	1 (very low)	3 (minor)
	Plankton		2 (low)	1 (very low)	2 (negligible)		2 (low)	1 (very low)	2 (negligible)
	Nekton (fish)		3 (medium)	1 (very low)	3 (minor)		3 (medium)	1 (very low)	3 (minor)
	Protected/threatened species (fish)		4 (high)	1 (very low)	4 (minor)		4 (high)	1 (very low)	4 (minor)

Activities/ sources of Impact	Receptors	Potential effects	Potential impact			Main protection/mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
MAE11: Discharge of drainage water (deck drainage, fire water, bilge water and slop water) from MODU and support/ supply vessels	Water quality	Reduction in water quality Potential for impacts on plankton and fish	3 (medium)	2	6 (moderate)	Drainage water from process areas will go to closed drains and only water from non-process areas will go to open drains (PP-5). Deck drainage (clean drains) will only be discharged to sea as long as no visible sheen is observable (sea surface monitored during discharge) (PP-6). Bilge water will be treated and discharged in accordance with MARPOL 73/78 Annex I, with discharge automatically stopped if effluent exceeds 15 ppm of oil (special area requirements for Mediterranean Sea, ships of >400 gross tonnage) **(R)** (PP-7). Oily waste and sludge from separation processes will be transported to shore for treatment and disposal (WM-18). Slop water will be treated onboard the MODU in a slop treatment unit. The separated drilling fluids and slops will be sent to shore for treatment/disposal and the separated water discharged to sea providing the oil in water content does not exceed 15 ppm (PP-8). The MODU and support/supply vessels (more than 400 gross tonnage) will have an International Oil Pollution Prevention Certificate, will	3 (medium)	1 (very low)	3 (minor)
	Plankton		2 (low)	2	4 (minor)		2 (low)	1 (very low)	2 (negligible)
	Nekton (fish)		3 (medium)	2 (low)	6 (moderate)		3 (medium)	1 (very low)	3 (minor)
	Protected/threatened species (fish)		4 (high)	2 (low)	8 (moderate)		4 (high)	1 (very low)	4 (minor)

Activities/ sources of Impact	Receptors	Potential effects	Potential impact			Main protection/mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
						maintain an Oil Record Book, and will have an approved Shipboard Oil Pollution Emergency Plan (SOPEP) in accordance with MARPOL 73/78 Annex I **(R)** (PP-58). Spill kits will be available onboard MODU and supply vessels; personnel will be trained to use spill kits (PP-54). The foam concentrate system, carbon dioxide firefighting equipment and dry powder extinguishers will only be discharged in emergency situations.			
MAE12: Uplift and discharge of cooling water from MODU	Water quality	Reduction in water quality/temperature effects Potential for indirect impacts on plankton and fish Direct impacts to plankton and fish from entrainment during uplift	3 (medium)	2 (low)	6 (moderate)	Discharge of cooling water will comply with allowable limits in Decision No. 8/1/2001 (maximum temperature of wastewater discharge to sea 35 °C) and TOTAL/World Bank requirement that temperature increase shall not exceed a maximum of 3 °C, 100 m away from the discharge point (R) (PP-9). No discharge of antifouling chemicals in cooling water, a MGPS will be used (PP-64)	3 (medium)	1 (very low)	3 (minor)
	Plankton		2 (low)	2 (low)	4 (minor)		2 (low)	1 (very low)	2 (minor)
	Nekton (fish)		3 (medium)	2 (low)	6 (moderate)		3 (medium)	1 (very low)	3 (minor)
	Protected/threatened species (fish)		4 (high)	2 (low)	8 (moderate)		4 (high)	1 (very low)	4 (minor)
MAE13: Discharge of ballast from MODU and support/supply vessels	Water quality	Potential for introduction of non-native invasive species in ballast water, with knock-on effects to rest of	3 (medium)	3 (potential for regional impacts) (medium)	9 (moderate)	MODU will carry out internal ballasting for a large proportion of its operations with no discharge of ballast to sea (PP-10). Any ballast water exchange will be carried out in compliance	3 (medium)	1 (very low)	3 (minor)
	Plankton		2 (low)	3 (medium)	6 (moderate)		2 (low)	1 (very low)	2 (negligible)

Activities/ sources of Impact	Receptors	Potential effects	Potential impact			Main protection/mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
	Nekton (fish)	marine ecosystem (secondary impacts)	3 (medium)	3 (medium)	9 (moderate)	with the 'International Convention for the Control and Management of Ships' Ballast Water and Sediments 2014' (see Section 2.10.2.2) **(R)** (PP-11). The MODU and support/supply vessels will have an onboard Ballast Water Management Plan, keep a record of all ballast water exchange operations in a Ballast Water Record Book, and have an International Ballast Water Management Certificate **(R)** (PP-59). Ballast water on drillship and support/supply vessels will be segregated and will not come into contact with oil and chemicals (PP-12).	3 (medium)	1 (very low)	3 (minor)
	Protected/ threatened species (fish)		4 (high)	3 (medium)	12 (major)		4 (high)	1 (very low)	4 (minor)
MAE14: Generation of solid waste on MODU and support/supply vessels	None providing waste managed properly	None under normal operations				All non-hazardous and hazardous solid waste generated by the Block 4 exploration drilling programme will be transported to shore for recycling/treatment/disposal in accordance with MARPOL 73/78 Annex V or incinerated onboard the MODU (with the exception of water-based drill cuttings and drill fluids, see row MAE02 and MAE03) **(R)** (WM-9). Waste will be segregated at source on site and coded according to the appropriate waste coding (WM-10). Waste receptacles will be designed to prevent release of wind born waste (WM-11).	-	-	-

Activities/ sources of Impact	Receptors	Potential effects	Potential impact			Main protection/mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
						Waste transfer notes will provide an auditable trail of the waste management process (WM-14). Waste management awareness will be raised among personnel through site inductions, toolbox talks, site HSE committee meetings (if applicable), performance reports and general waste management awareness campaigns (e.g., posters, brochures) (TR-1). Sorting of solid waste will be compliant with applicable national regulations in force (WM-19). Hazardous waste will be transported, stored and treated/disposed of in line with applicable national regulations in force (including reporting requirements, etc) (WM-13). For hazardous waste, containers will be chemically resistant to the contained product and may be sealed to reduce risks (WM-12). A waste management plan has been developed by TEP Liban and will be implemented by its contractors (WM-15).			

Activities/ sources of Impact	Receptors	Potential effects	Potential impact			Main protection/mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
MAE15: Operation of incinerator onboard MODU (not applicable to well B4-1)	Air quality	Reduction in air quality GHG emissions contribute to climate change	2 (low)	2 (low)	4 (minor)	Any onboard incineration will be carried out in compliance with the requirements of MARPOL 73/78 Annex XI Chapter 3, regulation 16 – Shipboard Incineration **(R)** (PP-14). Estimated incinerator emissions very low, see Tables 4.9 and 4.10.	2 (low)	1 (very low)	2 (negligible)
	Climate change		3 (medium)	2 (low)	6 (moderate)		3 (medium)	1 (very low)	3 (minor)
MAE16: MODU and support/supply vessel/helicopter transfer/plant operation resulting in air emissions	Air quality	Reduction in air quality GHG emissions contribute to climate change	2 (low)	2 (low)	4 (minor)	Atmospheric emissions on the MODU and support/supply vessels will be controlled in accordance with MARPOL 73/78 Annex VI **(R)** (PP-15). The MODU and support/supply vessels (more than 400 gross tonnage) will obtain an International Air Pollution Prevention Certificate in accordance with MARPOL 73/78 Annex VI **(R)** (PP-61). Sulphur content of marine fuel oil used onboard vessels will not exceed 0.5% by mass (unless vessels have scrubbers fitted) in line with MARPOL 2020 requirements **(R)** (PP-16). All machinery, equipment and installations will comply with generally accepted standards in the international petroleum industry, will be of proper construction, and kept in good working order (PP-17). Fuel efficiency measures shall be taken into account in the selection of MODU, support/	2 (low)	1 (very low)	2 (negligible)
	Climate change		3 (medium)	2 (low)	6 (moderate)		3 (medium)	1 (very low)	3 (minor)

Activities/ sources of Impact	Receptors	Potential effects	Potential impact			Main protection/mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
						supply vessels and helicopters (PP-18). Supply vessels transfers to the MODU will be optimised and the support vessel will drift around the MODU to minimise engine use (PP-19). Ozone depleting substances and all products listed in the Montreal Protocol - CFCs, HCFCs and Halons, will be prohibited except for essential use, under derogation **(R)** (PP-20). Air emissions data (including GHG information) will be submitted to the authorities **(R)** (MR-2).			

Activities/ sources of Impact	Receptors	Potential effects	Potential impact			Main protection/mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
MAE17: Well test of possible future appraisal well (not applicable to well B4-1)	Air quality	Reduction in air quality GHG emissions contribute to climate change	2 (low)	2 (low)	4 (minor)	Prior to well testing, alternatives to flaring of produced hydrocarbons (i.e., recovery) will be evaluated. (PP-21) If flaring is the sole option available for the disposal of well test fluids, only the minimum volume of hydrocarbons required for the test will be flowed and the well test duration will be reduced to the extent practical. (PP-22) An efficient well test flare burner head equipped with an appropriate combustion enhancement system (e.g., “evergreen burners” type) will be selected to minimise incomplete combustion, black smoke, and hydrocarbon fallout to the sea. (PP-23) Whenever possible, the liquid phase of the separator shall be re-injected into the process lines or stored in appropriate tanks, and only the gaseous phase shall be burned (PP-24). A permit will be obtained from the Ministry of Energy and Water for flaring during well test **(R)** (PE-1).	2 (low)	1 (very low)	2 (negligible)
	Climate change		3 (medium)	2 (low)	6 (moderate)	Air emissions data (including GHG information) will be submitted to the authorities **(R)** (MR-2).	3 (medium)	1 (very low)	3 (minor)

Activities/ sources of Impact	Receptors	Potential effects	Potential impact			Main protection/mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
MAE18: Underwater noise from vertical seismic profile (VSP) activities	Cetaceans turtles and seals	Potential for injury/hearing loss, alteration of behaviour, auditory masking, effects on zone of audibility	4 (high)	2 (low)	8 (moderate)	Following mitigation will be implemented (based on ACCOBAMS requirements): • Use of soft start procedures for VSP airguns (BIO-2). • Use of trained MMOs during VSP operations for monitoring of mitigation exclusion zone (radius 500 m) and delay in start-up of airguns if cetaceans (or turtles) observed within zone (BIO-3). • Use of PAM devices for cetacean detection during VSP operations (and particularly during hours of darkness/reduced visibility) (BIO-4). • Reporting of results and findings (MR-3).	4 (high)	1 (very low)	4 (minor)
	Nekton (fish)	Potential for injury/hearing loss, alteration of behaviour, auditory masking, effects on zone of audibility	3 (medium)	2 (low)	6		3	1 (very low)	3 (minor)
	Protected/threatened species (fish)		4 (high)	2 (low)	8 (moderate)		4 (high)	1 (very low)	4 (minor)
MAE19: Underwater noise from MODU and support/supply vessel operations	Cetaceans turtles and seals	Potential for alteration of behaviour, auditory masking, effects on zone of audibility	4 (high)	1 (very low)	4 (minor)	Underwater noise modelling and assessment found that marine mammal, turtles and fish injury/hearing loss not anticipated from continuous noise generated from operation of the MODU and support/supply vessels (with the exception of high-frequency cetaceans which are not anticipated in the region). No further mitigation suggested.	4 (medium/high)	1 (very low)	4 (minor)
	Nekton (fish)	Potential for injury/hearing loss, alteration of behaviour, auditory masking, effects on zone of audibility	3 (medium)	1 (very low)	3 (minor)		3 (medium)	1 (very low)	3 (minor)
	Protected/threatened species (fish)		4 (high)	1 (very low)	4 (minor)		4 (high)	1 (very low)	4 (minor)
MAE20: Light spill from MODU	Seabirds	Possible disorientation of seabirds.	3 (medium)	1 (very low)	3 (minor)	Light spill will be reduced by shielding lights and pointing lights directly at the work area (directional alignment) (PP-25).	3 (medium)	1 (very low)	3 (minor)
	Fish	Attraction of planktonic organisms and subsequently fish	3 (medium)	1 (very low)	3 (minor)		3 (medium)	1 (very low)	3 (minor)

Activities/ sources of Impact	Receptors	Potential effects	Potential impact			Main protection/mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
	Protected/threatened species (fish and seabirds)	and other large marine fauna. Disorientation of turtle hatchlings.	4 (high)	1 (very low)	4 (minor)	Area and work lighting will be limited to the amount and intensity necessary to maintain worker safety (PP-26).	4 (high)	1 (very low)	4 (minor)
	Cetaceans, turtles and seals		4 (high)	1 (very low)	4 (minor)		4 (high)	1 (very low)	4 (minor)
MAE21: Chemicals transfer and storage	None providing chemicals managed properly	None under normal operations	-	-	-	All chemicals will be held in secure and leak-proof containers suitably labelled to indicate the nature of the substance and risk involved (PP-27). All chemicals will be packaged according to manufacturer's instructions (CM-3). Labelling will comply with regulatory requirements in terms of format and composition **(R)** (CM-4). Chemical products that are required at the MODU (and haven't been pre-mixed onshore) will be packed into mini containers, or open cargo carrying units (CCUs), that are certified and appropriately colour coded for safe transfer from jetty to supply vessel and supply vessel to MODU (CM-5). MSDS will be present onboard the supply boat during transfer and on the MODU (CM-6). All personnel involved in the transfer and handling or all personnel who might be exposed to hazardous chemicals will be trained on the potential hazards involved (CM-7).	-	-	-

Activities/ sources of Impact	Receptors	Potential effects	Potential impact			Main protection/mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
						Chemicals will be stored separately according to their potential hazard and compatibility (CM-8). A full register of all chemicals inventory and consumption records shall be maintained on each site (CM-9).			
MAE22: Logging using radioactive sealed sources (also applicable to onshore storage and transport of radioactive sealed sources)	None under normal operations	None under normal operations	-	-	-	Radioactive sources will be managed in line with international regulations (MR-4). A permit will be obtained by the Contractor for the import, storage, use and export of radioactive materials from the Lebanese Atomic Energy Commission, a department of the Ministry of Public Health **(R)** (PE-2).	-	-	-

Activities/ sources of Impact	Receptors	Potential effects	Potential impact			Main protection/mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
Onshore activities									
OAE01: Logistics base operation - emissions to air	Air quality	Reduction in air quality	2 (low)	1 (very low)	2 (negligible)	The logistics base will be connected to the electricity grid of the Port of Beirut. One 60 kV back-up generator will be on site that will only be used if the electricity grid is down and the port generators are not working. Generators will be operated according to manufacturer's instructions to operate in most energy efficient manner and maintenance programme will be in place (PP-31). Low sulphur fuel will be used where practicable (PP-32). Any transfer of dry bulk from the drilling fluids mixing plant dry bulk silos will be carried out with the use of a dust collector unit to minimise dust migration to the surrounding environment (PP-40). Logistics base operator will monitor consumption of fuel in order to calculate air emission quantities (MR-5).	2 (low)	1 (very low)	2 (negligible)
	Climate change	GHG emissions contribute to climate change	3 (medium)	1 (very low)	3 (minor)		3 (medium)	1 (very low)	3 (minor)
OAE02: Logistics base operation - discharge of drainage water	Water quality	Local effect on water quality	2 (low)	1 (very low)	2 (negligible)	Site drainage from the logistics base will only be permitted from non-contaminated areas (PP-33). For other areas where there is the potential for spillages, and contaminated runoff, containment will be in place (PP-34).	2 (low)	1 (very low)	2 (negligible)

Activities/ sources of Impact	Receptors	Potential effects	Potential impact			Main protection/mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
OAE03: Logistics base operation -noise generation	Terrestrial ecology	Disturbance of fauna in vicinity of logistics base	1 (very low)	1 (very low)	1 (negligible)	Sensitive faunal receptors in the industrial site of Port of Beirut not anticipated. Equipment at the logistics base will be well maintained and individual mitigation measures applied if noise levels are higher than maximum allowable noise levels (where feasible) (PP-35).	1 (very low)	1 (very low)	1 (negligible)
OAE04: Logistics base operation – waste management	None providing waste managed properly	None under normal operations	-	-	-	Waste collection and temporary storage will be designed to minimise the risk of escape to the environment (for example by particulates, infiltration, runoff or odours) (PP-36). The compatibility of waste streams will be considered when segregating and storing wastes (WM-16). Wastes will be stored in areas that minimise the risk of accidental loss of confinement or leaching (bunded areas). All effluents from waste storage areas will be collected and disposed of appropriately (PP-37). Hazardous waste storage area will be designed as follows (PL-1): • Storage on an impervious surface connected to a drainage and collection system and/or in a bunded area, • Storage area equipped with suitable fire-fighting equipment and spillage	-	-	-

Activities/ sources of Impact	Receptors	Potential effects	Potential impact			Main protection/mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
						recovery equipment such as shovels and absorbent materials, • Restricted/controlled area and access to the storage site. The logistics base contractor will ensure vehicles transporting hazardous wastes from site have appropriate certification/licence to transport wastes of the particular carried waste codes (MR-6). The logistics base contractor and waste management contractors will ensure the final destination of the waste is guaranteed and complies with both regulatory requirements and Total contractual commitments and that licence to operate is in place (WM-17). Waste Transfer Notes signed by all parties will be sent to TEP Liban by logistics base contractor and copies retained on site (MR-7). Sorting of solid waste will be compliant with applicable national regulations in force (WM-19). Hazardous waste will be transported, stored and treated/disposed of in line with applicable national regulations in force (including reporting requirements, etc) (WM-13).			

Activities/ sources of Impact	Receptors	Potential effects	Potential impact			Main protection/mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
OAE05: Logistics base operation – chemicals management	None providing chemicals managed properly	None under normal operations	-	-	-	The chemical storage area(s) will be designed to avoid any leak or spillage to the environment. They will have adequate ventilation and shall be protected from rainfall and direct sunlight (PP-38). A certified firefighting and fire alarm system will be installed, with remote alarm control installed in the offices (MR-8). Logistics base contractor will keep and maintain a register of dangerous and hazardous goods stored on location along with relevant copies of MSDS (Material Safety Data Sheets) and dangerous goods (DG) declarations (MR-9).	-	-	-

Activities/ sources of Impact	Receptors	Potential effects	Potential impact			Main protection/mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
OAE06: Helicopter transfers to Beirut International Airport	Sensitive coastal habitats Terrestrial ecology Seabirds Protected/threatened species (seabirds)	Airborne noise may disturb fauna (IBA, KBA and MPA in close proximity to airport)	4 (high)	1 (very low)	4 (minor)	Beirut International Airport already has a significant number of aeroplane flights per day. Low number of helicopter flights (average 10 return trips per week) using small helicopters, is not anticipated to impact fauna that is already habituated to aeroplane noise. The helicopter flight path will be dependent upon meteorological conditions, air traffic and other parameters. A flight plan will be developed and agreed with the Lebanese aviation authorities (SOC-9). Avoidance of low flight directly over internationally recognised and proposed conservation areas and over local communities and popular beaches, in the vicinity of the airport, if safe and practical to do so (subject to Lebanese Air Force approval) (SOC-2).	4 (high)	1 (very low)	4 (minor)

Note: In the Main Protection/Mitigation Measures column, (R) refers to a regulatory commitment, and (C) refers to a completed action.

Source of impact codes: MAE - marine activities environment; OAE – onshore activities environment.

6.4 Social impact assessment – routine activities

This section evaluates socio-economic and cultural heritage impacts that may arise from planned/routine activities related to the Block 4 exploration drilling campaign.

The activities outlined in the project description (Chapter 4), social and cultural heritage sensitivities in the study area (Chapter 5), and input from public participation (Chapter 3), have been used to provide input into the analysis.

A summary table of socio-economic impacts and mitigations is presented in Table 6.10.

Given the remote offshore project location, many of the socio-economic and cultural heritage issues typically associated with terrestrial resource projects will not apply to the Block 4 exploration drilling campaign. Furthermore, shore-based activities will be confined to a logistics base in the Port of Beirut that is not publicly accessible. As such, project activities will not alter existing land-use practices nor displace people from their land.

6.4.1 Marine activities

6.4.1.1 MODU mobilisation, installation, plug, abandonment and demobilisation (MAS01)

Impacts of mobilisation, installation, P&A and demobilisation on shipping, fisheries and archaeological and cultural resources

Shipping: Potential impacts

A major shipping lane skirts the southern boundary of Block 4 and another shipping lane crosses the Block 4 priority area in a north-south direction, see Figure 5.33. Shipping routes extend from Beirut north towards Cyprus and south-west to join major shipping channels to reach the Suez Canal. Beirut Port is one of the largest and busiest ports on the eastern Mediterranean (see Section 5.5.3.7). The MODU mobilisation, installation and demobilisation has the potential to interfere with vessels passing near the restricted safety zone (500-m radius), requiring them to divert from their initial route.

Impacts from plug and abandonment of the Block 4 wells are not anticipated on shipping. The wellheads will be left in place on the seabed; however, the water depths in Block 4 negate possible effects on vessels and navigation. This is presented in more detail in Section 4.4.10.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as low (2): the geographic extent is local, and the impact duration is very short term with potential for minor interference to other users of resources.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.10
Medium (3)	Low (2)	Moderate (6)	MAS01

Shipping: Mitigation

The main control measures include

- ensuring that sea users are aware of the proposed drilling campaign activities and the presence of the MODU safety zone. The schedule of activities will be communicated to the Ministry of Public Works and Transport (and the Lebanese Navy, via the Lebanese Armed Forces (LAF)) which issue information and instructions to mariners pertaining to shipping hazards and safety zones (through a navigational telex (NAVTEX) notice to mariners).
- compliance with regulatory requirements such as the Petroleum Activities Regulations (PAR), Article 6: Vessels and crafts used for or involved in Petroleum Activities shall comply with applicable international and Lebanese laws and regulations regarding Petroleum Activities and navigation. The vessels and crafts shall abide by instructions given by the competent Lebanese authorities and by the competent Lebanese naval vessels, patrol boats or crafts.
- adherence to existing shipping corridors with known buffer zones and standard operating procedures. The United Nations Convention on the Law of the Sea (UNCLOS) 1982 requires all ships to respect safety zones around offshore installations.

Shipping: Residual impacts

The table below summarises residual impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1): Although the geographic extent and impact duration remain the same, mitigation measures ensure that other sea users are aware of the proposed drilling campaign resulting in only intermittent disruption of other sea users. Residual impacts are anticipated to be minor.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.10
Medium (3)	Very low (1)	Minor (3)	MAS01

Fisheries: Potential impacts

The social baseline study shows that fishing activities are artisanal in nature and are mainly concentrated in coastal waters. Fishing is not permitted between 6 and 12 nm from the shoreline for security reasons (B4-1 well site is 11 nm from shoreline).

Despite the above, with dwindling fish stocks in coastal waters, fishermen are travelling further out to sea to access fish. Stakeholder consultation activities have taken place with fishermen, recreational sea anglers, a fishing cooperative, and fishing households (women) from the coastal Governorates. Focus group discussions (FGD) with fishermen in Dbayeh revealed that they travel south to Damour and Naameh (Mount Lebanon) and Saida (South Lebanon). Although not in the direct vicinity of the coastal communities of Block 4, fishermen from the port of Saida (South Lebanon) travel up the coast to fish in the deep waters off Beirut. A small number of sea anglers also use vessels to travel up to 12 nm to carry out recreational fishing activities (FGD with fishermen in Jounieh Mount Lebanon). These locations overlap with Block 4.

Fishing vessels will not be allowed to operate in the 500-m safety zone surrounding the MODU during mobilisation, installation and decommissioning, and will therefore lose access to potential fishing grounds in the safety zone during these activities. This may cause a temporary loss of earnings for fishermen, the majority of whom do not have alternative livelihoods and are considered among the most vulnerable groups in the communities.

Impacts from plug and abandonment of the Block 4 wells are not anticipated on fisheries. The wellheads will be left in place on the seabed; however, the water depths in Block 4 negate possible effects on fisheries as seabed trawling is not anticipated at these depths, this is presented in more detail in Section 4.4.10.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as low (2): the geographic extent is local, and the impact duration is very short term with minor interference to fisheries (which are concentrated in coastal waters) and a rapid return to baseline conditions on completion of the activity.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.10
Low (2)	Low (2)	Minor (4)	MAS01

Fisheries: Mitigation

The main existing control measures described for shipping are also applicable to fishing activities. Additional specific mitigation measures for fisheries include

- The total area where fishing activities are excluded will be limited to the safety zone around each well. A safety zone authorisation will be submitted to the authorities for approval before drilling activities. Once drilling activities are complete and the MODU has demobilised, fishing operations can return.
- TEP Liban will inform fishermen through the fisheries associations when submitting a well plan for approval. In case a well is planned in an area of intensive fishing, which is not the case for Block 4, the discussions with the fisheries syndicates and cooperatives will be initiated as early as possible, and preferably not less than 30 days before planned commencement of drilling.
- The project will implement a grievance mechanism to register concerns.

Fisheries: Residual impacts

The table below summarises the residual impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1): Although the geographic extent and impact duration remain the same, mitigation measures ensure that other sea users and fisheries cooperatives are aware of the proposed drilling campaign resulting in only intermittent disruption of other sea users. Residual impacts are anticipated to be negligible.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.10
Low (2)	Very low (1)	Negligible (2)	MAS01

Archaeological and cultural resources: Potential impacts

Lebanon has over 5,000 years of cultural heritage with historical landmarks spread across the entire country, including in the coastal zone and some known sites offshore of the Governorates of North Lebanon and Mount Lebanon. However, few offshore studies have been carried out, and there is therefore little known about the extent of offshore antiquities.

The presence of archaeological resources in the Block 4 priority area was assessed by an archaeologist during the offshore EBS (surveillance of seabed video) and no archaeological resources were identified. There is, however, the potential for physical disturbance of unknown marine archaeological resources during the setting of anchors if a semi-submersible drilling rig is used.

A drillship has been selected for the first well (therefore no anchoring), but options of a drillship or semi-submersible remain open for any future exploration/appraisal wells in Block 4.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as low (2): The geographic extent is immediate and the impact duration is long term as disturbance or damage may be permanent. Nevertheless, the potential impact intensity is considered low because disturbance and / or damage to an unknown marine archaeological resource is likely to be only superficial during the setting of anchors.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.10
Low (2)	Low (2)	Minor (4)	MAS01

Archaeological and cultural resources: Mitigation

No features of archaeological interest were identified in the Block 4 priority area during the offshore EBS. While the potential for such features to be present remains, pre-drilling geophysical surveys around future well sites should enable any previously unknown archaeological sites to be identified and the chance finds procedure to be initiated.

If a semi-submersible rig is selected for any future exploration/appraisal wells in Block 4, the seabed will be surveyed ahead of anchoring to avoid sensitive seabed features.

Archaeological and cultural resources: Residual impacts

The table below summarises residual impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1): Although the geographic extent and impact duration remain the same, pre-drilling geophysical surveys and anchoring mitigation if a semi-submersible is used will minimise the potential impact of degradation of cultural heritage sites. The impact intensity is reduced to very low (1) and residual impacts are anticipated to be negligible.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.10
Low (2)	Very low (1)	Negligible (2)	MAS01

6.4.1.2 MODU operations (MAS02)

MODU operations may potentially impact fisheries in the area, unknown archaeological resources, offshore infrastructure (submarine cables and pipelines), and shipping and tourism.

Impacts of MODU operations on fisheries, archaeology and cultural resources, infrastructure, shipping and tourism

Fisheries: Potential impacts

MODU operations will be taking place inside a restricted 500 m safety zone requiring any transiting fishermen to divert their vessels and creating minor navigation inconvenience. There is a potential for a reduction in water quality from drilling discharges that may then impact fish and therefore fisheries. The impacts of drilling fluid and cuttings discharge on the water column, based on modelling, are presented in Section 6.3.1.2. Based on these findings, impacts on fisheries are not anticipated.

Routine operational discharges from the MODU include sanitary waste, food waste, desalination unit discharges, drainage (including bilge water, slop water and fire water), cooling water and ballast water. Based on the negligible/minor environmental impact of the majority of these discharges (see Sections 6.3.1.6 to 6.3.1.10) impacts on fisheries are not anticipated.

Vertical seismic profile (VSP) activity has potential short term impact on fish catch. Studies investigating the impact of seismic surveys[14] on fisheries generally conclude that adult fish exhibit avoidance behaviour, resulting in temporary displacement of fish from the seismic survey area. The extent of this displacement is considered to fall within the normal geographic range of the species with rapid recovery of pre-survey catch levels after the seismic survey has been completed. It should be noted that airgun operations associated with VSP activities in Block 4 are very short term (2–3 hours of shooting time per well VSP).

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1): The geographic extent is local and the impact duration is very short term. Fishing activity in the area is not intensive and any interference will be very limited.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.10
Low (2)	Very low (1)	Negligible (2)	MAS02

Fisheries: Mitigation

Measures relevant to mitigating water quality impacts (and therefore secondary impacts on fish and fisheries) are presented in MAE01-3, MAE06-13 and MAE20. These include

- preferential use of HQ Band Gold, OCNS Group E and PLONOR chemicals (see Section 2.10.2.3)
- ensuring that barite will meet World Bank heavy metals concentration standards, i.e., mercury <1 mg/kg and cadmium <3 mg/kg dry weight
- ensuring operational discharges from the MODU will be in accordance with the requirements of MARPOL 73/78
- ballast water exchange in compliance with the International Convention for the Control and Management of Ships' Ballast Water and Sediments 2014.

14 Both VSP and seismic surveys use an airgun array as the noise source.

Underwater noise impacts on fish and therefore fisheries from MODU operations will be managed and mitigated as described in MAE18-19 (see Table 6.9).

Fisheries: Residual impacts

The table below summarises residual impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1): The pre-mitigation intensity is very low (1) as justified previously and the above mitigation further reduces the potential for impact of MODU operations on fisheries. Residual impacts are anticipated to be negligible.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.10
Low (2)	Very low (1)	Negligible (2)	MAS02

Archaeological and cultural resources: Potential impacts

If a semi-submersible rig is used to drill any future exploration/appraisal wells in Block 4, anchors may be used to maintain its position. Each anchor would have a length of chain on the seabed which could be dragged around as the drilling rig moves. Dragging of the chains across the seabed could impact upon archaeological features.

There is also the potential for archaeological features to be disturbed during well spud.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as low (2): The geographic extent is immediate (the area of seabed affected by well spud and anchor chain drag is very small)) and the impact duration is long term because disturbance or damage may be permanent. Nevertheless, the potential impact intensity is considered low because disturbance and or damage to unknown marine archaeological resource is likely to be only superficial.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.10
Low (2)	Low (2)	Minor (4)	MAS02

Archaeological and cultural resources: Mitigation

The following control measures will be observed:

- known cultural heritage and archaeological sites will be avoided and their protection regimes according to regulatory requirements will be complied with (Antiquities System Decision 166/1933 and Cultural properties Law 37/2008).
- if a semi-submersible rig is selected for any future exploration/appraisal wells in Block 4, impacts will be minimised by ROV seabed survey ahead of anchoring to avoid sensitive seabed features.
- predrill well-site assessments will be completed to provide high-resolution bathymetric and 3D/2D seismic data to identify seabed geohazards, habitat and, detect archaeological sites previously not detected; to inform avoidance measures and a well site free of geohazards.

An archaeologist was present during the offshore EBS of the Block 4 priority area. No features of archaeological interest were identified in the priority area or at the B4-1 well site. While the potential for such features to be present remains, pre-drilling geophysical surveys around future well sites should enable any previously unknown archaeological sites to be identified and the chance finds procedure initiated.

Archaeological and cultural resources: Residual impacts

The table below summarises residual impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1): Although the geographic extent and impact duration remain the same, the implementation of the proposed mitigation measures will minimise the potential impact of degradation of cultural heritage sites. Residual impacts are anticipated to be negligible.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.10
Low (2)	Very low (1)	Negligible (2)	MAS02

Infrastructure (submarine cables and pipelines): Potential impacts

Submarine communication cables transit Block 4. These provide telecommunication signals for telephone, internet and private data traffic to and from Lebanon. MODU operations could potentially disturb these submarine cables (e.g., from anchoring, well spud, burial from cuttings discharge), which could damage communications onshore. There are no existing cables within the B4-1 well 500 m safety zone.

The location of existing cables including Breytar, CADMOS, and India-Middle East-Western Europe (IMEWE) and the Kirkuk submarine pipeline were identified and checked during the offshore EBS. All were confirmed as distant from the well location.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1): the geographic extent is high and the impact duration is short term. Nevertheless, as there are no existing cables or other subsea infrastructure within B4-1 well safety zone, no interference is expected.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.10
Low (2)	Very low (1)	Negligible (2)	MAS02

Infrastructure (submarine cables and pipelines): Mitigation

The main mitigation is to site the Block 4 wells to avoid impacts on submarine infrastructure.

The location of submarine infrastructure will be checked prior to the siting of wells.

Infrastructure (submarine cables and pipelines): Residual impacts

The table below summarises the residual impact analysis. The impact intensity remains very low (1) as wells will only be sited away from existing submarine infrastructure. Residual impacts are anticipated to be negligible.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.10
Low (2)	Very low (1)	Negligible (2)	MAS02

Shipping: Potential impacts

There is the potential for disruption to sea users, mainly tankers, cargo ships and container ships using the shipping lanes in proximity to Block 4 and area from Beirut port to the Block 4 priority area, as they will need to avoid the mandatory 500-m safety zone around the MODU.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as low (2): The geographic extent is local and impact duration very short term. The potential disruption is similar to MODU mobilisation, installation and demobilisation (Section 6.4.1.1, MAS01) where the activity may cause a minor interference with other users.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.10
Medium (3)	Low (2)	Moderate (6)	MAS02

Shipping: Mitigation

The main control measures include

- adherence to existing shipping corridors with known buffer zones and standard operating procedures
- ensuring sea users, through a notice to mariners, are aware of drilling programme activities and the presence of the safety zone during mobilisation and demobilisation. The schedule of activities will be communicated to the Ministry of Public Works and Transport and the Lebanese Navy via the LAF, which issues information and instructions to mariners pertaining to shipping hazards and safety zones.
- having one support vessel permanently at the drill site providing security/safety duties and alerting other non-project sea users to the 500 m safety zone.

Shipping: Residual impacts

The table below summarises residual impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1): although the geographic extent and impact duration remain the same, mitigation measures ensure that other sea users are aware of the proposed drilling campaign resulting in only intermittent disruption of other sea users. Residual impacts are anticipated to be minor.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.10
Medium (3)	Very low (1)	Minor (3)	MAS02

Tourism: Potential impacts

The location of the first well (B4-1) is approximately 20 km from the shoreline. Any future Block 4 exploration/appraisal wells would also be drilled within the Block 4 priority area, which is at least 12 km from the shoreline. The sight of drilling activities may make tourists less willing to visit beaches and generally lead to a reduction in tourism.

The timing of the B4-1 drilling programme, which is outside peak tourism season, will reduce the potential impact on tourism, however, the same may not be true for possible future wells.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as low (2): The geographic extent is medium and the impact duration is very short term The Project activity may be noticed but will cause very limited interference with tourism.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.10
Medium (3)	Very Low (1)	Minor (3)	MAS02

Tourism: Mitigation

No mitigation required.

Tourism: Residual impacts

The table below summarises the residual impact analysis. The impact intensity remains very low (1). Due to the distance of the B4-1 well site and potential future wells from the shore the residual impact is anticipated to be minor.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.10
Medium (3)	Very low (1)	Minor (3)	MAS02

6.4.1.3 Support activities (MAS03)

Impact of support activities (movement of supply vessels) on infrastructure, shipping, fisheries and tourism

Infrastructure (Port of Beirut): Potential impacts

The Port of Beirut is considered the largest port in the eastern Mediterranean. With an area of about 1.2 million m^2, it has 4 basins, 16 quays and a new terminal for containers capable of holding around 1 million TEUs (20-ft equivalent units) each year (BankMed, 2015). The volume and type of imports varies with season. In January and February, the import of vegetable is high. Before the Adha holiday there is usually increased import of livestock. The volume of exports is very low and more stable over the year.

The Port of Beirut is a governmental entity designed for commercial use. The port's development has been highly constrained by the presence of very deep water immediately offshore from the port, which has precluded the development of new outer harbours, and the proximity of the city of Beirut on the landside. Several schemes to redevelop older areas of the port and improve the container and passenger terminals are underway, or in advanced stage of planning, including the first phase of the container terminal expansion (increasing container terminal capacity by 450,000 TEU and allowing the terminal to process 1.5 million tonnes per annum).

The Port of Beirut's jurisdiction is limited to the quay line, with the Ministry of Public Works and Transport (MoPWT) being responsible for the areas beyond.

The Block 4 exploration drilling campaign will rely on the Port for the location of the logistics base. This base will serve as a transit and storage location for supplies, materials, equipment and waste from/to the MODU. One or two project supply vessels will be travelling between Block 4 and the Port of Beirut (8–10 return trips are estimated in total per week). The other support vessel will stay offshore at the well site and will carry out safety and security duties.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as low (2): the geographic extent is local and the impact duration is very short term. Support activities are expected to cause minor interference owing to the low number of project supply vessel movements (8-10 return trips per week) during the drilling period.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.10
Low (2)	Low (2)	Minor (4)	MAS03

Infrastructure (Port of Beirut): Mitigation

Measures to reduce the intensity of the impact include

- project supply vessels having designated moorings at the onshore logistics base, reducing interference with other non-project vessels using the port
- project supply vessels operating in accordance with directions from the Port Authority.

Infrastructure (Port of Beirut): Residual impacts

The table below summarises residual impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1): although geographic extent and impact duration remain the same, the above mitigation measures will reduce impact to a very limited and intermittent interference within the Port of Beirut. Residual impacts are anticipated to be negligible.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.10
Low (2)	Very low (1)	Negligible (2)	MAS03

Shipping: Potential impacts

Project supply vessel transfers in and out of Beirut Port have the potential to interfere with other sea users, particularly commercial vessels (tankers, tugs, pilot boats and cargo vessels) also accessing the port. The Port of Beirut received approximately 3000 ships in 2015 and handles over 8 million MT/year of general cargo. In July 2019 alone, a total of 78 container ships and 58 general cargo vessels arrived at the port (Port of Beirut, 2019).

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as low (2): the geographic extent is local and impact duration very short term. The low number of project support vessel movements during the drilling period will lead to minor interference with other sea users.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.10
Medium (3)	Low (2)	Moderate (6)	MAS03

Shipping: Mitigation

Measures to reduce the intensity of the impact include

- the supply vessel movements and the likely duration of their activities will be communicated to the port maritime authorities
- all supply vessels will be operating in accordance with the requirements of the Port Authority, which plans and coordinates vessel traffic movements within its jurisdiction and provides information services concerning the arrival, berthing, anchoring and departure of vessels and also information on navigation, visibility, tidal information and safety of vessels and persons in Beirut Port
- fitting all support/supply vessels with navigational aids and communication systems and following specified shipping routes and speed restrictions.

Shipping: Residual impacts

The table below summarises residual impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1): although geographic extent and impact duration remain the same, the mitigation measures will ensure a very limited and intermittent interference with other sea users. Residual impacts are anticipated to be minor.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.10
Medium (3)	Very low (1)	Minor (3)	MAS03

Fisheries: Potential impacts

The fisheries sector in Lebanon is small-scale and is carried out mainly as a subsistence or recreational activity. While there are plans to develop a commercial fishing fleet, fishing activities remain artisanal and most fish consumed in Lebanon is imported. The movement of support vessels between the MODU and the logistics base has the potential to impact fisheries that use the same access corridors to their fishing grounds. Some artisanal fishing vessels pass by the port to reach fishing grounds off Beirut. However, the Port of Beirut authorities confirmed that no fishing boats use the port.

There is the potential for effects on fisheries from routine project vessel discharges (sanitary waste, food waste, bilge water, cooling water, ballast water, etc.). Based on the negligible/minor environmental impact of the majority of these discharges (see Sections 6.3.1.6 to 6.3.1.10), impacts on fisheries are not anticipated.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as low (2): the geographic extent is local and the impact duration is very short term. The low number of project supply vessel movements and their associated discharges will cause minor interference to fisheries.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.10
Medium (3)	Low (2)	Moderate (6)	MAS03

Fisheries: Mitigation

Mitigation measures include those to mitigate the impacts on shipping (MAS 03 shipping, Table 6.10) and mitigation measures aimed at reducing impacts to water quality and subsequently fish and fisheries from project vessel operations (MAE 08-13 operational discharges, Table 6.9).

Fisheries: Residual impacts

The table below summarises the residual impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1): although geographic extent and impact duration remains the same, the implementation of the above mitigation will result in very limited interference with fisheries. Residual impacts are anticipated to be minor.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.10
Medium (3)	Very low (1)	Minor (3)	MAS03

Tourism (recreational activities): Potential impacts

There is the potential for interference between project supply vessels and recreational touristic vessels (pleasure craft) associated with day cruises and scuba-diving activities in the area. In addition, a small number of sea anglers travel up to 12 nm from shore to carry out recreational fishing activities. There are no bathing waters in the immediate vicinity of the Port of Beirut that would be impacted by supply vessels arriving and departing from the port.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as low (2): the geographic extent is local and the impact duration is very short term. The low number of project related vessel movements throughout the drilling period, in comparison to the vessel traffic already in the area will result in minor interference with recreational activities.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.10
Medium (3)	Low (2)	Moderate (6)	MAS03

Tourism (recreational activities): Mitigation

The main mitigation measure is the avoidance of interference with other sea users through notification of project activities to the Port Authority and the issuance of a notice to mariners by the MoPWT.

Drilling activities for the first well in Block 4 are scheduled during the low tourism season, although any future Block 4 exploration/appraisal wells may be drilled at other times of the year. Details of mitigation measures applicable to this impact are listed in MAS 01: shipping, Table 6.10.

Tourism (recreational activities): Residual impacts

The table below summarises residual impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1): although geographic extent and impact duration remain the same, implementation of the above mitigation, including avoidance of peak tourist season for the first well, will mean there is very limited interference with tourism. Residual impacts are anticipated to be minor.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.10
Medium (3)	Very low (1)	Minor (3)	MAS02

6.4.2 Onshore activities

6.4.2.1 Logistics base operation (OAS01)

Impacts of logistics base operation on public health, tourism, infrastructure, general economy, education and training, security

Public health: Potential impacts

The logistics base will be located within a large industrial area within the footprint of the existing Port of Beirut. Potential public health impacts from the logistics base operations include a decrease in air quality from project emissions and an increase in ambient noise. There are residential areas located inland from the Port, with the closest community approximately 200 m from the logistics base (Gemmeyze neighbourhood). The residential area is separated from the port by the main highway.

<u>Air emissions</u>

The logistics base will be connected to the electricity grid of the Port of Beirut. In addition, there will be one back-up generator present on site (to be used only in case electrical grid power supply is unavailable and the port generators are also unavailable). Estimated air emissions from generator use at the logistics base (based on a worst-case scenario of one generator used 24 hours a day during the drilling programme) are included in Tables 4.11 and 4.12.

<u>Airborne noise:</u>

Sources of noise at the logistics base will be limited to those associated with loading and unloading operations, and those from the drilling fluids mixing plant and bulk facilities (generators, pumps, agitators and air compressors). None of these are anticipated to be particularly acute noise sources, especially in the context of other activities taking place at Beirut Port.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1): the geographic extent is local and the impact duration is short term. The incidence of chronic and acute illness and reduction of wellbeing will stay within normal variation in baseline levels during the logistics base operations.

Due to the significant existing activities at the Port of Beirut and the location of the highway any additional air emissions or airborne noise will be negligible.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.10
Low (2)	Very low (1)	Negligible (2)	OAS01

Public health: Mitigation

The main existing control measures for air quality include

- compliance with the regulatory requirements, including, but not limited to the requirements of PAR, OPRL, EPA and Ambient Air Quality Standards and Emission Limit Values (Decision 8/1/2001)
- adopting Best Available Techniques (BAT) as stipulated by the Air Quality Law (78/2018) to minimise the impacts on air quality
- obtaining an emissions permit from the MoE as per Law No. 78/2018 once the implementation decision is enforced.

Additional mitigation measures include

- using low-sulphur fuels in generators where practicable
- planned, preventive maintenance as per manufacturer's recommendation will be mandatory for all equipment
- transfer of dry bulk from the drilling fluids mixing plant dry bulk silos will be carried out with the use of a dust collector unit to minimise dust migration to the surrounding environment.

The main existing control measures for airborne noise include

- compliance with the regulatory requirements, including, but not limited to requirements of PAR, OPRL and EPA. Equipment that has the highest source of noise levels will be located as far from the closest residential properties as possible.
- the logistics base contractor being responsible for compliance with Lebanese maximum allowable noise levels (Decision 52/1/96), see Section 2.10.1.3. Noise monitoring will be carried out to determine what, if any, noise mitigation is required and feasible (such as installation of acoustic barriers).

Public health: Residual impacts

The table below summarises the residual impact analysis. The impact intensity remains as very low (1). Implementation of listed mitigation will further reduce impact of the logistics base on public health to within normal baseline variation. Residual impacts are anticipated to be negligible.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.10
Low (2)	Very low (1)	Negligible (2)	OAS01

Tourism: Potential Impacts

The logistics base will be located inside the area occupied by the commercial Port of Beirut (area of about 1.2 million m^2). It will be operational for the duration of the Block 4 exploration drilling programme (and also the Block 9 exploration drilling programme).

There are no tourism sensitive businesses inside the port or bathing waters in the immediate vicinity of the port.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1): the geographic extent is immediate and the impact duration is very short term. Owing to pre-existing industrial land use in the port and limited increase in overall port activities associated with Block 4 exploration drilling campaign, impact intensity is considered very low with very limited, if any, interference with tourism.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.10
Medium (3)	Very low (1)	Minor (3)	OAS01

Tourism: Mitigation

No expansion of the port footprint will be required from the construction and operation of the project logistics base.

The project will select a logistics base operator based on strict HSE criteria compliant with international regulations for oil and gas activities and applicable TOTAL E&P rules.

Tourism: Residual impacts

The table below summarises residual impact analysis. The impact intensity remains very low (1) and residual impacts are anticipated to be minor.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.10
Medium (3)	Very low (1)	Minor (3)	OAS01

Infrastructure (Port of Beirut): Potential impacts

Although the infrastructure offered by the Port of Beirut and its servicing capacities are one of the largest in the region, there is still the potential for the project logistics base and associated activities to create additional pressure on existing services and space inside the port facilities.

The logistics base support activities, as well as the drilling fluids mixing plant operations, will require fresh water. Estimated water requirement at the logistics base is 2300 m^3 for well B4-1 (2200 m^3 required for drilling fluids mixing, 100 m^3 required by logistics base personnel for washing, etc.). This water will be taken from the Beirut city water line.

The offshore MODU will be self-sufficient in terms of daily water use from onboard desalination.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as low (2): the geographic extent is immediate and the impact duration very short term but minor interference of port infrastructure is likely.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.10
Low (2)	Low (2)	Minor (4)	OAS01

Infrastructure (Port of Beirut): Mitigation

The main existing control measures include

- the logistics base contractor complying with the port's operational limits and the operator's HSE requirements
- contractors being responsible for protecting infrastructure and reinstating any damages if caused by their activities
- installing a surge tank at the logistics base, which will be filled with fresh water during off-peak community demand. Water will then be released to meet the requirements of the drilling fluids mixing plant without risk of interference to the Beirut city water supply.

Infrastructure (Port of Beirut): Residual impacts

The table below summarises residual impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1) owing to above mitigation measures ensuring a very limited or intermittent interference with port infrastructure. Residual impacts are anticipated to be negligible.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.10
Low (2)	Very low (1)	Negligible (2)	OAS01

General economy: Potential impacts

There are a range of positive potential economic impacts from the project if the exploration drilling results in the discovery of commercially viable hydrocarbon reserves. However, at this exploration drilling phase, only limited employment and requirements for goods and services are anticipated.

Employment: It is proposed that 180 people will be employed on the MODU and a further 50 will be employed at the logistics base. The staff on the MODU are likely to be expatriates, as specific skills and experience are required that are not currently available in Lebanon. Many of the staff employed at the logistics base will be Lebanese nationals. There is, therefore, the potential for positive impacts on employment, which in turn could lead to an increase in household income and an improvement in living standards. There is also the potential for skills development of the local workforce, which could enhance future job opportunities. Although opportunities for employment and skills development are limited during this exploration phase, it is anticipated that there would be significant beneficial impacts if the exploration phase is successful.

Provision of goods and services: There are opportunities for positive impacts on national companies in Lebanon if they succeed in winning contracts, for catering, cleaning, security, logistics, etc., during the drilling campaign, with about 25 contracts anticipated to be awarded. However, the informal, unregulated and small-scale nature of local businesses, market access and power supply may hamper local businesses in meeting project standards and requirements. Additionally, there are a range of potential environmental, social and human rights impacts if insufficient due diligence is exercised when subcontracting. This risk will be managed through vendor qualification and contractual procedures.

The table below summarises the pre-mitigation impact analysis. The impact intensity has been scored as beneficial (0), as the impacts are considered positive.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.10
Low (2)	Beneficial (0)	Beneficial (0)	OAS01

General economy: Mitigation

Employment:

- During the exploration phase, local employment opportunities will be maximised to the extent possible to accommodate project needs.
- Project contractors will use local labour and advertise vacancies locally. TEP Liban will also make it a contractual requirement that its contractors and subcontractors comply with all applicable labour laws.

Provision of goods and services:

- PAR Article 157: the right holder shall ensure that operator gives preferential treatment to the procurement of Lebanese originating goods and services when such goods and services are internationally competitive with respect to quality, availability, price and performance.

General economy: Residual impacts

The table below summarises the residual impact analysis. The impact intensity has been scored as beneficial (0), as the impacts on local employment and services provision are considered positive, while acknowledging that both employment and procurement opportunities are limited at this exploration phase of the project. Residual impacts are anticipated to be beneficial.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.10
Low (2)	Beneficial (0)	Beneficial (0)	OAS01

Education and training: Potential impacts

Offshore hydrocarbon exploration is yet to become established in Lebanon and the expertise associated with this sector is not widely available locally. However, even at an early stage in industry development, there are opportunities for local industry players and the local labour market to learn from international project requirements including technical, environmental, safety and social aspects. There are several universities in Lebanon that are offering specialised petroleum engineering and related studies and produce young graduates to the labour market every year.

The logistics base operator will be contractually guided to adhere to good industry practice. Competency training and professional guidance will be offered to their personnel if necessary. Given the limited duration of the drilling activities, longer-term education and skills development are not anticipated at this stage.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored as beneficial (0), as the overall impact on education and training through involvement of local suppliers is considered positive.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.10
Low (2)	Beneficial (0)	Beneficial (0)	OAS01

Education and training: Mitigation

- PAR Article 155: the right holder and contractor shall give priority to training of Lebanese in order to facilitate the employment of Lebanese at all levels of right holders/contractor's organisation.

Education and training: Residual impacts

The table below summarises residual impact analysis. The impact intensity has been scored as beneficial (0) while acknowledging that opportunities for education and training are limited at this exploration phase of the project. Residual impacts are anticipated to be beneficial.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.10
Low (2)	Beneficial (0)	Beneficial (0)	OAS01

Social conditions (security): Potential impacts

The logistics base will be established within the Port of Beirut. It will be fenced and equipped with 24/7 surveillance and security guards. A pass will be required for access through the port gates, users will need to undergo a safety induction and provide identification to obtain a pass. Control and record of any movement (personnel and vehicles) will be carried out. Customs officials operate inside the port and all vehicles will be checked by the Army Intelligence Directorate on arrival and departure.

The table below summarises the pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1): The geographic extent is immediate and the impact duration is very short term, as the logistics base will be fully contained within the existing port facilities.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.10
Low (2)	Very low (1)	Negligible (2)	OAS01

Social conditions (security): Mitigation

The logistics base operator will cooperate with the general security at the port and will be required under their contract with TEP Liban to develop a security plan and to regularly assess security risks.

Social conditions (security): Residual impacts

The table below summarises the residual impact analysis. The impact intensity remains very low (1) with the above mitigation further reducing potential impact. Residual impacts are anticipated to be negligible.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.10
Low (2)	Very low (1)	Negligible (2)	OAS01

6.4.2.2 Transport of supply materials to/from logistics base (onshore vehicle activity) (OAS02)

Impacts of materials transport on public health, social conditions and infrastructure

Offshore drilling operations will require onshore support, which will be provided from the logistics base inside the Port of Beirut. The logistics base will also require supplies from inland. It is anticipated that water and food will be transported to the logistics base and that personnel will commute daily for work. Potential impacts from the transport of those materials and people could contribute towards additional air emissions and airborne noise affecting public health of nearby communities.

It should be noted that drilling chemicals will be delivered by vessel to the logistics base from the service contractor's warehouses (also in Beirut Port).

Public health: Potential impacts

Air quality

Air emissions associated with vehicle movements may impact negatively on the air quality and subsequently health of local populations along the vehicle routes. Dust emissions are not likely to be an issue during transportation as the roads are sealed/asphalted.

Airborne noise

The transport of supplies to and from the logistics base may change the noise environment along the vehicle routes. Besides potential damage to the auditory system, increased noise levels could cause sleep and rest disturbance, lack of concentration and reduction in performance, and nuisance.

The table below summarises the pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1): the geographic extent is local and impact duration is very short term. The limited amounts of supplies and personnel being transported and the existing levels of traffic movement at the port and on surrounding roads will ensure that the incidence of chronic and acute illness and reduction of wellbeing stays within normal variation in baseline levels.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.10
Low (2)	Very low (1)	Negligible (2)	OAS02

Public health: Mitigation

Air quality

The main mitigation measures include

- compliance with Lebanese maximum emission limits (Decision 8/1/2001), see Section 2.10.1.1

- regular maintenance of vehicles to ensure smooth running of engines and efficient and clean burning of fuels, low sulphur fuels will be used where practicable
- implementation of a grievance mechanism to provide opportunities for community members to express any concerns or issues.

Airborne noise

The main mitigation measures include

- compliance with the regulatory requirements, including, but not limited to requirements of PAR, OPRL, EPA and MoE decision No. 52/1/1996 maximum allowable noise levels, see Section 2.10.1.3.
- implementation of traffic movement restrictions in the early morning hours at the port (data from meeting with Port of Beirut)
- implementation of a grievance mechanism to provide opportunities for community members to express any concerns or issues.

Public health: Residual impacts

The table below summarises residual impact analysis. The impact intensity remains very low (1) with the above mitigation further reducing potential impact on public health. Residual impacts are anticipated to be negligible.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.10
Low (2)	Very low (1)	Negligible (2)	OAS02

Social conditions (road safety and congestion): Potential impacts

Road safety is a major concern in Lebanon (see Section 5.5.3.9). Roads are busy and congested, and there is limited road safety infrastructure. Traffic volumes for onshore support activities will be limited to logistics base personnel commuting to work and provision of water and food supplies.

The table below summarises the pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as low (2): the geographic extent is local and the impact duration is very short term owing to the limited amounts of supplies and personnel being transported on the roads.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.10
Low (2)	Low (2)	Minor (4)	OAS02

Social conditions (road safety and congestion): Mitigation

The main existing control measures include

- restricting vehicle movements to defined access routes and demarcated working areas (including dedicated parking areas if outside the logistics base)
- adhering to speed restrictions (speed limit in and around logistics base will be set at 20 km/) defined in a driving and transportation policy
- implementing a grievance mechanism to provide opportunities for community members to express any concerns or issues.

Social conditions (road safety and congestion): Residual impacts

The table below summarises residual impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1). Although the geographic extent and impact duration remain the same the application of mitigation measures result in a very limited or intermittent interference reducing the impact intensity. Residual impacts are anticipated to be negligible.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.10
Low (2)	Very low (1)	Negligible (2)	OAS02

Infrastructure (road network): Potential impacts

Lebanon is served by a network of more than 7000 km of primary and secondary roads, 6200 km of which are paved. Despite improvements, the road system is in poor condition and increased congestion means the road infrastructure needs continuous maintenance. Road use by project vehicles could add to increased pressure on road infrastructure with potential for further deterioration or damage during transportation of supplies and personnel to the logistics base.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as low (2): the geographic extent is local and impact duration very short term.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.10
Low (2)	Low (2)	Minor (4)	OAS02

Infrastructure (road network): Mitigation

The main mitigation measures applicable to road infrastructure include

- restricting vehicle movements to defined access routes and demarcated working areas (including dedicated parking areas if outside logistics base)
- logistics contractor shall comply with driving and transportation policy requirements under the contract including speed limits and slow speeds when crossing villages etc
- contractors being responsible for protecting infrastructure and reinstating any damages if caused by their activities
- implementing a grievance mechanism to provide opportunities for community members to express any concerns or issues.

Infrastructure (road network): Residual impacts

The table below summarises residual impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1). Although the geographic extent and impact duration remain the same the application of mitigation measures reduces the impact intensity. Residual impacts are anticipated to be negligible.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.10
Low (2)	Very low (1)	Negligible (2)	OAS02

6.4.2.3 Support activities (helicopter transfer) (OAS03)

Impacts of helicopter transfers on public health, tourism and Infrastructure

Personnel will be transported by helicopter from Beirut International Airport to the MODU (subject to approval from the authorities). Two helicopters will support the operations, each with a capacity of 8 to 12 passengers. It is assumed that the helicopter transit route between Block 4 and the airport will be a direct line between the two. Each trip is estimated to take 8 minutes and around 10 return trips per week would be required.

Public health: Potential impacts

Helicopter movements generate airborne noise, which may disturb local communities. The level to which the existing noise environment is affected depends on the noise source levels and distance between the source and the receptors. The whole of the coastline in the vicinity of Beirut International Airport is built up with residential development.

Impacts from project helicopter movements need to be considered in line with total aircraft movements from Beirut International Airport (a total of 73,626 total aircraft movements in 2018; Beirut Airport Stats, 2019). It is not anticipated that an additional 10 return helicopter trips per week (for the Block 4 exploration drilling campaign) will have a noticeable increase to the local community in terms of noise levels.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1): the geographic extent is local and impact duration is very short term. However, owing to the relatively low number of helicopter transfers (10 return journeys per week), the current total aircraft movements in the area and the short term nature of the Block 4 drilling campaign no health impacts or reduction of wellbeing is expected beyond normal variation in baseline levels.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.10
Low (2)	Very low (1)	Negligible (2)	OAS03

Public health: Mitigation

Safety will be the main consideration in the definition of the route between the airport and Block 4, with optimisation of the travel distance and avoidance of sensitive receptors also being considered.

Other mitigation measures include

- developing a flight plan for each transfer and agreed with the relevant authority
- avoiding low flights directly over local communities and popular beaches in the vicinity of the airport, if safe and practical to do so
- planning helicopter transfers for daylight hours, which will help to minimise noise disturbance to local communities at night.

Public health: Residual impacts

The table below summarises residual impact analysis. The impact intensity remains very low (1) with the above mitigation measures further reducing the potential impact on public health. Residual impacts are anticipated to be negligible.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.10
Low (2)	Very low (1)	Negligible (2)	OAS03

Tourism: Impacts

Helicopter movements generate noise impacts, which may disturb tourist facilities or activities. The beach resorts of La Siesta, Coral Beach, Kempinski Summerland, Eden Bay, Movenpick, Riviera, and Senses, and one public beach, Ramlet el-Baida, are to the north of the airport (see Figure 5.88).

As stated above, impacts from project helicopter movements need to be considered in line with total aircraft movements from Beirut International Airport. It is not anticipated that an additional 10 return helicopter trips per week will have a noticeable increase to holiday makers using the tourist facilities to the north of the airport.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1): the geographic extent is local and impact duration is very short term. However, owing to the relatively low number of helicopter transfers (10 return journeys per week), the current total aircraft movements in the area and the short term nature of the Block 4 drilling campaign very limited or no interference is expected.

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.10
Medium (3)	Very low (1)	Minor (3)	OAS02

Tourism: Mitigation

The mitigation measures for tourism are the same as those for public health (OAS 03), above.

Tourism: Residual impacts

The table below summarises residual impact analysis. The impact intensity remains very low (1) with the above mitigation further reducing potential impact on tourism. Residual impacts are anticipated to be minor.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.10
Medium (3)	Very low (1)	Minor (3)	OAS03

Infrastructure (air traffic): Potential impacts

There is a potential burden on existing flight control facilities at Beirut International Airport owing to the additional helicopter transfers required for the Block 4 exploration drilling campaign.

The table below summarises pre-mitigation impact analysis. The impact intensity has been scored in accordance with a combination of factors from Table 1.2 as very low (1): the geographic extent is local and impact duration very short term, however, owing to the relatively low number of helicopter transfers (10 return journeys a week) and the short term nature of the Block 4 drilling campaign, there will be a very low (1) impact intensity on air traffic infrastructure

Receptor sensitivity	Potential impact intensity	Potential impact significance	Cross-reference to Table 6.10
Low (2)	Very low (1)	Negligible (2)	OAS03

Infrastructure (air traffic): Mitigation

The mitigation measures for air traffic infrastructure are the same as those for public health (OAS 03), above.

Infrastructure (air traffic): Residual impacts

The table below summarises residual impact analysis. The impact intensity remains very low (1) with the above mitigation further reducing potential impact on air traffic. Residual impacts are anticipated to be negligible.

Receptor sensitivity	Residual impact intensity	Residual impact significance	Cross-reference to Table 6.10
Low (2)	Very low (1)	Negligible (2)	OAS03

6.4.3 Impacts on ecosystem services

Ecosystem services are the many and varied benefits that humans receive from ecosystems, which sustain and fulfil human wellbeing. These benefits may be direct (e.g., provision of food plants and animals) or indirect, through the functioning of ecosystem processes that produce the direct services.

Ecosystem services are typically organised into four categories:

- provisioning services: the goods and products people obtain from terrestrial and aquatic ecosystems (e.g., food, freshwater, timber, construction materials, medicinal plants)
- regulating services: the benefits people obtain from the regulation of ecosystem processes, such as surface water purification (e.g., intact forested catchments), carbon storage and sequestration, climate regulation, protection from natural hazards, etc.
- cultural services: the non-material benefits people obtain from ecosystems, such as spiritual wellbeing, recreation and aesthetic enjoyment and social unity
- supporting services: natural processes that maintain the other services, for example, soil formation, nutrient cycling, and primary and secondary production.

The main ecosystem services near the project's offshore location relate to provisioning services, which are mainly based on marine resource usage and cultural services.

Impacts of the routine Block 4 exploration drilling activities on fisheries, shipping and cultural heritage have all been assessed, with impacts classed as negligible to minor. These are summarised in Table 6.10.

6.4.4 Summary social and cultural heritage impact assessment table

A systematic assessment of the potential social and cultural heritage impacts of the proposed Block 4 exploration drilling campaign routine activities is provided in Table 6.10, along with potential and residual scorings of impact severity.

Table 6.10: Social and cultural heritage impacts of the Block 4 exploration drilling campaign – routine activities

Activities/ sources of impact	Receptors	Potential effects	Initial impact			Main protection/ mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
Marine activities									
MAS01: MODU mobilisation, installation, plug and abandonment and demobilisation	Shipping	Disruption to sea users – mainly tankers, cargo ships and container ships passing Block 4 drilling location, may require diversion to avoid MODU 500-m safety zone. No potential effects on shipping anticipated from leaving the wellhead in place on the seabed following well abandonment, see Section 4.4.10.	3 (medium)	2 (low)	6 (moderate)	Ensure sea users are aware of drilling programme activities and presence of safety zone during mobilisation and demobilisation through a notice to mariners (SOC-4) The schedule of activities will be communicated to the Ministry of Public Works and Transport and the Lebanese Navy via the Lebanese Armed Forces (LAF) that issues information and instructions to mariners pertaining to shipping hazards and safety zones (HSS-15). Compliance with the regulatory requirements, Petroleum Activities Regulations (PAR), Article 6: Vessels and crafts used for or involved in Petroleum Activities shall comply with applicable international and Lebanese laws and regulations regarding Petroleum Activities and navigation. The vessels and crafts shall abide by instructions given by the competent Lebanese authorities and by the	3 (medium)	1 (very low)	3 (minor)

Activities/ sources of impact	Receptors	Potential effects	Initial impact			Main protection/ mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
						competent Lebanese naval vessels, patrol boats or crafts (SOC-15). Adherence to existing shipping corridors with known buffer zones and standard operating procedures as stipulated in in UNCLOS (SOC-3).			
	Fisheries	Potential disruption to fisheries as fishing will not be permitted within the MODU 500-m safety zone for security reasons. Limited fisheries at the well site owing to MODU location being outside 6 nm fishing area. No potential effects on fisheries anticipated from leaving the wellhead in place on the seabed following well abandonment, see Section 4.4.10.	2 (low)	2 (low)	4 (minor)	Operators will submit Safety Zone Authorisation to the authorities for approval prior to drilling activities (SOC-5). Operators shall inform fishermen through the fisheries associations about well plan approvals to ensure well location avoidance. Discussions will be initiated approximately 1 month before planned commencement of drilling in case extensive fishing area is impacted (SOC-6). Grievance mechanism to be made available for community members who are affected by offshore drilling activities (SOC-1).	2 (low)	1 (very low)	2 (negligible)
	Archaeological and cultural resources	Potential for physical disturbance of unknown marine archaeological resources during setting of anchors if semi-submersible rig is used for any future exploration/	2 (low)	2 (low)	4 (minor)	An archaeologist was present during the Environmental Baseline Survey conducted in Block 4 and did not identify any cultural heritage sites within the Block 4 priority area **(C)**.	2 (low)	1 (very low)	2 (negligible)

Activities/ sources of impact	Receptors	Potential effects	Initial impact			Main protection/ mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
		appraisal wells in Block 4				If semi-submersible rig selected, impacts will be minimised by surveying seabed ahead of anchoring to pre-determine an anchor pattern and selecting optimum anchor positions that avoid sensitive seabed features (BIO-05).			
MAS02: MODU operations	Fisheries	Potential for reduction in water quality from drilling and operational discharges to impact fisheries. Limited fisheries at the well site owing to MODU location being outside 6 nm fishing area.	2 (low)	1 (very low)	2 (negligible)	Following environmental mitigation measures related to marine fauna protection will be implemented (see sources of impact as referenced below): - MAE01-3, - MAE06-08, - MAE10-13, - MAE20. Preference for HQ Band Gold, OCNS Group E and PLONOR chemicals, see Section 2.10.2.3 (CM-2) Barite will meet heavy metals concentration standards, i.e., mercury <1 mg/kg and cadmium <3 mg/kg dry weight (total) (CM-1). All operational discharges from MODU will be in accordance with the requirements of MARPOL 73/78 **(R)** (PP-13). Any ballast water exchange will be carried out in compliance with the 'International Convention	2 (low)	1 (very low)	2 (negligible)

Activities/ sources of impact	Receptors	Potential effects	Initial impact			Main protection/ mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
						for the Control and Management of Ships' Ballast Water and Sediments 2014' (R) (PP-11) Underwater noise impacts on fish and therefore fisheries from MODU operations will be managed and mitigated as described in MAE18-19 (BIO-2)			
	Archaeological and cultural resources	Potential for physical disturbance of unknown marine archaeological resources during well spud and from anchor drag if semi-submersible used for future wells.	2 (low)	2 (low)	4 (minor)	Known cultural heritage and archaeological sites will be avoided and their protection regimes according to regulatory requirements will be complied with (Antiquities System Decision 166/1933 and Cultural properties Law 37/2008) (CH-1). Predrill well-site assessments will be completed to provide high-resolution bathymetric and 3D/2D seismic data to identify seabed geohazards, habitat and, detect archaeological sites previously not detected; to inform avoidance measures and a well site free of geohazards. (CH-2). If a semi-submersible rig is selected for any future exploration/appraisal wells in Block 4, impacts will be minimised by ROV seabed survey ahead of anchoring	2 (low)	1 (very low)	2 (negligible)

Activities/ sources of impact	Receptors	Potential effects	Initial impact: Sensitivity	Initial impact: Intensity	Initial impact: Significance	Main protection/ mitigation measures	Residual impact: Sensitivity	Residual impact: Intensity	Residual impact: Significance
						to avoid sensitive seabed features (BIO 05).			
	Infrastructure (Submarine cables and pipelines)	Potential for disturbance and damage to submarine cables	2 (low)	1 (very low)	2 (negligible)	Location of Breytar; CADMOS; and India-Middle East-Western Europe (IMEWE) cables and the Kirkuk submarine pipeline were checked during EBS survey and they are distant from the location of the well (**C**).	2 (low)	1 (very low)	2 (negligible)
	Shipping	Disruption to sea users – mainly tankers, cargo ships and container ships using the shipping lanes in proximity to Block 4 – in particular area from Beirut port to Block 4 priority area.	3 (medium)	2 (low)	6 (moderate)	Adherence to existing shipping corridors with known buffer zones and standard operating procedures as stipulated in in UNCLOS (SOC-3). Ensure sea users are aware of drilling programme activities and presence of safety zone during mobilisation and demobilisation through a notice to mariners (SOC-4) (The schedule of activities will be communicated to the Ministry of Public Works and Transport and the Lebanese Navy via the Lebanese Armed Forces (LAF) that issues information and instructions to mariners pertaining to shipping hazards and safety zones) (SOC-5). One support vessel will be permanently at the drill site providing security and safety duties, alerting other non-project sea users	3 (medium)	1 (very low)	3 (minor)

Activities/ sources of impact	Receptors	Potential effects	Initial impact			Main protection/ mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
						about 500 m safety zone (SOC-14).			
	Tourism	Physical presence of MODU affecting tourist enjoyment of seascape	3 (medium)	1 (Very low)	3(minor)	The closest future drilling location in the Block 4 priority area is 12 km from the shore (the first well will be 20 km from shore). MODU operations and its location should not be visibly disturbing to tourists using facilities along the coast. No mitigation required.	3 (medium)	1 (very low)	3 (minor)
MAS03: Support activities (movement of support vessels)	Infrastructure (Beirut Port)	Potential to interfere with other sea users passing through Beirut Port and within the transit route to the MODU – including commercial vessels, fishing vessels, recreational and touristic vessels. Increased vessel transfer through Beirut Port area increases risk of vessel collision.	2 (low)	2 (low)	4 (minor)	Supply vessels will have designated mooring jetty at the onshore logistics base reducing interference with other non-project vessels using the Port (SA-3). Follow communication from Port Authorities, who are responsible for Port operations up to the quay line (SA-2). The support/supply vessel movements and the likely duration of their activities will be communicated to the port maritime authorities (SA-4). All vessels fitted with navigational aids, communication systems and follow specified shipping routes and speed restrictions (SA-1). MAE 08-13 operational discharges.	2 (low)	1 (very low)	2 (negligible)
	Shipping		3 (medium)	2 (low)	6 (moderate)		3 (medium)	1 (very low)	3 (minor)
	Fisheries		3 (medium)	2 (low)	6 (moderate)		3 (medium)	1 (very low)	3 (minor)
	Tourism, (recreational activities)		3 (medium)	2 (low)	6 (moderate)		3 (medium)	1 (very low)	3 (minor)

Activities/ sources of impact	Receptors	Potential effects	Initial impact			Main protection/ mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
Onshore activities									
OAS01: Logistics base operation	Public Health (airborne noise, air quality)	Potential for reduction in air quality owing to use of back-up generator at logistics base Potential for increase in ambient noise levels to disturb residents and businesses in vicinity of the logistics base	2 (low)	1 (very low)	2 (negligible)	Compliance with Lebanese maximum emission limits (Decision 8/1/2001), see Section 2.10.1.1. **(R)** (PP-39). Planned, preventive maintenance as per manufacturer's recommendation will be mandatory for all equipment (PP-52). Low sulphur fuel to be used where practicable (PP-32). Any transfer of dry bulk from the drilling fluids mixing plant dry bulk silos will be carried out with the use of a dust collector unit to minimise dust migration to the surrounding environment (PP-40). Final design of the Logistics Base layout will consider locating the equipment with highest source of noise as far from the closest residential properties as possible (PP-41). Noise monitoring will be carried out at the logistics base to determine if noise mitigation measures shall be applied (where feasible) (PP-42). Airborne noise levels from the logistics base will comply with Lebanese	2 (low)	1 (very low)	2 (negligible)

Activities/ sources of impact	Receptors	Potential effects	Initial impact			Main protection/ mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
						maximum allowable noise levels (Decision 52/1/96), see Section 2.10.1.3, at the Logistics base fence line (PP-43).			
	Tourism	Limited – there are no tourism sensitive businesses inside the port, or bathing waters in the immediate vicinity of the port	3 (medium)	1 (very low)	3 (minor)	Logistics base location selected to be in an area which is already used for industrial activities with existing restriction zones between residential and industrial buildings No expansion of the port footprint will be required owing to presence of project logistics base (SOC-18). Logistics base operator will be selected based on strict HSE criteria compliant with international regulations for oil and gas activities and applicable TOTAL E&P rules (HSS-16).	3 (medium)	1 (very low)	3 (minor)
	Infrastructure (Port of Beirut)	Presence of logistics base could create additional pressure on existing Port's infrastructure	2 (low)	2 (low)	4 (minor)	Logistics base contractor will be required to comply with the port's operational limits and Operator's HSE requirements (SOC-8). Contractors are responsible for protecting infrastructure and reinstating damages if caused by their activities (SOC-13). A surge tank will be installed at the logistics base; surge tank will be filled with fresh water	2 (low)	1 (very low)	2 (negligible)

Activities/ sources of impact	Receptors	Potential effects	Initial impact			Main protection/ mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
						during off-peak community demand in order to supply project requirements specifically with regard to mud plant activity (PL-6).			
	General economy (employment and service provision)	Potential for positive impacts on the employment of a local workforce (opportunities limited at this exploration phase) Opportunities in terms of provision of services, e.g., catering, cleaning, security and logistics (opportunities limited at this exploration phase)	2 (low)	0 (beneficial)	0 (beneficial)	Contractors will be encouraged to consider the use of local labour and to advertise any Project related vacancies locally (SCM-1). TEP Liban will also make it a contractual requirement that its contractors and subcontractors comply with all applicable labour laws (SOC-16). Preferential treatment will be given to the procurement of Lebanese originating goods and services (SCM-2). PAR Article 157 right holder shall ensure that operator gives preferential treatment to the procurement of Lebanese originating goods and services when such goods and services are internationally competitive with respect to quality, availability, price and performance **(R)** (SCM-2)**.**	2 (low)	0 (beneficial)	0 (beneficial)

Activities/ sources of impact	Receptors	Potential effects	Initial impact			Main protection/ mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
	Education and Training	Potential for positive impacts on skills development for the local workforce (opportunities limited at this exploration phase)	2 (low)	0 (beneficial)	0 (beneficial)	PAR Article 155: the right holder and contractor shall give priority to training of Lebanese in order to facilitate the employment of Lebanese at all level or right holders/contractor's organisation **(R)** (SCM-3).	2 (low)	0 (beneficial)	0 (beneficial)
	Social conditions (security)	Security issues associated with use of the logistics base	2 (low)	1 (very low)	2 (negligible)	The logistics base operator will cooperate with General Security of the Port and regularly assess security risks through security plan as required under their contractual conditions with TEP Liban (HSS-13).	2 (low)	1 (very low)	2 (negligible)
OAS02: Transport of personnel and supplies to/ from the logistics base	Public Health	Potential for reduction in air quality and increase in noise levels along transport routes with impacts on human health	2 (low)	1 (very low)	2 (negligible)	Compliance with Lebanese maximum emission limits (Decision 8/1/2001), see Section 2.10.1.1. (R) (PP-39) Regular maintenance of vehicles to ensure smooth running of engines and efficient and clean burning of fuels (PP-52). Low sulphur fuels will be used where practicable (PP-32). Project will implement a grievance mechanism; the grievance mechanism will be clearly communicated to relevant stakeholders (SOC-1).	2 (low)	1 (very low)	2 (negligible)

Activities/ sources of impact	Receptors	Potential effects	Initial impact			Main protection/ mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
						Compliance with the regulatory requirements, including, but not limited to requirements of PAR, OPRL, EPA and MoE decision No. 52/1/1996, National maximum allowable noise levels and the permissible noise exposure standards (PP-62). Logistics base operator will respect traffic movement restrictions at the Port. (SOC-17).			
	Social conditions (road safety and congestion)	Increased risk of road safety incidents and nuisance effects from congestion along transport routes	2 (low)	2 (low)	4 (minor)	Speed restrictions will always be adhered to, these will be defined in a driving and transportation policy. Speed limits around logistics base will be 20 km/hour (HSS-1). A vehicle movement plan will be developed and implemented at the logistics base (HSS-2). Project will implement a grievance mechanism; the grievance mechanism will be clearly communicated to relevant stakeholders (SOC-1).	2 (low)	1 (very low)	2 (negligible)
	Infrastructure (road network)	Potential for deterioration and damage to existing road infrastructure from increased traffic	2 (low)	2 (low)	4 (minor)	A vehicle movement plan will be developed and implemented at the logistics base (HSS-2). Logistics contractor shall comply with driving and transportation policy requirements under the	2 (low)	1 (very low)	2 (negligible)

Activities/ sources of impact	Receptors	Potential effects	Initial impact			Main protection/ mitigation measures	Residual impact		
			Sensitivity	Intensity	Significance		Sensitivity	Intensity	Significance
						contract including speed limits and slow speeds when crossing villages etc. (HSS-3). Contractor will be responsible for protecting existing infrastructure and reinstating any damage if caused by its activities (SOC-13). Project will implement a grievance mechanism; the grievance mechanism will be clearly communicated to relevant stakeholders (SOC-1).			
OAS03: Support activities (helicopter transfers)	Public health	Increase in airborne noise disturbing local communities along coastline	2 (low)	1 (very low)	2 (negligible)	A flight plan will be developed for the transfer route and agreed with the relevant authority (SOC-9). Avoidance of low flight directly over internationally recognised and proposed conservation areas and over local communities and popular beaches, in the vicinity of the airport, if safe and practical to do so (subject to Lebanese Air Force approval) (SOC-2). Helicopter transfers will be planned for daylight hours to minimise noise disturbance to local communities at night (SOC-10).	2 (low)	1 (very low)	2 (negligible)
	Tourism	Increase in airborne noise disturbing holidaymakers at resorts north of airport	3 (medium)	1 (very low)	3 (minor)		3 (medium)	1 (very low)	3 (minor)
	Infrastructure (air traffic)	Potential burden on existing flight control facilities at Beirut International Airport	2 (low)	1 (very low)	2 (negligible)		2 (low)	1 (very low)	2 (negligible)

Note: In the Main protection/mitigation measures column, (R) refers to a regulatory commitment, and (C) refers to a completed action.

Source of impact codes: MAE – marine activities environment; MAS – marine activities social; OAE – onshore activities environment; OAS – onshore activities social.

6.5 Accidental events, cumulative and transboundary impacts

6.5.1 Accidental events/major hazards

Discharges of environmentally hazardous substances or other impacts may potentially occur owing to major hazards and extreme natural events. These events are normally associated with loss of containment leading to spills, fires, explosions and/or hazardous emissions. While rare, such events may result in significant loss of life, serious environmental harm and asset and reputation damage. These are essentially unplanned events, to be anticipated as possibilities, for which preventative action and reactive responses are required.

Table 6.1 lists the potential accidental event scenarios considered in this assessment[15]. The methodology for assessing the accidental events is discussed in Section 1.8.7.4.

Impact scoring for each scenario is included in Table 6.11. For each accidental event scenario potential impacts are presented, followed by proposed mitigation measures to prevent and reduce the risk to 'as low as reasonably practicable' (ALARP). The residual impact/risk, taking the mitigation into consideration, is then assessed.

Environmental and social sensitivities in the study area (Chapter 5) and oil spill modelling provided input to the assessment.

[15] "Accidental event scenarios developed based on discussion with TEP Liban's drilling and wells team".

Table 6.11: Environmental and social impacts of the Block 4 exploration drilling campaign – non-routine/accidental event scenarios

Activities/ sources of Impact	Receptors (sensitivity)	Potential effects	Initial impact				Main protection/mitigation measures	Residual impact			
			Sensitivity[16]	Intensity	Likelihood	Significance/ risk		Sensitivity	Intensity	Likelihood	Significance/ risk
Accidental events (representative scenarios)											
AE1: Dropped Object from MODU (lifting)	Sediment quality/composition (2) Benthos (2)	Physical disturbance of seabed sediments and benthos from dropped object	2 (low)	1 (very low)	3 (very unlikely)	6 (low)	**Mitigation to reduce likelihood of occurrence:** Lifting equipment and cranes will be certified and subject to a preventative maintenance programme (HSS-4). Crane operators will be certified (HSS-5). Lifting will be carried out in accordance with HSE bridging document agreed between Total E&P Liban and the drilling contractor (HSS-6). **Actions to reduce intensity** ROV survey will be conducted after drilling operations are completed to provide status of the seafloor condition around the well site (MR-1).	2 (low)	1 (very low)	2 (extremely unlikely)	4 (low)

[16] Sensitivity scoring for each aspect based on scoring of most sensitive receptor.

Activities/ sources of Impact	Receptors (sensitivity)	Potential effects	Initial impact				Main protection/mitigation measures	Residual impact			
			Sensitivity[16]	Intensity	Likelihood	Significance/ risk		Sensitivity	Intensity	Likelihood	Significance/ risk
AE2: Loss of chemical containment onboard MODU	Sediment quality/composition (2) Water quality (3) Benthos (2) Plankton (2) Fish (3) Protected/threatened species (fish) (4) Fisheries (2)	Reduction in water quality and sediment quality Potential indirect effects on benthos plankton, fish and fisheries	4 (high)	2 (low)	3 (very unlikely)	24 (moderate)	**Mitigation to reduce likelihood of occurrence:** Suitable and certified CCUs (Cargo Carrying Units) will be used for chemicals transfer; they will be checked visually for integrity at logistics base before transfer offshore (PP-44). Chemicals will be stored separately according to their potential hazards and compatibility. Chemical storage onboard the MODU will be restricted (CM-10). **Actions to reduce intensity:** Chemicals selected with preference for products with lowest toxicity, lowest bioaccumulation potential and highest biodegradation (CM-2).	4 (high)	2 (low)	2 (extremely unlikely)	16 (moderate)

Activities/ sources of Impact	Receptors (sensitivity)	Potential effects	Initial impact				Main protection/mitigation measures	Residual impact			
			Sensitivity[16]	Intensity	Likelihood	Significance/ risk		Sensitivity	Intensity	Likelihood	Significance/ risk
AE3: Radioactive source lost in hole	Sediment quality/composition (2)	Potential radiation impact on sediments and geology	2 (low)	2 (low)	4 (unlikely)	16 (moderate)	**Mitigation to reduce likelihood of occurrence:** Logging operations carried out by a certified team (RA-1). **Actions to reduce intensity:** Best efforts will be made to retrieve the source – fishing equipment will be available on site. Failing this, section where radioactive source lost will be cemented up (RA-2). Only sealed radioactive sources will be used (CM-11).	2 (low)	1 (very low)	3 (very unlikely)	6 (low)

Activities/ sources of Impact	Receptors (sensitivity)	Potential effects	Initial impact				Main protection/mitigation measures	Residual impact			
			Sensitivity[17]	Intensity	Likelihood	Significance/ risk		Sensitivity	Intensity	Likelihood	Significance/ risk
AE4: Riser rupture, release of NADF drilling fluid to sea	Sediment quality/composition (2) Water quality (3) Benthos (2) Plankton (2) Fish (3) Protected/threatened species (fish) (4) Fisheries (2)	Reduction in water quality and sediment quality Potential indirect impacts on benthos, plankton, fish and fisheries	4 (high)	3 (medium)	3 (very unlikely)	36 (moderate)	**Actions to reduce likelihood of occurrence:** Upfront analysis of metocean data will be carried out in order to adapt riser equipment (PL-2). Riser fatigue analysis will be carried out and riser joints fully inspected and changed if necessary (MR-10). Daily metocean and weather forecast will be assessed during operations (MR-11). Loss of MODU position drills will be carried out along with endurance tests (TR-8). Rig acceptance audit will be carried out MR-12). **Actions to reduce intensity:** Drilling fluid chemicals selected with preference for products with lowest toxicity, lowest bioaccumulation potential and highest biodegradation (CM-2). BOP auto shear function will be in place in order to reduce volume of drilling fluids	4 (high)	3 (medium)	2 (extremely unlikely)	24 (moderate)

[17] Sensitivity scoring for each aspect based on scoring of most sensitive receptor.

Activities/ sources of Impact	Receptors (sensitivity)	Potential effects	Initial impact				Main protection/mitigation measures	Residual impact			
			Sensitivity[17]	Intensity	Likelihood	Significance/ risk		Sensitivity	Intensity	Likelihood	Significance/ risk
							released from the well during an accidental event (PP-45). Riser emergency disconnect sequence will be tested (PP-46). Oil spill contingency plan will be in place (PP-55) – see line AE 6.				
AE5: Shallow gas blowout, release of gas into water column during riserless operations	Air quality (2) Water quality (3) Sediment quality/composition (2) Benthos (2) Fish (3) Protected/threatened species (fish) (4) Fisheries (2) Shipping (3)	Reduction in air quality, water quality and sediment quality Potential indirect impacts on benthos, fish and fisheries Potential for gas in water column to affect shipping	4 (high)	4 (high)	3 (very unlikely)	48 (high)	**Actions to reduce likelihood of occurrence:** Geohazard assessment conducted – no shallow gas identified in selected well site area. ROV monitoring will be carried out during riserless operations (MR-13). Shallow gas procedures will be known and practised, and shallow gas drills will be conducted (TR-2). **Actions to reduce intensity:** First two sections of well will be drilled riserless. If shallow gas encountered, it will be released at seabed with no impact on MODU (HSS-7). Oil spill contingency plan, blowout contingency plan and emergency response plan will be in place (PP-55) – see line AE 6.	4 (high)	3 (medium)	2 (extremely unlikely)	24 (moderate)

Activities/ sources of Impact	Receptors (sensitivity)	Potential effects	Initial impact				Main protection/mitigation measures	Residual impact			
			Sensitivity[17]	Intensity	Likelihood	Significance/ risk		Sensitivity	Intensity	Likelihood	Significance/ risk
AE6: Blowout – release of condensate and gas	Air quality (2) Water quality (3) Plankton (2) Fish (3) Seabirds (3) Protected/threatened species (fish and seabirds) (4) Cetaceans, turtles & seals (4) Coastal habitats (4) Fisheries (2) Shipping (3) Tourism (3) Public Health (2) Social conditions (2) General economy/industry (2) Infrastructure (2) Archaeology and cultural resources (3)	Oil spill modelling of blowout scenario carried out. For a 90 day release scenario modelling indicates offshore waters and shoreline of Lebanon likely to be affected. Transboundary impacts also predicted in offshore waters and shoreline of Syria. Potential condensate spill impacts on plankton, fish, seabirds, cetaceans, turtles and seals and coastal habitats. Potential condensate spill impacts on social receptors – fishing, shipping, tourism, infrastructure (water intakes), archaeological	4 (high)	4 (high)	3 (very unlikely)	48 (high)	**Actions to reduce likelihood of occurrence:** Pore pressure will be closely monitored (flow checks) (MR-14). Drilling fluid weight and properties will be controlled (PL-3). Integrity of cementing operations will be checked (MR-15). BOP and well control equipment testing will be conducted (MR-16). Critical personnel will be trained and certified in well control (TR-3). Rig audit will be carried out (MR-12). Well shut in and well control procedure will be in place (PL-4). Frequent kick drills will be conducted (TR-4). **Actions to reduce intensity:** Oil spill contingency plan (OSCP), blowout contingency plan (BOCP), and emergency response plan (ERP) will be in place for project (PP-55).	4 (high)	4 (high)	2 (extremely unlikely)	32 (moderate)

Activities/ sources of Impact	Receptors (sensitivity)	Potential effects	Initial impact				Main protection/mitigation measures	Residual impact			
			Sensitivity[17]	Intensity	Likelihood	Significance/ risk		Sensitivity	Intensity	Likelihood	Significance/ risk
		and cultural resources and therefore general economy/industry. Potential health impacts on coastal communities from spills reaching shore and possible consumption of contaminated fish.					The OSCP will align with the 'National Oil Spill Contingency Plan (NOSCP) in Lebanese Waters' (2017) and will be communicated to the LPA (PP-55). Sensitive coastal areas will be protected as a priority in line with coastal sensitivity mapping in TEP Liban's OSCP and mapping in the NOSCP (SOC-11). Any dispersant usage will be approved in advance by the MoE (PP-47). **Spill reporting and transboundary notification:** All spills in Lebanese waters will be reported to the Joint Maritime Operations Chamber (JMOC) (MR-17). Transboundary impacts will be communicated to Lebanese authorities so that they can notify and consult with potentially affected neighbouring countries (MR-18).				

Activities/ sources of Impact	Receptors (sensitivity)	Potential effects	Initial impact				Main protection/mitigation measures	Residual impact			
			Sensitivity[17]	Intensity	Likelihood	Significance/ risk		Sensitivity	Intensity	Likelihood	Significance/ risk
AE7: Collision of third-party ship with MODU – release of third party fuel inventory, possible damage to MODU and riser	Water quality (3) Plankton (2) Fish (3) Seabirds (3) Protected/threatened species (fish and seabirds) (4) Cetaceans, turtles & seals (4) Sensitive marine habitats (offshore) (4) Fisheries (2) Shipping (3)	Damage to vessel Reduction in water quality Potential indirect impacts on plankton, fish, seabirds, cetacean, turtle and seals, marine habitats and fisheries	4 (high)	4 (high)	2 (extremely unlikely)	32 (moderate)	**Actions to reduce likelihood of occurrence:** MODU position and 500 m exclusion zone will be notified to the authorities (MR-19). A Notice to mariners (NAVAID/NAVAREA system) will be issued (SOC-12). Support vessel will be at well site providing security and safety (fire-fighting, etc.) and will alert any vessels on a collision course (HSS-8). There will be 24/7 radio communications and watches (HSS-9). **Actions to reduce intensity:** Oil spill contingency plan and emergency response plan will be in place (PP-55) – see line AE 6.	4 (high)	4 (high)	1 (remote)	16 (moderate)

Activities/ sources of Impact	Receptors (sensitivity)	Potential effects	Initial impact				Main protection/mitigation measures	Residual impact			
			Sensitivity[17]	Intensity	Likelihood	Significance/ risk		Sensitivity	Intensity	Likelihood	Significance/ risk
AE8: Helicopter crash on MODU deck – release of aviation fuel to sea	Water quality (3) Plankton (2)	Reduction in water quality Potential indirect impacts on plankton	3 (medium)	2 (low)	3 (very unlikely)	18 (moderate)	**Actions to reduce likelihood of occurrence:** Selection procedure in place for certified helicopter contractor, and flying crew will be certified (HSS-10). Preventive maintenance plan will be in place for helicopters (PP-52). Helicopters will only operate within their weather limits and during daylight hours (except in case of MEDEVAC which is not restricted to daylight flights) (HSS-11). Helideck will meet CAP 437 specs for lights, marking, net, dimension, integrity and certification (PL-5). **Actions to reduce intensity:** Oil spill contingency plan and emergency response plan will be in place (PP-55) – see line AE 6.	3 (medium)	1 (very low)	2 (extremely unlikely)	6 (low)

Activities/ sources of Impact	Receptors (sensitivity)	Potential effects	Initial impact				Main protection/mitigation measures	Residual impact			
			Sensitivity[17]	Intensity	Likelihood	Significance/ risk		Sensitivity	Intensity	Likelihood	Significance/ risk
AE9: Loss of containment during offshore materials transfer to MODU – release of drilling fluids or marine diesel to sea	Sediment quality/composition (2) Water quality (3) Benthos (2) Plankton (2) Fish (3) Protected/threatened species (fish) (4) Fisheries (2)	Reduction in sediment and water quality Potential indirect impacts on benthos, plankton, fish and fisheries	4 (high)	2 (low)	4 (unlikely)	32 (moderate)	**Actions to reduce likelihood of occurrence:** Marine diesel transfers will start in daylight hours only (PP-49). Certified and pressure tested transfer hoses will be used that are visually inspected before use and allow spill free connection and disconnection (MR-22). Transfer hoses will be self-floating, or equipped with floating device, to limit the risk of sinking and potential rupture with vessel's propeller (PP-50). **Actions to reduce intensity:** Drilling fluid chemicals selected with preference for products with lowest toxicity, lowest bioaccumulation potential and highest biodegradation (CM-2). Vessels will have a shipboard oil pollution emergency plan (SOPEP) in line with MARPOL requirements (PP-51).	4 (high)	1 (very low)	3 (very unlikely)	12 (low)

Activities/ sources of Impact	Receptors (sensitivity)	Potential effects	Initial impact				Main protection/mitigation measures	Residual impact			
			Sensitivity[17]	Intensity	Likelihood	Significance/ risk		Sensitivity	Intensity	Likelihood	Significance/ risk
AE10: Loss of rig stability (rig capsize) with release of fuel inventory	Water quality (3) Plankton (2) Fish (3) Seabirds (3) Protected/threatened species (fish and seabirds) (4) Cetaceans, turtles & seals (4) Sensitive marine habitats (offshore) (4) Coastal habitats (4) Fisheries (2) Shipping (3) Tourism (3) Public health (2) Social conditions (2) General economy/industry (2) Infrastructure (2) Archaeological and cultural resources (3)	Oil spill modelling of a 6000 m^3 release of marine diesel at well site indicates offshore waters and shoreline of Lebanon likely to be affected. Transboundary impacts also predicted in offshore waters and shoreline of Syria, and low probability of impacts in offshore waters of Cyprus. Potential condensate spill impacts on plankton, fish, seabirds, cetaceans, turtles and seals and coastal habitats. Potential condensate spill impacts on social receptors – fishing, shipping, tourism, infrastructure (water intakes), archaeological	4 (high)	4 (high)	2 (extremely unlikely)	32 (moderate)	**Actions to reduce likelihood of occurrence:** Marine crew will be certified (HSS-12). Preventive maintenance procedure in place. Weather forecast and daily weather bulletin will be closely monitored by MODU Mariners (MR-11). MODU will only operate within weather limit (HSS-14). Emergency disconnect sequence will be in place that is tested and exercised (TR-5). **Actions to reduce intensity:** Oil spill contingency plan (OSCP) and emergency response plan (ERP) will be in place (PP-55) – see line AE 6.	4 (high)	4 (high)	1 (remote)	16 (moderate)

Activities/ sources of Impact	Receptors (sensitivity)	Potential effects	Initial impact				Main protection/mitigation measures	Residual impact			
			Sensitivity[17]	Intensity	Likelihood	Significance/ risk		Sensitivity	Intensity	Likelihood	Significance/ risk
		and cultural resources and therefore general economy/industry. Potential health impacts on coastal communities from spills reaching shore and possible consumption of contaminated fish.									
AE11: Earthquake resulting in loss of well integrity and release of hydrocarbons to sea	Similar to AE 10	Similar to AE10	4 (high)	4 (high)	1 (remote)	16 (moderate)	**Actions to reduce likelihood of occurrence:** Rig crew will be ready to disconnect in case of emergency (TR-6). **Actions to reduce intensity:** Oil spill contingency plan (OSCP) and emergency response plan (ERP) will be in place (PP-55) – see line AE 6.	4 (high)	4 (high)	1 (remote)	16 (moderate)

Activities/ sources of Impact	Receptors (sensitivity)	Potential effects	Initial impact: Sensitivity[17]	Initial impact: Intensity	Initial impact: Likelihood	Initial impact: Significance/ risk	Main protection/mitigation measures	Residual impact: Sensitivity	Residual impact: Intensity	Residual impact: Likelihood	Residual impact: Significance/ risk
AE12: Loss of containment during materials transfer to supply vessels at logistics base quay side – release of drilling fluids/diesel to sea	Water quality (2) Tourism (3) – logistics base located close to yachting club	Reduction in water quality within the port Disruption of access to water for sailing club vessels during any clean-up	3 (medium)	1 (very low)	4 (unlikely)	12 (low)	**Actions to reduce likelihood of occurrence:** Transfer hoses will have valve fittings that allow spill free connection and disconnection (MR-21). Certified and pressure tested transfer hoses will be used that are visually inspected before use and allow spill free connection and disconnection (MR-22). **Actions to reduce intensity:** Drilling fluid chemicals selected with preference for products with lowest toxicity, lowest bioaccumulation potential and highest biodegradation (CM-2). Oil and chemical spill kits will be available at logistics base and clearly marked (PP-53). Periodic inspections and restocking of kits will be carried out by the logistics base contractor (MR-23). Relevant key personnel will be trained in spill response (TR-7). Vessels will have a shipboard oil pollution emergency plan (SOPEP) in line with MARPOL requirements (PP-51).	3 (medium)	1 (very low)	3 (very unlikely)	9 (low)

Notes: Source of impact codes: AE – accidental events

From Table 6.11, it can be seen that the residual significance/risk for the following scenarios is low/broadly acceptable:

- dropped object from MODU (AE1)
- radioactive source lost in hole (AE3)
- helicopter crash on MODU deck – release of aviation fuel to sea (AE8)
- loss of containment during offshore materials transfer to MODU – release of drilling fluids or marine diesel to sea (AE9)
- loss of containment during materials transfer to supply vessels at logistics base quay side – release of drilling fluids/diesel to sea (AE12).

As the impact significance/risk is low, they are not discussed in any further detail in this chapter.

From Table 6.11, it can be seen that the residual significance/risk for the following scenarios is moderate/tolerable if level demonstrated to be ALARP:

- loss of chemical containment onboard MODU (AE2)
- riser rupture – release of drilling fluid to sea (AE4)
- shallow gas blowout – release of gas into water column (AE5)
- blowout – release of condensate and gas (AE6)
- collision of third-party ship with MODU – release of third-party fuel inventory, possible damage to MODU and riser (AE7)
- loss of rig stability (rig capsize) due to severe metocean conditions with release of fuel inventory (AE10)
- earthquake resulting in loss of well integrity and release of hydrocarbons to sea (AE11).

The potential impacts of the accidental worst-case large-scale hydrocarbon release scenarios (AE6, AE7 and AE10) are discussed in more detail in Section 6.5.2. Potential cumulative and transboundary effects are discussed in Sections 6.5.2.6 and 6.5.4, respectively.

6.5.2 Impacts from large-scale hydrocarbon loss of containment (AE6, AE7 and AE10)

6.5.2.1 Oil spill modelling study

A critical step for oil spill management is the evaluation of potential impacts of the most significant release scenarios, such as a massive release of liquid hydrocarbons during a blowout, or a significant release of diesel from loss of rig or vessel collision.

Impact evaluation is informed by spill drift modelling and location of sensitive environmental and social receptors.

Oil spill drift modelling associated with the Block 4 exploratory drilling programme has been conducted by TEP Liban (TEP Liban, 2019b) to determine potential impacts on Lebanese waters and coastline, and potential transboundary effects on neighbouring countries.

In this study, the following scenarios were modelled (presuming that the drilling objective is a reservoir rich in gas with low quantities of associated condensate):

- Scenario 1 (AE6) – a continuous release (subsea blowout) of condensate for 90 days at well site B4-1 with a flow rate of 1562 bbls/day
- Scenario 2 (AE7 or AE10) – an instantaneous release of 6000 m^3 of marine diesel at the sea surface at well site B4-1 (this scenario could feasibly result from loss/ sinking of the MODU with release of the whole rig fuel inventory, or collision of a third-party vessel with the MODU).

The fate and effects of these releases were modelled using the SINTEF OSCAR (Oil Spill Contingency and Response) model. OSCAR is a three-dimensional dynamic simulation tool for oil spill planning and response. OSCAR models oil as particles that are transported by currents, winds and turbulent diffusion and which undergo weathering (evaporation, dissolution and dispersion).

The modelling was based on specific metocean data available for the Block 4 area, see Table 6.12.

Table 6.12: Spill drift modelling metocean input data

Metocean input data	
Metocean data set (source)	SAT-OCEAN
Covered area	31°N to 37°N and 29°45'E to 37°E
Spatial resolution	1/32°
Temporal resolution	3 hours
Vertical layers	34
Tidal contribution	Data includes tidal currents
Data range	13 months from 01/12/2014 to 31/12/2015
Currents data	HYCOM/SAT-OCEAN model
Wind data	CCMP blended with NCEP 1/4°

Source: TEP Liban (2019b)

Modelling approach

Spill drift modelling is conducted to inform future operations impact assessment analysis and planning of oil spill response strategies to support a robust and compliant preparedness. Representative scenarios of significant accidental discharge of liquid hydrocarbons at sea are considered.

The modelling is usually developed through two phases. At the first phase stochastic and deterministic spill modelling is carried out, without response measures, for each representative scenario to evaluate the range of impacts that could be envisaged if all preventive measures would fail and no response is applied. This is a very conservative view and has been used to prepare this chapter of the EIA. A second phase will be developed later in the project considering appropriate response measures defined to minimise the impacts identified during the first step. The findings of these later studies will feed into the project oil spill contingency plan.

It is important to note that spill drift modelling results should not be considered as a reliable and accurate prediction of potential future outcomes for several reasons:

- modelling is based on sets of modelled metocean conditions from historical datasets, not accurately representing future conditions, but rather global trends
- the modelling assumes that a worst credible discharge occurs, none of the measures designed to prevent this from happening are considered
- no response measures are considered, i.e., no attempt to control, contain, disperse or recover an oil spill is taken into account.

Stochastic modelling is used to predict the probability of sea surface, shoreline or water column oiling that may occur following a spill event.

Stochastic modelling involves running numerous individual spill trajectory simulations using a range of prevailing wind and current conditions that are historically representative of the season and location of where the spill event may occur.

The stochastic model output does not represent the extent of any one oil spill event (which would be substantially smaller) but rather provides a summary of the total individual simulations for a given scenario or oil type.

Deterministic modelling (or single spill trajectory analysis) is used to predict the fate (transport and weathering behaviour) of oil spilled over time under predefined hydrodynamic and meteorological conditions.

When carrying out deterministic modelling, the conditions that give rise to the simulation with the greatest shoreline oiling from the stochastic modelling are typically selected.

The outcomes of deterministic modelling provide a reasonable approximation of what an oil spill could look like under certain prevailing conditions, but not the probability of those conditions being prevalent.

Conversely, stochastic modelling provides a probabilistic analysis but not an accurate prediction of what an individual spill could look like.

A summary of the first phase modelling results is provided below.

Scenario 1 – well blowout with release of condensates

<u>Stochastic modelling</u>

For the B4-1 well blow-out scenario, several simulations were initially modelled (input data in Table 6.13) and the results are presented in Figure 6.20 and Figure 6.21.

Figure 6.20 presents the stochastic modelling results of 6 random simulations and demonstrates the variability in the drift of each individual release scenario. Figure 6.21 presents the stochastic modelling results of all 16 simulations and the cumulative probability of surface waters being affected.

The spill modelling shows a drift to the east and north-east, with potential impacts to the northern coast of Lebanon and a very low probability of impacts to the southern coast of Syria. The limited extent of the predicted impacts is related to the depth of the wellhead, which favours dissolution of hydrocarbons in the water column, and the tendency for condensates to evaporate rapidly (within a few days following release).

Table 6.13: Scenario 1 (well blowout) – release characteristics

Release characteristics	
Location of release	B4-1 at seabed (1,520 m water depth)
Conditions of release	Continuous No offshore response
Quantity released	1562 bbls/day condensate for 90 days
Period of year for simulations	December to March 90 days release duration 120 days simulation duration
Number of iterations	16 stochastic, 1 deterministic
Product released	Condensate (REV 2009 13 GRADER C)

Source: TEP Liban (2019b)

Deterministic modelling

The simulation resulting in the most oiling onshore during the stochastic modelling was considered to be the worst-case scenario and was selected to illustrate deterministic results.

Figure 6.22 shows that oil spill initial drift is towards the east north-east and oil first impact on the shoreline is observed around day 3 along 15 km of the Lebanon coast. At this simulation time-step around 3% of the oil remains at the sea surface, 30% has dispersed in the water column and around 66% is already evaporated and biodegraded.

At day 45, the slick continues its drift northeast into the waters of Syria, however shoreline impacts in Syria are not predicted for this deterministic simulation.

Impact on sensitive areas

Figure 6.20 (stochastic modelling of 6 spill scenarios) and Figure 6.22 (deterministic modelling of the worst-case spill scenario in terms of shoreline impacts) indicate that the spill path will not impact the sensitive offshore area identified in the EBS, the Palm Islands Nature Reserve, or Ras El Chekka Ramsar site.

Figure 6.21 (stochastic modelling of 16 spill scenarios) shows the cumulative area that could be impacted from running all these spill events simultaneously. This indicates a low possibility of surface oiling (<10%) at Palm Islands and Ras El Chekka. The sensitive offshore area identified in the EBS has a higher possibility of surface oiling, although this benthic site is unlikely to be impacted by surface condensates.

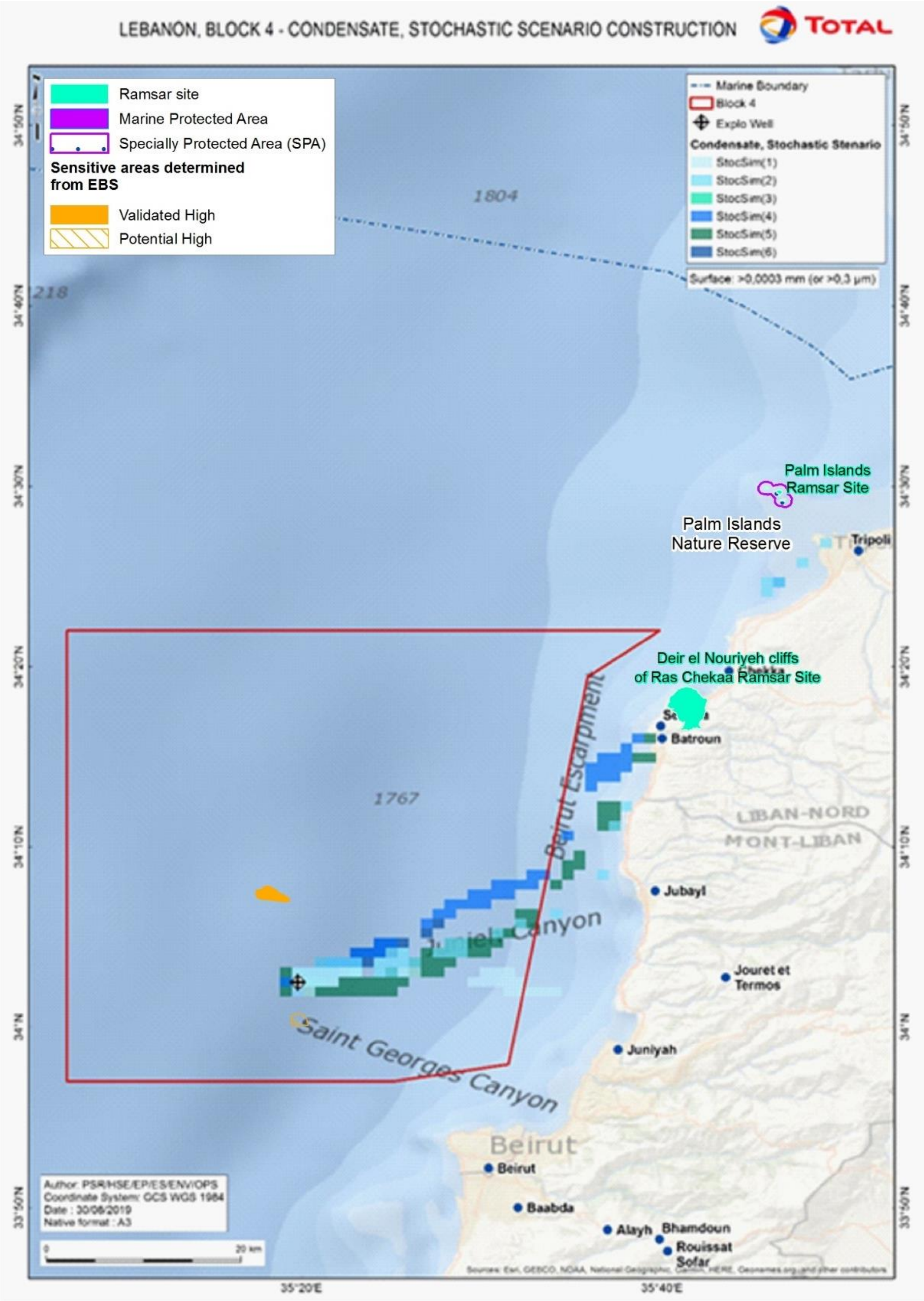

Figure 6.20: Stochastic simulation for a 90-day spill of condensate (blowout scenario) observed over 120 days, cut of thickness 0.3 µm[18]

Source: TOTAL E&P

[18] Corresponds to Bonn Agreement Oil Appearance Code 2 and above (rainbow, metallic, discontinuous true oil colour and continuous true oil colour), see Appendix 6.2. In the case of condensate releases, 0.3 µm is selected as the thickness cut off as they are very light hydrocarbons with a fast rate of biodegradation and evaporation which are unlikely to be detected in the mapping if a higher cut off thickness is selected.

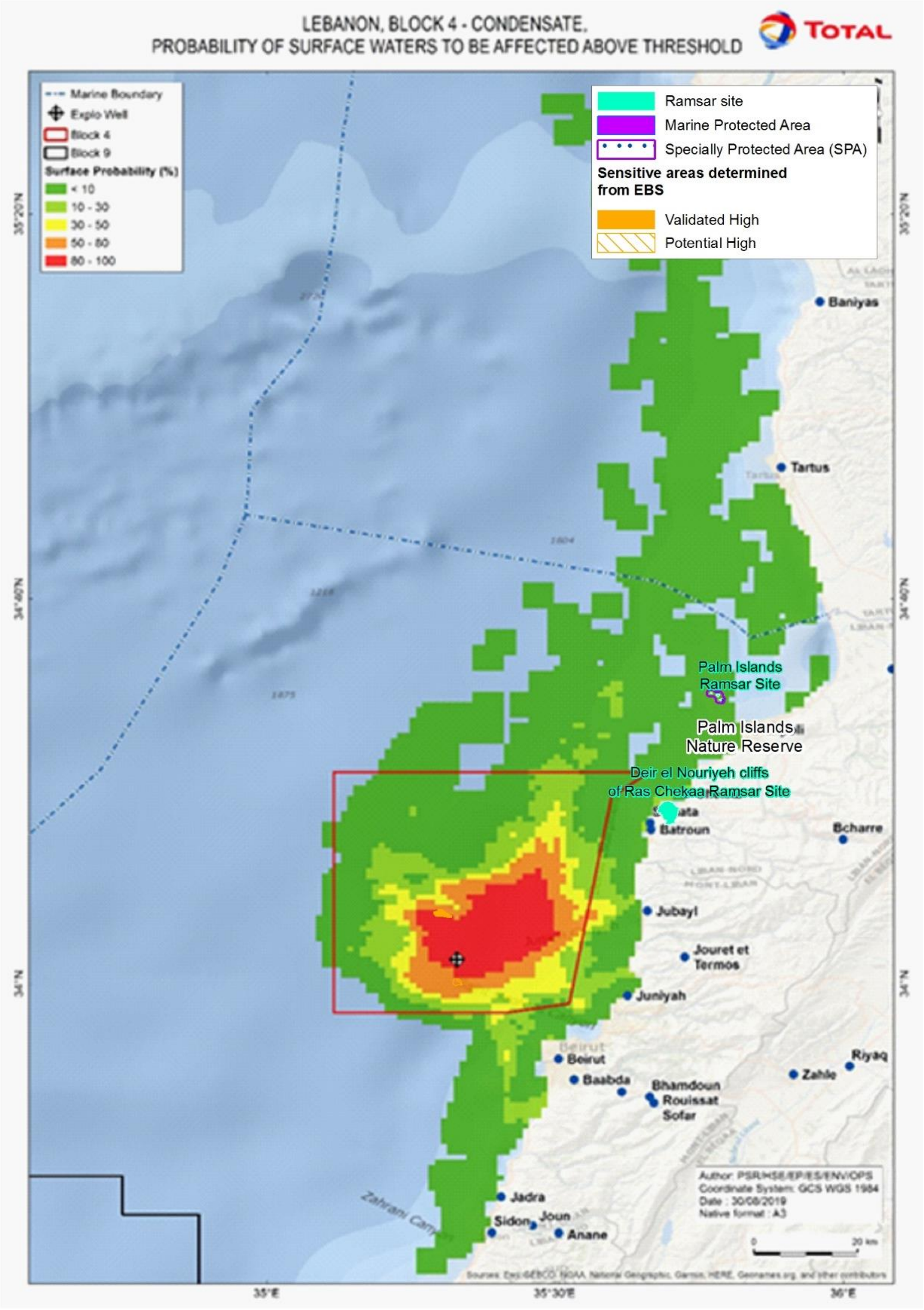

Figure 6.21: Cumulative surface probability of condensates, cut of thickness 0.3 µm

Source: TOTAL E&P

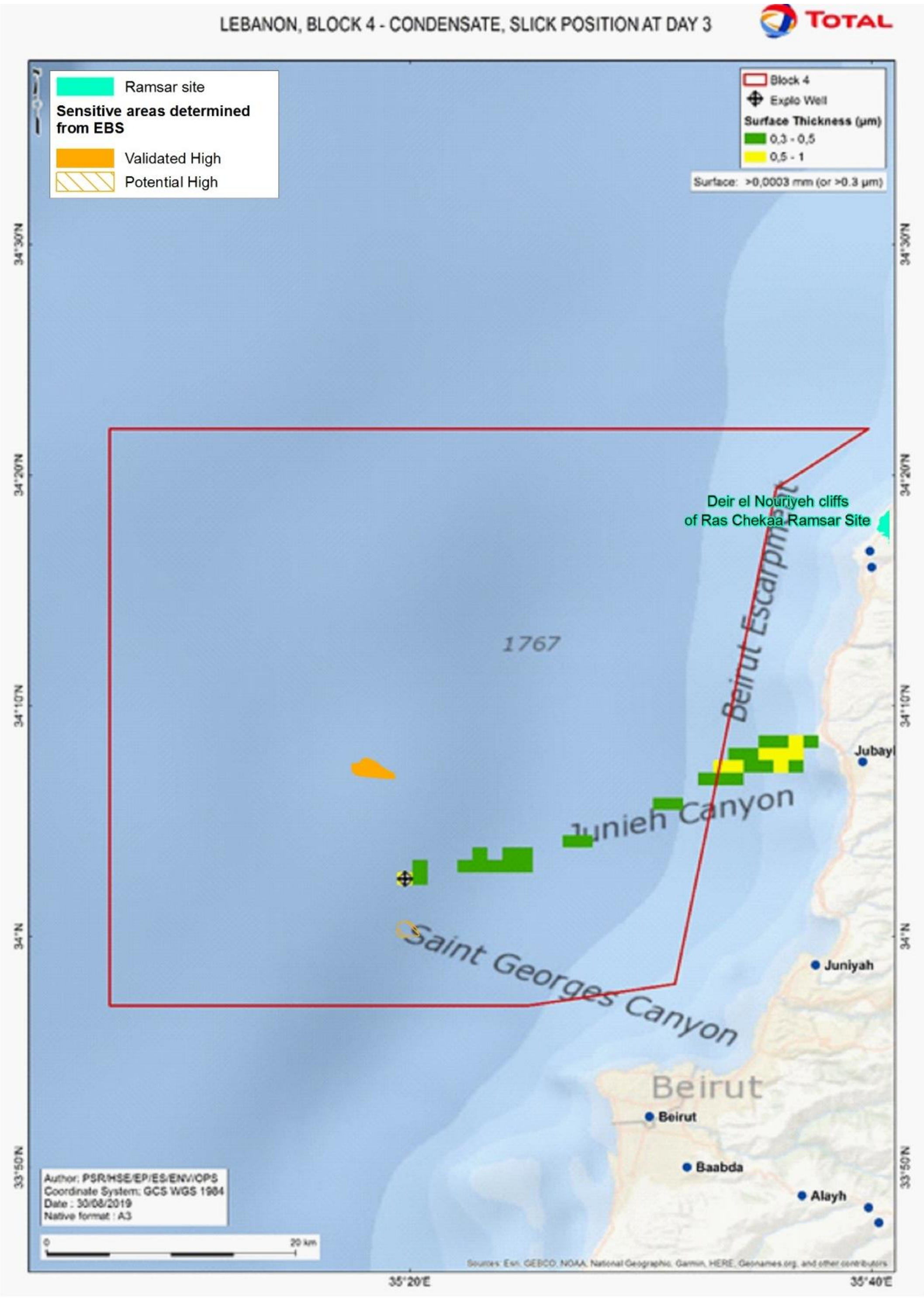

Figure 6.22: Slick position at day 3 – oil first impact at shore, cut off thickness 0.3 µm

Source: TOTAL E&P

Scenario 2 – instantaneous release of marine diesel at well site (e.g., loss of MODU or vessel collision)

Stochastic modelling

For the marine diesel release scenario, several simulations were initially modelled (input data in Table 6.14) and the results are presented in Figure 6.23 and Figure 6.24.

Figure 6.23 presents the stochastic modelling results of six random simulations and demonstrates the variability in the drift of each individual release scenario. Figure 6.24 presents the stochastic modelling results of all 45 simulations and the cumulative probability of surface waters being affected.

The spill modelling shows the same drift as Scenario 1, to the east and north-east, with potential impacts to the northern coast of Lebanon, the southern coast of Syria, and offshore waters of Cyprus (low probability). The extent of the impacts is greater with this scenario due to the longer persistence of diesel hydrocarbons compared to condensates (8–10 days depending on weather conditions).

Table 6.14: Scenario 2 (marine diesel release) – release characteristics

Release characteristics	
Location of release	B4-1 at sea surface
Conditions of release	Instantaneous No offshore response
Quantity released	6000 m^3
Period of year for simulations	December to March Release duration 21 hours Simulation duration 45 days stochastic Simulation duration 15 days deterministic
Number of iterations	45 stochastic, 1 deterministic
Product released	Marine diesel (MARINE DIESEL IKU)

Source: TEP Liban (2019b)

Deterministic modelling

The simulation resulting in the most oiling onshore during the stochastic modelling was considered to be the worst-case scenario and was selected to illustrate deterministic results.

Oil spill drift is towards the northeast with oil first impact on the shoreline observed around day 2 approximately 10 km south of Tripoli in Lebanon (see Figure 6.25). At this simulation time-step, about 60% of the oil remains at the sea surface, 10% has dispersed in the water column and about 26% is already evaporated.

At day 6, the slick continues its drift north/northeast and splits into two slicks. The first with an area approximately 14 × 7 km drifts north into Syrian waters. The second, approximately 16 × 10 km, remains in Lebanese waters.

At the end of the simulation (day 15), shoreline impacts are predicted in Lebanon and Syria, see Figure 6.26.

Impact on sensitive areas

Figure 6.23 (stochastic modelling of six spill scenarios), Figure 6.25 (deterministic modelling of the worst-case spill scenario in terms of shoreline impacts) and Figure 6.26 (cumulated oil concentration onshore) indicate that the spill path will not impact the sensitive offshore area identified in the EBS, the Palm Islands Nature Reserve or Ras El Chekka Ramsar site.

Figure 6.24 (stochastic modelling of 16 spill scenarios) shows the cumulative area that could be impacted from running all these spill events simultaneously. This indicates a low possibility of surface oiling at Palm Islands (5–20%) and Ras El Chekka (5–10%). The sensitive offshore area identified in the EBS has a higher possibility of surface oiling, although this benthic site is unlikely to be impacted by surface diesel.

Possible future exploration / appraisal wells

In the event that a subsequent exploration / appraisal well is drilled in the Block 4 priority area, in a location closer to shore than well B4-1, TEP Liban would carry out further spill modelling and submit the results in a Notification of Change Report to the authorities.

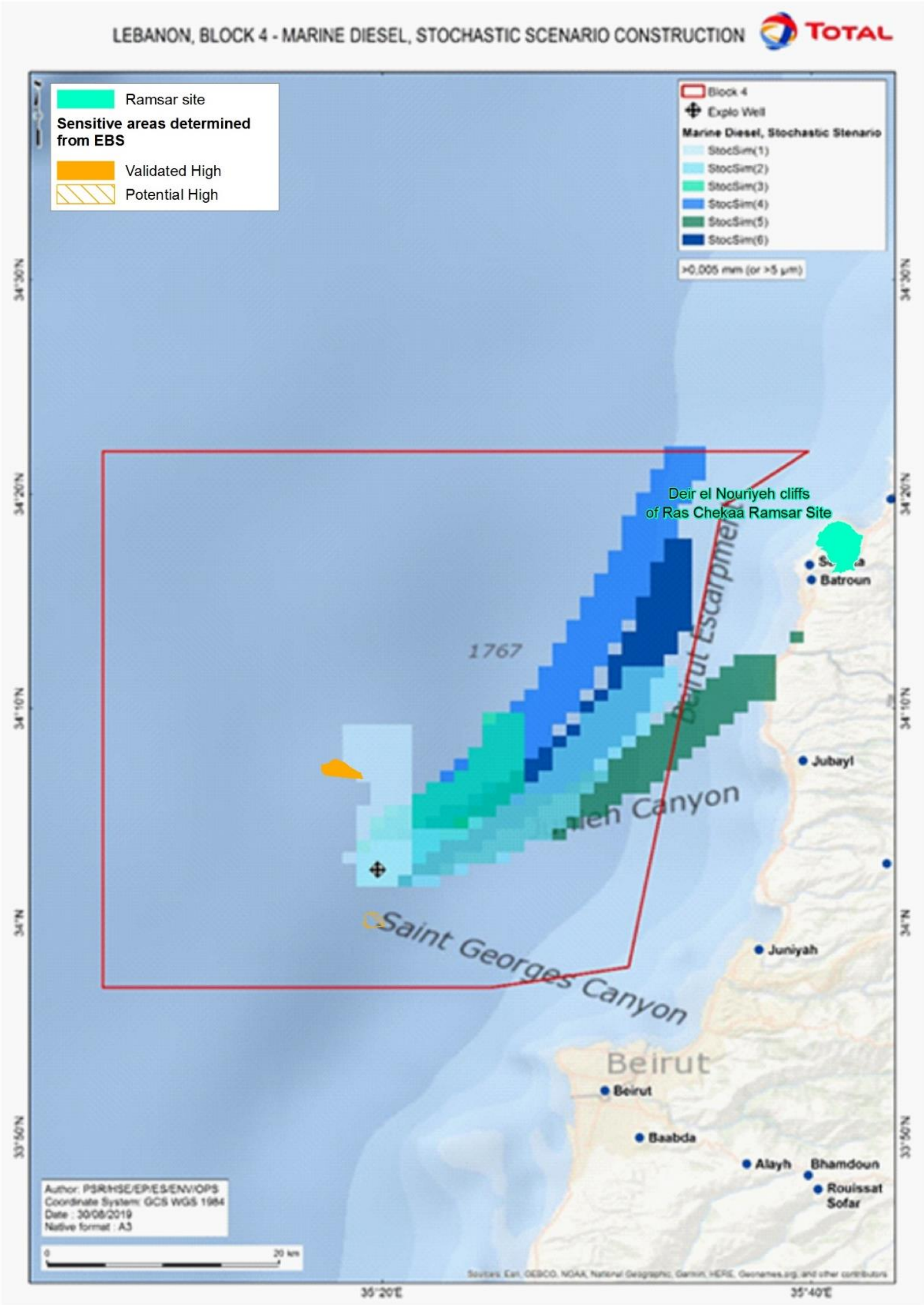

Figure 6.23: Stochastic simulations for an instantaneous spill of marine diesel observed over 30 days, cut of thickness 5 µm[19]

Source: TOTAL E&P

[19] Corresponds to Bonn Agreement Oil Appearance Code 3 and above (metallic, discontinuous true oil colour and continuous true oil colour), see Appendix 6.2. In the case of diesel releases 5 µm is selected as the thickness cut off in order to focus oil spill response and deployment of equipment.

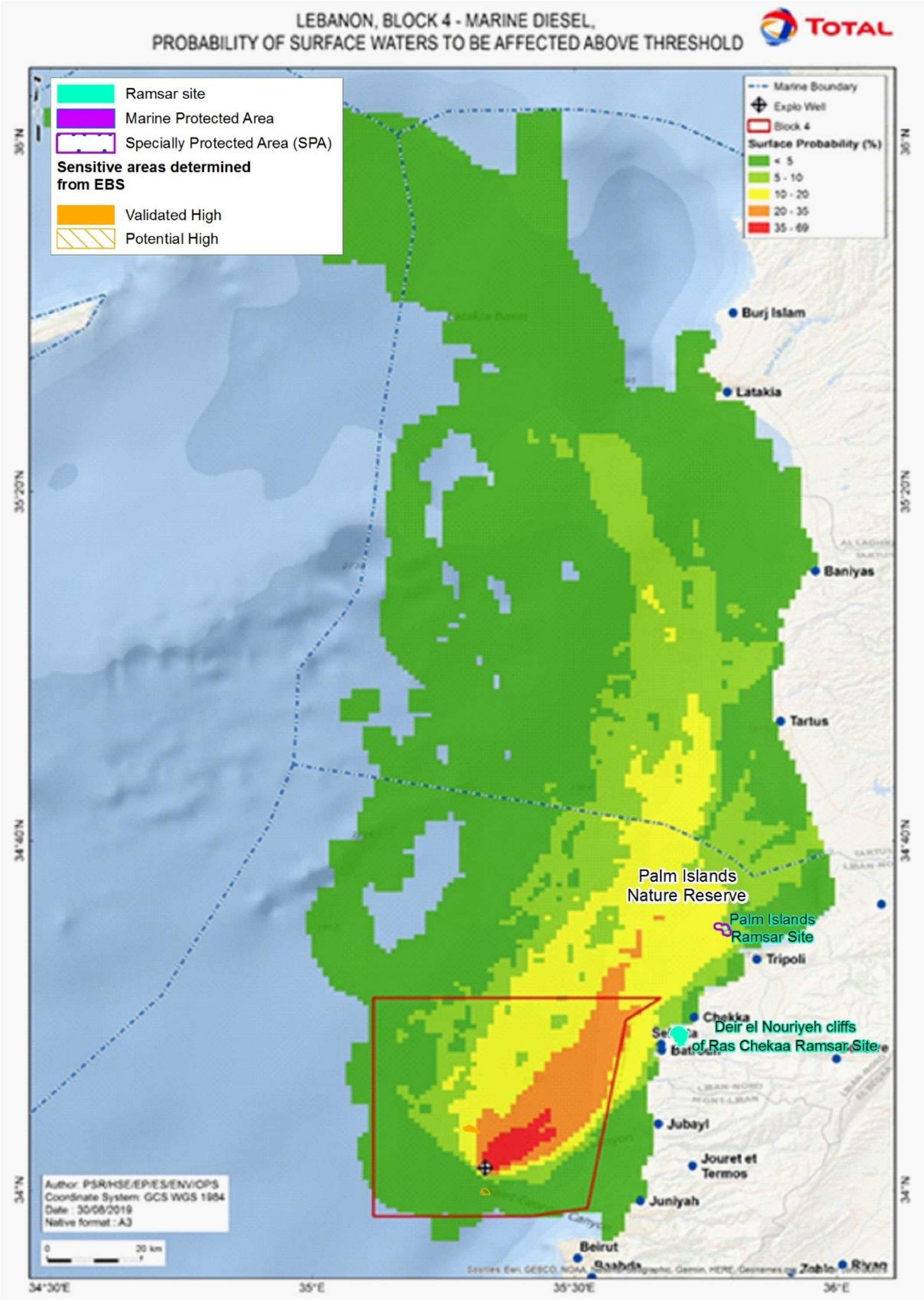

Figure 6.24: Cumulative probability of marine diesel, cut of thickness 5 µm

Source: TOTAL E&P

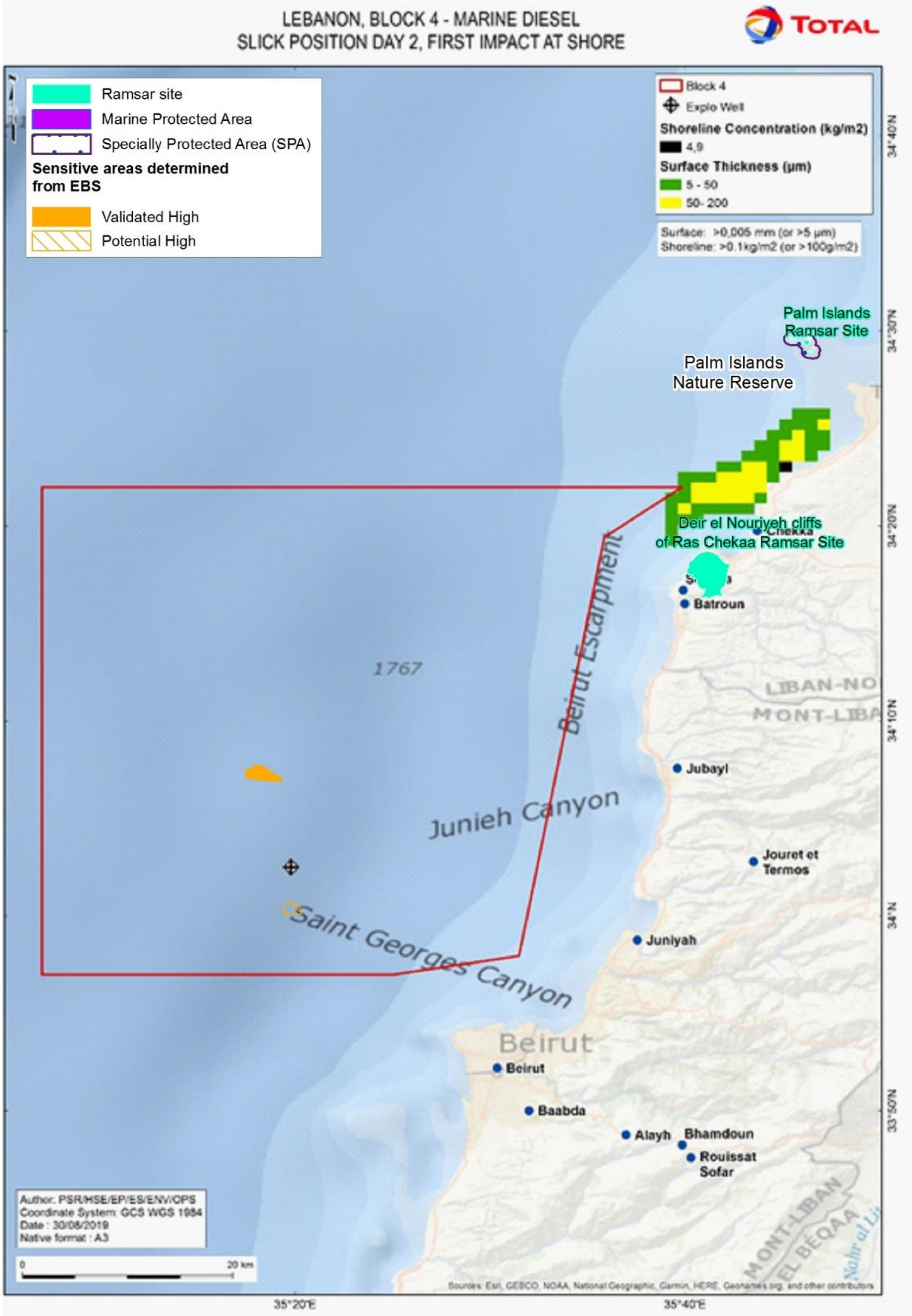

Figure 6.25: Slick position at day 2 – oil first impact at shore, cut-off thickness 5 µm

Source: TOTAL E&P

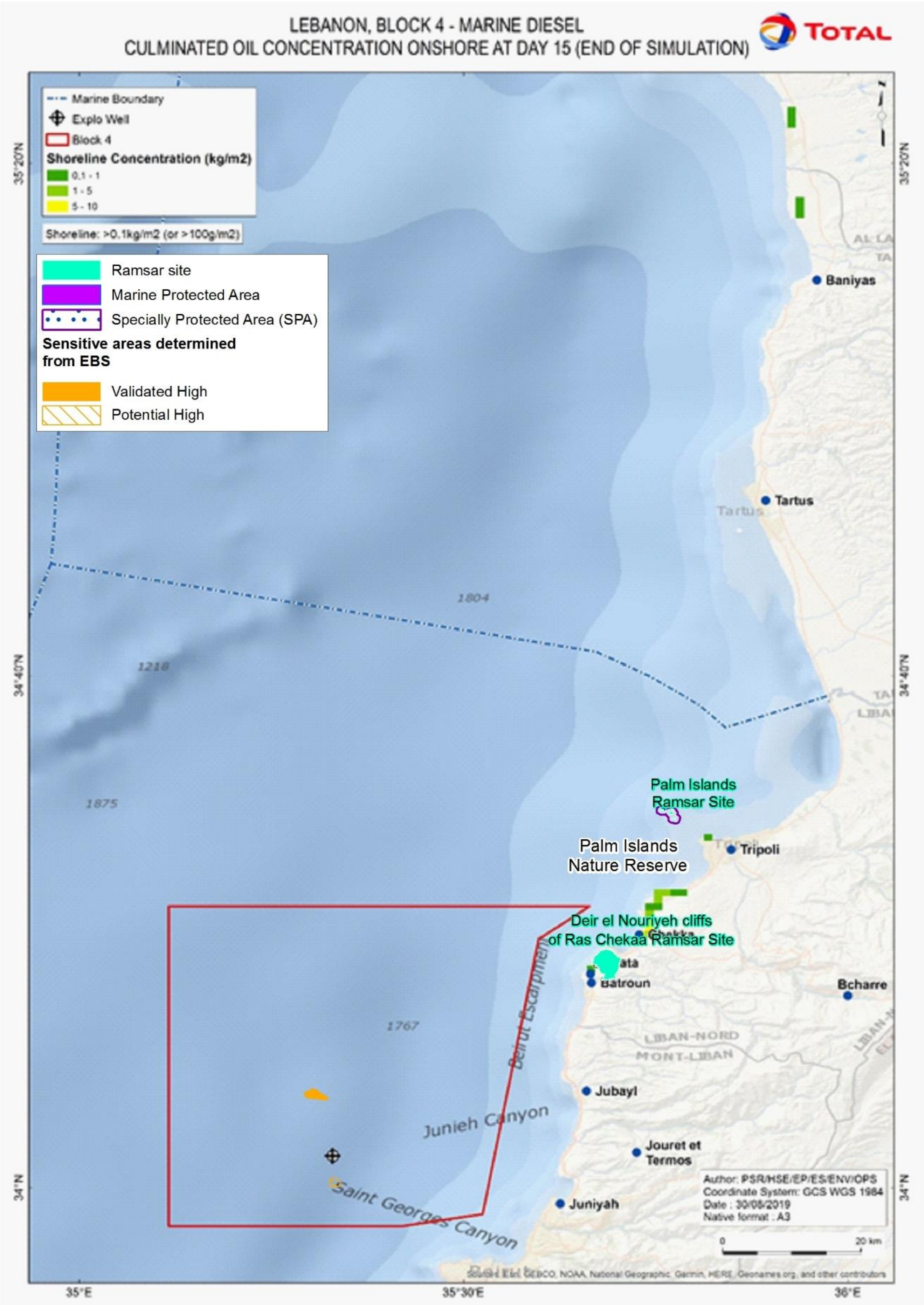

Figure 6.26: Cumulated oil concentration onshore at day 15 (end of simulation)

Source: TOTAL E&P

6.5.2.2 Potential impacts of a hydrocarbon spill on marine biota and habitats

The degree of damage caused by a hydrocarbon spill event will depend upon the quantity spilled, the chemicals involved, the sensitivity of the marine area impacted, and the wind and weather conditions at the moment of the accident.

The following section presents the possible impacts of a hydrocarbon spill on sensitive environmental receptors potentially present in the offshore area of Block 4.

The discussion below focuses on offshore Lebanese waters. Coastal and shoreline impacts are presented in Section 6.5.2.3, social and archaeological/cultural resource impacts are presented in Section 6.5.2.4 and potential transboundary impacts are discussed in Section 6.5.4.

Plankton

Laboratory studies have revealed that planktonic organisms are sensitive to exposure to oil components. Both acute toxic and sub-lethal effects of certain oil components have been demonstrated in the laboratory (Kühnholt, 1977; Falk Petersen et al., 1985). Some field studies have also demonstrated short term impacts on plankton following an oil spill, but the effects appeared to be only very short lived and localised (Anon, 1985; Khalaf et al., 2006). Most field studies carried out in connection with oil spills have in fact failed to demonstrate any impacts on plankton (Plovson, 2015).

For example, after the 2002 oil spill from the shipwrecked tanker *Prestige* on the northwest coast of Spain (64,000 tonnes of oil spilled), studies of chlorophyll, primary production, zooplankton biomass and species composition of the phytoplankton and zooplankton showed no observable impacts (Varelaa et al., 2006).

The fact that long-term effects have not been observed on plankton populations, despite the toxicity of oil, is probably partly due to the enormous regeneration capacity of plankton and the possibility of transport by the current of plankton into an affected area from adjacent unaffected areas, both of which counteract short term reductions in numbers caused by the oil. Another factor may be that the oil and its soluble components (which are the most toxic components), rapidly evaporate or are diluted to non-toxic concentrations downstream of the spill (Anon, 1985; Neff and Stubbefield, 1995; Batten et al.,1998; Kennington and Rowlands, 2004).

As with plankton, fish eggs and larvae are also quite sensitive to oil, as demonstrated in numerous laboratory toxicity tests (Kühnholt 1977; Tilseth, Solberg and Westrheim 1984; Serigstad and Adoff 1985; Falk Petersen and Kjørsvik 1987). However, in several studies effects on pelagic fish eggs and larvae were not observed in the field following oil spills. One reason for this may be that toxic concentrations of oil components are generally confined to the uppermost parts of the water column immediately beneath an oil slick and that fish eggs and larvae are encountered below the toxic water layers.

Other studies have demonstrated massive kills of fish eggs and larvae near oil spills without causing any significant effect on fish populations in the open sea. For example, studies following an oil spill from the *Argo Merchant* in the USA in 1976 (25,000 t of fuel oil spilled) found 20% of cod eggs and 46% of pollock eggs and larvae in the spill area to be dead or moribund. However, the same fish stocks studied in 1977 and 1978 showed no major impacts (Longwell, 1977, 1978; IPIECA, 1997).

The lack of effects on numbers in subsequent adult populations following massive kills of eggs and larvae is probably because most fish species produce vast numbers of eggs and larvae and have extensive spawning grounds (IPIECA, 1997).

Spawning information in Lebanese waters is limited. Tsikliras et al. (2010) collected all available information on the spawning seasons of Mediterranean marine fish. Those applicable to the Block 4 area are summarised in Table 5.22. From this it can be seen that during the proposed drilling period for well B4-1 (December–February) spawning is limited to two species of demersal lizardfish and the mottled grouper in waters off neighbouring occupied Palestine.

The commercial fish species that dominate the fish catch in Lebanon have not been recorded spawning in the Block 4 area. Round herring spawns from January to May off Greece; European anchovy spawns from April to September off Spain, Croatia, Algeria, Italy, Turkey, Croatia and Tunisia; European pilchard spawns from September to March off Turkey, Greece, Tunisia and Croatia; chub mackerel spawns from May to June off Italy and Croatia; and round sardinella spawns from April to August off Greece, Tunisia, Algeria, Libya and Egypt (Tsikliras et al., 2010).

Based on the above, Block 4 has not been identified as an area of particular significance for fish spawning, although it should be noted that this may be due to lack of scientific studies in the area.

Fish

Fish are not generally affected by oil slicks on the sea surface and have been shown to detect and exhibit avoidance behaviour to hydrocarbon products. Mature fish of most species can tolerate water-soluble oil fractions of about 10 mg/l. Some species can survive much higher levels unless whole oil or dispersed oil droplets coat the gills and cause asphyxiation.

Although various development disorders in fish, as well as mortalities, are believed to occur to some degree under oil slicks, so far it has proved impossible to detect consequential effects on adult populations. Potential sublethal effects of spilled oil on fish include impairment of reproductive processes and increased susceptibility to disease and predators.

Block 4 has not been identified as an area of particular significance for fish populations, although several IUCN Red List fish species (in particular shark and ray species) have been recorded in Lebanese waters.

Although not identified as a major problem in open waters, hydrocarbons and other toxicants in oil can contaminate the flesh or sharks, either through direct contact or via the food chain. Oil spills can also affect shark habitats such as seagrass beds and coral reefs. Studies conducted since the *Deepwater Horizon* oil spill in 2010 found that sharks have the ability to accumulate environmental contaminants (e.g., polycyclic aromatic hydrocarbons) at levels that may be detrimental to their health (Walker, 2011).

Marine mammals (cetaceans, seals)

Hydrocarbons may affect marine mammals through various pathways: direct contact, inhalation of volatile components, and ingestion (directly or indirectly through the consumption of fouled prey species) (Geraci and St. Aubin, 1987; Loughlin et al., 1996).

Cetacean skin is highly impermeable and not seriously irritated by brief exposure to hydrocarbons; direct contact is not likely to produce a significant impact. Whales and dolphins apparently can detect slicks on the sea surface but do not always avoid them; therefore, they may be vulnerable to inhalation of hydrocarbon vapours, particularly those components that are readily evaporated. Ingestion of the lighter hydrocarbon fractions found in diesel fuel can be toxic to marine mammals. Ingested diesel fuel can remain within the gastrointestinal tract and be absorbed into the bloodstream and, thus, irritate and/or destroy epithelial cells in the stomach and intestines. Certain constituents of diesel fuel (i.e., aromatic hydrocarbons, polycyclic aromatic hydrocarbons) include some well-known carcinogens. These substances, however, do not show significant biomagnification in food chains and are readily metabolised by many organisms. Released hydrocarbons may also foul the baleen fibres of mysticete whales, thereby impairing food-gathering efficiency or result in the ingestion of diesel fuel.

Marine mammal species recorded in the Eastern Mediterranean are listed in Table 5.24. Regularly occurring cetaceans in the region include bottlenose dolphin, stripped dolphin, short-beaked common dolphin, Risso's dolphin, Cuvier's beaked whale and rough-toothed dolphin, while fin whales, sperm whales, and false killer whales are considered as visitors to the area. Marine mammal sightings during the Offshore Environmental Baseline Survey of Block 4 in March–April 2019 were limited to two bottlenose dolphins. Baleen whales are not generally recorded in the eastern Mediterranean.

The critically endangered Mediterranean monk seal has been recorded in Lebanese waters. Although it is generally associated with rocky coastlines and caves, it does move into offshore waters (sometimes extensive distances) as demonstrated by tagging studies conducted by Adamantopoulou et al. (2011) in the Eastern Mediterranean Sea.

Turtles

As with marine mammals, hydrocarbons in the marine environment may affect sea turtles through direct contact, inhalation of volatile components, and ingestion. Several aspects of sea turtle biology and behaviour place them at risk, including lack of avoidance behaviour, indiscriminate feeding in convergence zones and inhalation of large volumes of air before dives (Milton et al., 2003). Studies have shown that direct exposure of sensitive tissues (e.g., eyes, nostrils, other mucous membranes) to diesel fuel or volatile hydrocarbons may produce irritation and inflammation. Hydrocarbons can also adhere to turtle skin or shells. Hatchling and juvenile turtles feed opportunistically at or near the surface in oceanic waters and are especially sensitive to released hydrocarbons.

Satellite tracking of green turtles in the eastern Mediterranean indicates that turtles migrate along the eastern coast through the waters of Syria, Lebanon and Occupied Palestine (though this migration route is less significant that the high-use seasonal pelagic corridor running south-west from Turkey and Cyprus to Egypt that was used by >50% of all tracked turtles), see Section 5.4.6. A green turtle foraging area was also identified off Tripoli. These migratory and foraging IUCN Red List turtle species are considered susceptible to impacts from an offshore hydrocarbon spill. It should be noted that no sea turtles were observed during the Offshore Environmental Baseline Survey of Block 4 in March–April 2019.

Seabirds

Direct contact of marine birds with hydrocarbons may result in the fouling of feathers with subsequent limitation or loss of flight or insulating/water-repellent capabilities. Other effects include irritation or inflammation of skin or sensitive tissues (such as eyes and other mucous membranes); or toxic effects from ingestion of the hydrocarbon or the inhalation of volatile components. The significance of impact on seabirds would be dependent on the type and number of birds present, the percentage of the total population this number represented, the amount of time the birds are actually on the sea surface while at sea, and the specific physiological reactions following exposure to spilled condensate.

Birds that spend much of their time on the surface of the water are particularly sensitive to oil slicks. The shearwater species for example moult their flight feathers while offshore over winter months and they are flightless for a period following moulting until flight feathers grow back (Camphuysen and Van der Meer*,* 2001). During these periods the birds tend to form rafts or aggregations on the sea surface.

During the Offshore Environmental Baseline Survey of Block 4 in March–April 2019, a total of 419 individual seabirds were observed within the priority area and southern end of Block 4. The Laridae family (gulls) was the most sighted family of seabirds, with the most clearly identifiable species the lesser black-backed gull (*Larus fuscus*). Other gull species were also recorded along with shearwaters, skuas, ducks, and herons. These offshore species are considered susceptible to impacts from an offshore hydrocarbon spill, particularly the shearwaters that have a flightless moulting period.

Benthic communities (benthos)

Due to the water depth at the B4-1 well location (1520 m), and in the rest of the Block 4 priority area (1450–1760 m), impacts on the benthic communities in the abyssal plain and canyon habitats are not anticipated from a hydrocarbon spill at the well site.

Sensitive marine habitats (offshore)

Mapping in Section 6.5.2.1 presents the extent of the modelled spill scenarios in relation to the offshore sensitive area identified by the EBS in Block 4. The benthic features of this site (abundant molluscs, urchins, crabs and fish centred on an outcrop area) are unlikely to be impacted by a surface spill in these water depths.

Block 4 is also located within the East Levantine Canyons EBSA which encompasses the whole of the Lebanese and Syrian coastline. The EBSA includes deep canyons, as well as hydrothermal vents and submarine freshwater springs. The benthic features of this EBSA are not considered particularly vulnerable to an oil spill owing to the very deep waters in the Block 4 priority area and at the B4-1 well site. The species the EBSA supports (cartilaginous fish, bony fish, marine mammals and turtles) have been discussed earlier in this section.

6.5.2.3 Potential impacts of a hydrocarbon spill on coastal biota and habitats

As stated earlier, the degree of damage caused by a hydrocarbon spill event will depend upon the quantity spilled, the chemicals involved, the sensitivity of the area impacted, and the wind and weather conditions at the moment of the accident.

The following section presents the possible impacts of hydrocarbon spills on sensitive environmental receptors (coastal habitats) present in the Lebanese coastal zone of the study area.

Seagrass beds

Petroleum products can damage seagrass beds in a variety of ways, including (Howard et al., 1989; Runcie et al., 2004; Wilson, 2010)

- direct mortality due to smothering leading to reduced growth rates
- direct mortality due to asphyxiation or the toxic effects of the water-soluble fraction of oil
- photosynthetic stress.

These impacts can have knock-on effects to the species using the seagrass beds as a food source and habitat for critical life stages.

In the study area, seagrass beds are present in some of the proposed MPAs and near Nahr Ibrahim Estuary (see Section 5.4.9) and constitute nursery and feeding grounds for an array of marine species. This habitat is therefore considered sensitive to hydrocarbon spills.

Deterministic spill modelling of a large-scale release of hydrocarbons conducted for the project (see Figure 6.20 and Figure 6.26) predicts that seagrass beds at Byblos could be impacted from the modelled scenarios.

Vermetid reefs

Vermetid molluscs form reefs that protect coasts from erosion, regulate sediment transport, serve as carbon sinks, and provide habitat for many fish and invertebrates. These habitats are currently under threat from the spread of invasive species, pollution, and climate change. The location of vermetid reefs along the Lebanese coast is presented in Section 5.4.2.3.

Biogenic reef fauna are generally very sensitive to oil spill and elevated concentrations of toxic oil components in the water (Povlsen and Hjorth, 2015). This habitat is also considered sensitive to oil spill impacts as their shallow water location in the littoral zone (see Figure 5.63) makes them susceptible to smothering by any hydrocarbons reaching the shoreline.

According to Chemello and Silenzi (2011), living vermetid reefs are only present in a few locations along the Lebanese (e.g., Sidon and Tyre) and they hypothesise that this may be linked to oil spills and cleaning operations following the 2006 war.

Deterministic spill modelling of a large-scale release of hydrocarbons (see Figure 6.20 and Figure 6.26) predicts that vermetid reefs at Byblos could be impacted from the modelled scenarios.

Turtle nesting grounds

Turtles are very vulnerable at beach nesting sites during the breeding season. If these sites are oiled it can lead to contamination of adult turtles, eggs and newly hatched juveniles.

Breeding female turtles bury their eggs above the high-water mark. Thus, the nests should be beyond the reach of spilled oil unless a spill coincides with a severe storm. The most critical period in which a spill could occur is when the hatchlings emerge, thereby interfering with their seaward migration. It is probable, although not specifically proven, that the presence of an oil slick will disorientate the hatchlings, which would lengthen their exposure to predators on the beaches and/or interfere with their swimming abilities. Hatchling survival is not high in any case (Bjorndal, 1982) and increased mortalities, attributable to oil spills, could be reflected in the overall population. Should a spill coincide with the emergence of hatchlings the impact on regional populations could therefore be severe and have a long-term effect.

Nesting sites for green and loggerhead turtles are found on sandy shorelines in Lebanon. A survey of the Lebanese coast for turtle nesting in 2004 found that the overall nesting potential for marine turtles is greatest in the south (Kasparek and Aureggi, 2005). The most important nesting beach is El-Mansouri in southernmost Lebanon, which is of moderate importance regionally. Nesting has also been reported as occurring nearby at El-Aabbassiyeh and in the Tyre Coast Nature Reserve. These nesting beaches should be considered as priority areas for protection in the case of a spill event.

Deterministic spill modelling of a large-scale release of hydrocarbons (see Figure 6.20 and Figure 6.26) predicts that a release at the well site would move in a north-northeast direction. Turtle nesting sites in southern Lebanon therefore not anticipated to be impacted.

Coastal habitats – designated protected areas

Deterministic spill modelling of a large-scale release of hydrocarbons (see Figure 6.20 and Figure 6.26) predicts that Enfeh Peninsula KBA/proposed MPA and Ras El Chekaa Ramsar site could be impacted from the modelled scenarios.

Stochastic modelling of multiple simultaneous spills (16 in total) indicates a low probability of surface oiling at Palm Islands Nature Reserve.

These sites are highly susceptible to potential oil spill impacts and will be considered as priority areas for protection in the development of TEP Liban's oil spill contingency plan.

6.5.2.4 Potential impacts of a hydrocarbon spill on social and archaeological/cultural resources

Social receptors identified in Lebanese waters include fisheries and aquaculture, natural resource users, tourism and recreation, shipping (including ports), infrastructure (in particular water intakes), coastal towns and communities (public health, social conditions), and archaeological and cultural resources.

Impacts on these receptors can have an indirect impact on general economy/industry.

The sensitivity of these receptors to a potential hydrocarbon spill is discussed below.

Fisheries

Hydrocarbon spills have the potential to affect fisheries as follows:

- fishing gear may be contaminated by oil. The risk of contamination is greatest for floating gear, such as drift nets and seines and fixed traps extending above the sea surface. Bottom trawls, lines, dredges and gill nets are usually well protected, provided they are not lifted through an oily sea surface or affected by sunken oil.

- the catch may become contaminated which in turn may result in the tainting of fish. In some cases, there may be a loss of sales because clean fish are presumed to be tainted if they come from a spill area and fishing may be banned for a short time in the region of an oil spill in order to maintain market confidence.
- halting of fishing until the gear is cleaned. Such impacts will be of short duration and in most cases, it will be possible to move to other fishing grounds free of oil slicks.
- fisheries closures may be imposed by authorities in areas heavily impacted by spills.

Lebanon does not have a commercial fishing fleet. Instead it relies on a traditional, small-scale fleet of motorised wooden vessels (under 12 m in length) that are generally restricted to shallower coastal waters (fishing is mostly concentrated within 6 nm of the closest shore in line with legislative restrictions, however, some fishermen are prepared to travel distances of up to 25 nm offshore to reach fishing grounds). The main fishing gear used are trammel nets, gillnets (drift nets also known as shovels), long lines (with hooks), drifting long lines, hand lines and trolling lines, purse seine nets, lampara and to a lesser extent beach seines.

The activity is artisanal and those engaged in fishing generally do so on a full-time basis with no alternative livelihood activities or social security arrangements. These fisheries are therefore highly vulnerable to a possible hydrocarbon spill.

Aquaculture

Aquaculture facilities in the study area are limited to one shrimp farm along the north coast, in Akkar Governorate.

Aquaculture facilities are very vulnerable to hydrocarbon spills. Possible impacts include

- mass mortality of farmed species (in this case shrimp) in coastal waters smothered by oil or exposed directly to toxic components in the oil
- oil tainting (objectionable oil-derived taste) of shrimp by acquiring oil-derived substances in the tissues, which impart unpleasant odours and flavours rendering the polluted specimens unfit for sale. Tainting can result from very low concentrations of oil since caged species cannot swim away.
- worsening of existing stress effects in aquaculture facilities due to the presence of oil pollutants. Oil components may significantly add to the stresses already imposed by keeping animals in artificial conditions.
- loss of market confidence – application of temporary harvesting bans may prevent normal production, or a loss of market confidence may occur, leading to price reductions or outright rejection of seafood products by commercial buyers and consumers.

The shrimp farm is therefore highly susceptible to potential oil spill impacts.

Deterministic spill modelling of a large-scale release of hydrocarbons (see Figure 6.20 and Figure 6.26) predicts that a release at the well site would move in a north–northeast direction, however the spill path doesn’t go as far north as Akkar Governorate.

Tourism

The tourism industry may be significantly affected by a hydrocarbon spill with the most serious consequences just before and during the tourist season. Peak tourist numbers in

Lebanon were recorded in the months of June, July and August in 2018 (Trading Economics, 2019).

Hydrocarbon contamination of recreational beaches and waters off these beaches can deleteriously affect typical tourist activities such as sunbathing, boating, angling, scuba-diving and sightseeing. Affected beaches may have to be closed during clean up.

Hotel and restaurant owners and others who gain their livelihood from the coastal tourist trade can suffer economic losses due to oil spill impacts. Holidaymakers may cancel bookings of accommodation in the affected area and rumours of oil spill affecting the coast might prevent bookings or entail cancelling of bookings even in areas along the coast not directly affected by oil.

In surveys after the Exxon Valdez spill in March 1989, 59% of tourism businesses in the spill area reported spill-related cancellations that summer season, and visitor spending in Southwest Alaska decreased 35% from that recorded in the previous summer (Chang et al., 2014).

Typical bathing beaches are easy to clean because they are often composed of fine-grained sand and because good access roads to the beaches are available and the physical disturbance to coastal areas affected by oil spill is usually comparatively short-lived. Once the shorelines are cleaned, normal trade can resume. However, the duration of interruption of business can be prolonged, even after a clean-up has taken place because negative media attention and public perception of a coastal tourist area that has been affected by an oil spill has damaged the image of the areas.

Recreational and tourist sites along the Lebanese coast (see Figure 5.87) are utilised by local and foreign visitors and comprise beaches, bathing sites, recreational sailing marinas and scuba-diving sites. Although tourism is mostly seasonal, many people’s livelihoods depend on the sector and it is considered a highly sensitive receptor to potential spills.

Deterministic spill modelling of a large-scale release of hydrocarbons (see Figure 6.20 and Figure 6.26) predicts that the recreational beaches near Byblos, Jbeil and Tahet el-Rih could be impacted from the modelled scenarios.

Shipping and ports

Oil spills in or near ports may hamper normal ship traffic and calls. Vessels can be oiled in the waterline and oil in the water intakes for cooling the engine might create operational problems for the vessels. Mooring lines and berths may also be oiled. In addition, breakwaters that are usually made of rock or concrete may be difficult to clean as the oil may penetrate deep into the structure. This oil may become a secondary source of oil pollution. Risk of ignition of the floating oil (if easily flammable oil is spilled) might prevent sailing, loading and unloading operations. Furthermore, deployed oil spill combat equipment (e.g., booms) may also hamper usual shipping operations. Furthermore, deployed oil spill combat equipment may also hamper usual shipping operations.

The consequences for ports are economic losses and claims from ship owners and firms relying on harbour operations. The impact might also cause temporary unemployment for workers at the port. On the other hand, spilled oil may be easily prevented from entering ports by placing booms across the narrow entrances. The sheltered nature of ports allow for a rapid and effective response, so the length of interruption is generally short.

There four main Lebanon ports of Beirut, Tripoli, Sidon and Tyre are managed by public entities (BankMed, 2015). Virtually all maritime traffic is handled by the ports of Beirut and Tripoli, with the former port being the major handler of imported and exported goods (Dar, 2018). The location of these ports within the study area is presented in Figure 5.85.

Deterministic spill modelling of a large-scale release of hydrocarbons (see Figure 6.20 and Figure 6.26) predicts that the ports of Chekka, Heri and Anfi could be impacted from the modelled scenarios.

Infrastructure (water intakes)

Hydrocarbon contamination in the vicinity of water intakes can cause severe economic effects. If oil is taken into the water circulation system of the facilities, which are vital for normal operations, machinery or products could be destroyed. Temporary closure of the intake as a precaution against damage might affect the entire operation of the plant and thus vital economic interests. The consequences of temporary closure of an electric power plant, for instance, are likely to be significant, as electricity is vital for local communities and industry (ITOPF, 2007).

The location of coastal power plants in Lebanon (all with water intakes) are presented in Figure 5.89.

Deterministic spill modelling of a large-scale release of hydrocarbons (see Figure 6.20 and Figure 6.26) predicts that a release at the well site would move in a north–northeast direction. Coastal power plants near Beirut and Tripoli are therefore not anticipated to be impacted.

Coastal villages – public health and social conditions

A major spill of volatile crude oil close to a population centre may raise health concerns and complaints of breathing difficulties headache and nausea. In extreme cases, the oil may represent a fire hazard and necessitate the evacuation of such communities. In addition, the smell of oil can be very unpleasant and presents a nuisance to people living close to the affected coastline (ITOPF, 2007).

A health study carried out after the Braer oil spill off the coast of Scotland in 1993 showed that residents living within 4.5 km of the wreck site experienced a higher incidence of irritated throats and eyes compared to non-exposed residents living farther away. Most symptoms (97%) however, resolved within a week. Similarly, a range of acute symptoms after the Sea Empress accident in Wales in 1996 was observed. The authors observed a statistically significant increase in the prevalence of headaches, nausea, sore eyes, sore throat, cough, itchy skin, rashes, shortness of breath and general weakness among the exposed (Eykelbosh, 2014).

Such impacts are of short duration and, as the Braer study showed, disappear within a week. This is probably because the volatile components that cause these symptoms, usually evaporate within a week.

The Lebanese population is concentrated in several urban areas in the coastal zone and notably in Beirut (see Table 5.31).

Impacts on public health can also result from consumption of oil contaminated fish. As stated earlier, however, fish are not generally affected by oil slicks on the sea surface and have been shown to detect and exhibit avoidance behaviour to hydrocarbon products. In addition, fishermen are not generally permitted to fish in oil-contaminated waters (fisheries closures imposed by the authorities) to restrict oil contaminated seafood reaching the consumer.

Natural resource users

Sand and gravel extraction, salt production, and seashell collection constitute a noteworthy part of the subsistence economy in the Lebanese coastal zone. People who take part in these subsistence activities are the poorest segment of the community, with low education and skills levels who depend on these resources for their livelihood.

Sand and gravel extraction are carried out in the coastal zone at Mayrouba, Chekka and Dbayeh; seasonal salt production is conducted in the coastal town of Anfeh; and seashells are collected on beaches along the shoreline and sold in Tripoli and Chekka or along highways. These activities have the potential to be impacted if an oil spill was to reach the shoreline in these areas.

Deterministic spill modelling of a large-scale release of hydrocarbons (see Figure 6.20 and Figure 6.26) predicts that sand and gravel extraction sites at Chekka and salt production at Anfeh could be impacted from the modelled scenarios.

Archaeological and cultural resources

In most cases, marine hydrocarbon spills will not have a direct impact on coastal archaeological and cultural resources but the perception of the historical monument/ feature to visitors may be negatively affected during oil spill events. However, some artefacts such as wrecks, historical quays or berths could be affected through direct contact with oil.

Several archaeological and cultural sites with significant historical importance are located in Lebanon’s coastal zone including the UNESCO World Heritage Sites of Byblos and Tyre; the crusader castle of Saint Gilles, the ancient southern port quay and necropolis in Tripoli; Ras Enfeh; the Salinas wall promenade and Our Lady of Natour monastery in Anfeh; and the great Phoenician wall and roman amphitheatre in Batroun.

Offshore antiquities, including underwater cities, ancient breakwaters and Phoenician walls are present in Batroun and Anfeh (North Lebanon) and in Aamchit (Mount Lebanon). Efforts are ongoing to uncover underwater coastal antiquities in Bebnine and Chekka. Additionally, the coastal waters of Lebanon have some shipwrecks sites considered of great value.

Deterministic spill modelling of a large-scale release of hydrocarbons (see Figure 6.20 and Figure 6.26) predicts that the offshore archaeological sites of Aamchit, Ras Anfeh and Chekka could be impacted from the modelled scenarios.

6.5.2.5 Spill mitigation measures

Modelling of project-specific major hydrocarbon spill scenarios by TEP Liban (see Section 6.5.2.1) indicates sensitive receptors in offshore waters, coastal waters and along the shoreline of Lebanon have the potential to be impacted. In addition, transboundary impacts are possible, see Section 6.5.4.

Controls and actions to reduce the likelihood of a spill/release incident are a key part of the mitigation and have been included in Table 6.11.

TEP Liban will develop an oil spill contingency plan (OSCP) that focuses on optimising response at sea in order to minimise coastal and transboundary impacts. A second phase of modelling will be conducted to optimise the mobilisation of resources and provide input into the OSCP.

The OSCP will be consistent with the Total Affiliate emergency response plan. It will

- identify the important organisational and operational points to be taken into consideration in a spill response effort, in particular first response actions
- ensure the response effort deployed is the most suitable to the types, levels and possible evolution of the spill
- mitigate the consequences of the spill.

The OSCP will cover activities associated with offshore drilling, all related activities and relevant sites such as the logistics base and supply vessels. Leakages of liquid hydrocarbons such as NADFs will also be taken into consideration in the OSCP.

The OSCP will provide necessary information and guidance when activated for

- personnel in charge of operations on the site of the spill
- personnel involved in the Advanced Command Centre (or on-site Command post)
- personnel involved in the TOTAL Affiliate Headquarters Emergency Cell
- personnel potentially involved from TOTAL headquarters in France.

All scenarios will be considered, with a particular focus on major spills of condensates or diesel in order to establish the appropriate response. Coordination of responses in any potentially affected neighbouring countries will be taken into consideration.

For a potential blowout scenario with release of condensates, for example, the strategy will be to address the spill from the source to potentially impacted areas through several response barriers, as follows:

- first oil spill response barrier – monitoring of natural attenuation with mechanical mixing to favour natural dispersion of non-evaporated residues[20] and efforts made to control the source of hydrocarbon release using a capping stack[21]
- second oil spill response barrier – confinement and recovery of hydrocarbons (if residues are in a recoverable state)
- third oil spill response barrier – coastal response considered to confine and recover residual oil not treated by the first and second barriers, in advance the most sensitive sites identified during preparation of the OSCP will have been protected (protective booms, absorbent booms, etc.) when first observations confirm direction of slick
- ultimately coastal clean-up will be considered with set-up of work sites focused on the most sensitive and impacted areas.

It should be noted that chemical dispersion in most often not efficient on condensates, it is therefore not considered a primary response strategy for a blowout scenario. Nevertheless, subsea chemical dispersion could be considered as an optional response, depending on observations in the monitoring area.

[20] Careful attention will be paid to the high evaporation rates of fresh condensate with a strong focus on safety around the area of resurgence.

[21] Use of capping stack will be covered by the project blowout contingency plan.

An example of the TOTAL global spill response strategy is presented in Figure 6.27 with the main primary and optional responses that will be considered in the case of a major spill of condensates.

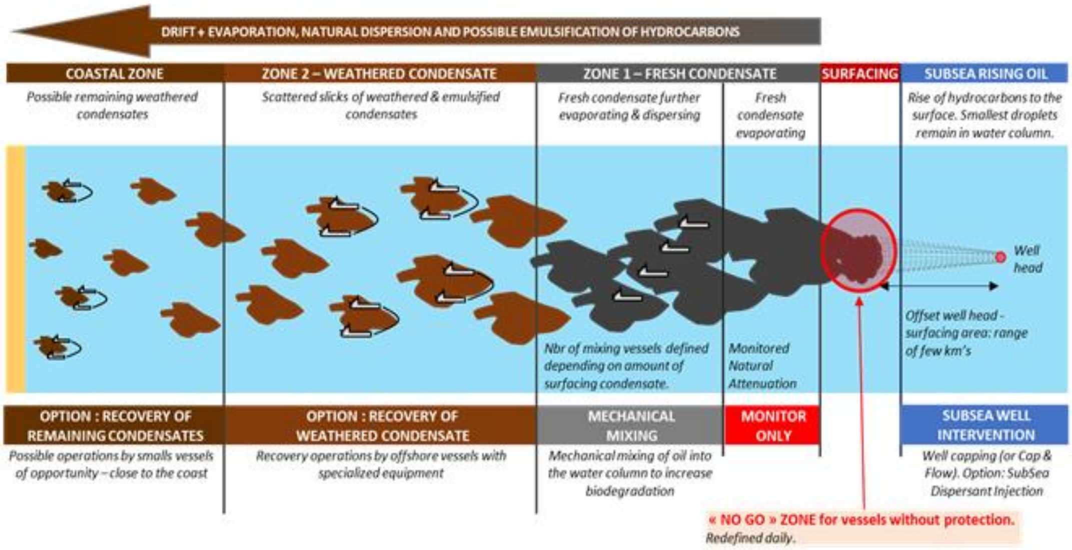

Figure 6.27: Offshore spill response schematic for condensate release
Source: TOTAL E&P

The OSCP will align with the 'National Oil Spill Contingency Plan (NOSCP) in Lebanese Waters' (2017) and be submitted to the LPA.

In the event of a spill, a tiered response would be initiated by TEP Liban that is appropriate to the scale of the incident (see Table 6.15). Sensitive coastal areas will be protected as a priority in line with coastal sensitivity mapping in TEP Liban's OSCP and mapping in the NOSCP.

If the decision is made by TEP Liban that dispersant use is an appropriate response, approval will be obtained from the Ministry of Environment. Only named products which have been specifically approved by the MoE may be used as dispersants. Until such time that the MOE has an established testing (toxicity and effectiveness) and approval system for dispersants, the MoE will normally accept documentary evident to show that a named product has passed a recognised test procedure for both effectiveness and toxicity in another country.

All spills in Lebanese waters will be reported to the Joint Maritime Operations Chamber (JMOC). JMOC will pass the spill report on to the MOPWT-DGLMT and MoE and then to other affected ministries.

In addition to the OSCP TEP Liban will also develop a blowout contingency plan (BOCP), and an emergency response plan (ERP) for the project, see Chapter 8.

Table 6.15: Spill response tier levels from TEP Liban's oil spill contingency plan

OFFSHORE SPILLS - TIER LEVELS

Status 01/10/2019

TIER LEVELS (- to +)

		☐ TIER 1	☐ TIER 2	☐ TIER 3
SPILL	General characteristics	☐ (Very) Minor spill. Minor to insignificant pollution offshore. ☐ Source stopped.	☐ Intermediate spill. Potential to significant pollution. ☐ Source stopped or minor release of few days.	☐ Major to catastrophic spill. Significant to catastrophic pollution. ☐ Spill that may escalate &/ or be continuous.
LOCATION	OFFSHORE Non-persistent oil Extent	☐ **< 50 m3** ☐ Offshore spill. No risk of damage on the coast. Possible (minor) transboundary spill.	☐ **50 to 300-400m3** ☐ Offshore. No risk of significant damage on the coast. Possible transboundary spill.	☐ **> 400 m3** ☐ Offshore. Possible residual spill on the coast. Possible large transboundary spill.
	Note. Extended to +/-100m3 for drilling mud (sinks)			
RESPONSE	Resources	☐ Tier 1 resources (TEP Liban) + Contracted companies in country	☐ Tier 1 resources (TEP Liban) + Other O&G operators + Service companies in country/ close countries + National resources	☐ All Tier 1 + 2 resources + Mobilization of regional & international assistance
	Management	☐ **TEP Liban**: Site personnel + support of HO if needed Or **captain of vessel** if PSV incident	☐ **TEP Liban** : site, IMT & CMT + Total HQ : "spot" support + Drilling unit Company HQ + **Authorities**: Follow-up & possible supervision (partial activation of the National OSCP) Or shipowner if PSV incident	☐ **TEP Liban**: site, IMT & CMT + Total HQ assistance (remote & in country) + Drilling unit Company HQ + **Authorities**: Supervision of incident management (NOSCP full activation) Or shipowner if PSV incident

Note. Persistents: crude, HFO & IFO, utility oils, etc. Non-persistent: Condensate, MGO, drilling mud NABM, etc.

COASTAL, PORT, LOGISTICS BASE & INLAND SPILLS - TIER LEVELS

Status 01/10/2019

TIER LEVELS (- to +)

		Tier 1	Tier 2	Tier 3
LOCATION	LOGISTICS BASE WATERS, PORT & CLOSE WATERS Non-persistent oil Extent	☐ **< 1-2 m3** ☐ Very close installations & quaysides, river banks, beaches.	☐ **2 m3 to 35m3** ☐ Installations, quaysides, river banks, beaches, etc. in the area.	☐ **> 40 m3** ☐ Installations, quaysides, river banks, beaches, coastal villages, islands etc. in extended area.
	LOGISTICS BASE INLAND Non-persistent oil Extent	☐ **< 10-15 m3** ☐ Logistics base, storage area	☐ **15 m3 to 150m3** ☐ Logistics base, storage area & immediate surroundings	☐ **> 150 m3** ☐ Logistics base, storage area & surroundings + soil infiltration
RESPONSE	Resources	☐ Tier 1 resources (of Logistics Base) + Contracted companies on site.	☐ Tier 1 resources + Other O&G operators + Port Authorities + Service companies in country/ close countries + National resources	☐ All Tier 1 + 2 resources + Mobilization of regional & international assistance
	Management	☐ **Manager of Logistics base** Port Authorities 1/ Or captain of vessel if PSV incident	☐ **Port Authorities** + TEP Liban assistance + Total HQ : "spot" support + Authorities: Follow-up & possible supervision (partial activation of the National OSCP) Or shipowner if PSV incident	☐ **Port Authorities** + TEP Liban assistance: IMT & CMT + Total HQ assistance (remote & in country) + **Authorities**: Supervision of incident management (NOSCP full activation) Or shipowner if PSV incident

Note. Persistents: crude, HFO & IFO, utility oils, etc. Non-persistent: Condensate, MGO, drilling mud NABM, etc.

6.5.2.6 Residual impact/risk

The residual impact of a hydrocarbon release on Lebanon's marine and coastal biota/ habitats, social receptors and archaeological/cultural heritage resources is dependent on its location and the amount and type of hydrocarbon released. For the major spill scenarios modelled (see Section 6.5.2.1), the results indicate impacts to the offshore marine environment in the Block 4 area, coastal waters of Lebanon and stretches of the shoreline if no spill response is initiated. In reality, this is not the case as the TEP Liban OSCP and BOCP will be in place with immediate response measures to limit environmental and social impacts. Taking into account the low residual likelihood of such an event (1 to 2 – remote to extremely unlikely), and the mitigation measures in place, residual significance/risk has been categorised as **moderate/tolerable risk if demonstrated to be ALARP** (16–32 depending on scenario, see Table 6.11).

6.5.3 Cumulative impacts

A cumulative impact can be defined as the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (e.g., developers, local communities, government) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

This definition of 'cumulative impacts' therefore considers the additive impact of the primary activity (i.e., the current project) and third-party activities. By taking account of existing or other projects planned in the foreseeable future, it is intended to overcome the deficiencies associated with the limited scope of an individual project-based environmental and social impact assessment.

As stated previously, TEP Liban's drilling programme in Block 4 will be the first offshore exploration drilling activity in Lebanon. The only other offshore block in Lebanese waters that has currently been awarded is Block 9, also to TEP Liban. Drilling in Block 9 is not scheduled to begin until 2020; however, there is the potential that future drilling in Block 4 and Block 9 may be simultaneous activities. Based on the fact that Block 4 and Block 9 are approximately 45 km apart (distance between nearest boundaries) cumulative impacts are not anticipated.

No other future projects are known to be taking place in the Block 4 area.

6.5.3.1 General

Factors affecting the Mediterranean Sea, coastline and coastal communities do not exist in isolation; different pressures act over time and in unison to affect the resilience of ecosystems and their ability to deliver ecosystem services.

The National Centre for Ecological Analysis and Synthesis (NCEAS) has undertaken modelling to perform comprehensive spatial analysis and mapping of human pressures throughout the Mediterranean Basin. This work builds on a previous global analysis of cumulative human impacts (Halpern et al., 2008) including additional information to better reflect the specific pressures and ecosystems of the Mediterranean Sea and coasts. A total of 22 spatial datasets of human activities and stressors and 19 ecosystem types were assembled and used in the analyses and maps (NCEAS, 2008).

The analysis concluded that pressures that exert the greatest impacts on Mediterranean marine ecosystems are climate change, demersal fishing, ship traffic and, in coastal areas, run-off from land and invasive non-indigenous species. The lowest estimated impacts are associated with oil spills and oil rigs, due to a combination of the limited spatial extent of these pressures and their overlap with habitats with relatively low vulnerability to these potential threats (UNEP/MAP, 2012).

6.5.4 Transboundary impacts

Transboundary impacts are those that extend or occur across a national boundary, i.e., impacts that affect countries other than the country in which the project will be constructed or operated. The closest national border to Block 4 is that of Syria which is just over 30 km to the north.

Modelling of routine discharges from the project (e.g., cuttings dispersion modelling, underwater noise modelling) indicate that transboundary impacts are not anticipated owing to the area affected being relatively localised (e.g., short term effects on the water column from cuttings discharge up to 25 km from the well site; marine mammal noise disturbance effects (mild disturbance) from MODU drilling and vessel operations up to 8.6 km from well site).

The potential for transboundary air quality impacts was also considered. However, owing to the transient, localised and relatively low volumes of such emissions, the potential for any transboundary effects on air quality are negligible.

Transboundary impacts are therefore only predicted as a result of a large-scale accidental event. Section 6.5.2.1 includes modelling of major spill scenarios at the B4-1 well site. The transboundary impacts predicted by the stochastic modelling of multiple simultaneous spills (Figure 6.21 and Figure 6.24) are summarised in Table 6.16 and show potential for effects on the offshore waters and shorelines of Lebanon and Syria, and a low probability of impact on the offshore waters of Cyprus.

Table 6.16: Summary of transboundary impacts from spill modelling

		Lebanon	Syria	Cyprus
Scenario 1 – blowout scenario, continuous release of condensate for 90 days				
Stochastic modelling	Offshore impacts	✓	✓	
	Shoreline impacts	✓	✓	
Deterministic modelling	Offshore impacts	✓	✓	
	Shoreline impacts	✓	✓ v. low probability	
Scenario 2 – instantaneous release of 6000 m^3 of marine diesel				
Stochastic modelling	Offshore impacts	✓	✓	✓ v. low probability
	Shoreline impacts	✓	✓	
Deterministic modelling	Offshore impacts	✓	✓	
	Shoreline impacts	✓	✓	

A summary of the key environmental sensitivities in neighbouring countries to Lebanon is provided in Figure 6.28.

In terms of shoreline susceptibility in the Eastern Mediterranean, the nature of shoreline sediments is related to the shoreline morphology. Geomorphological mapping reveals a straight coastline between Lake Bardawil (Egypt) and Haifa in Occupied Palestine. Spits and bays, usually forming local traps for spilt oil, occur from Haifa towards Lebanon, where rocky shorelines are common. A similar shoreline morphology is maintained in Syria despite the presence of linear, low-lying beaches south of Tartus, and dunes and barrier reef south of Latakia.

Internationally recognised conservation areas in Syria (the only neighbouring country with shoreline predicted to be impacted by the spill modelling) are presented in Figure 6.28 and more information is provided in Table 6.17. Of the internationally recognised sites listed in Table 6.17, Latakia Beach is considered the most vulnerable to oil spill impacts due to turtle nesting activities at this site. Surveys conducted by MEDASSET along the Syrian coastline have recorded high numbers of green and loggerhead turtle nests along the beaches between Latakia and Jablah to the south. The survey classed Latakia beach as one of the top ten nesting sites of green turtle in the Mediterranean (MEDASSET, 2018).

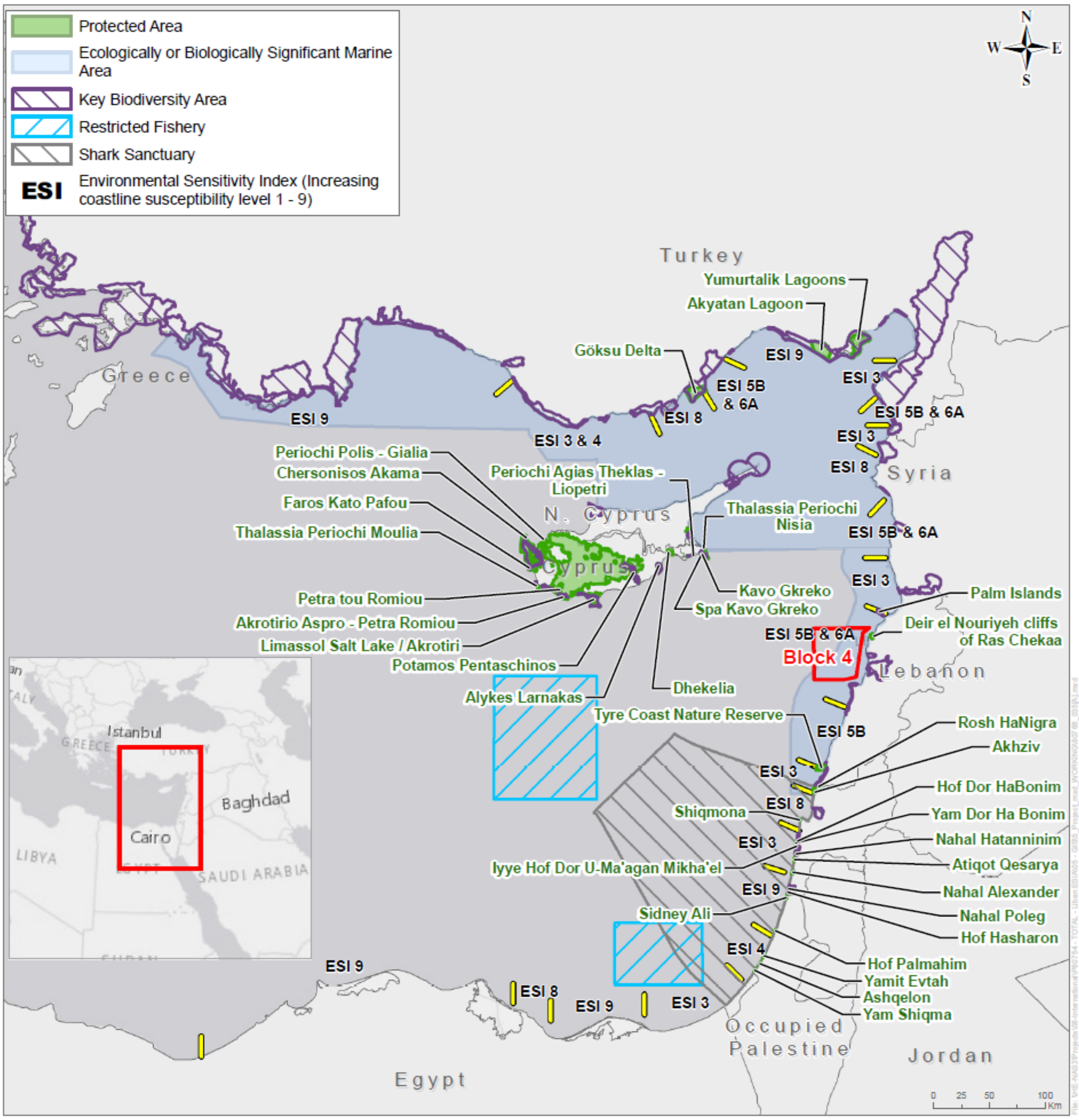

Figure 6.28: Environmental sensitivities in neighbouring countries to Lebanon

Note only Lebanon, Syria and offshore waters of Cyprus potentially affected by transboundary oil spill impacts as indicated by modelling**.** Source: ESI data Alves et al. (2016); Protected Areas IUCN-WDPA

Table 6.17: Internationally recognised conservation areas along the Syrian coast

Protected area	Area (km^2)	Designation	Summary description
Designated protected areas along Syrian coast			
None			
Internationally recognised conservation areas along Syrian coast (north to south)			
Umm al-Tuyyur	120	KBA IBA	Located in the north of Syria, it is a mainly rocky coast, extending north from the sheer limestone cliffs of Jabal Tarnajah (Ras al-Janzir) to the rocky headland of Ras al-Basit. Comprises sand beach with seagrass beds offshore, and a 10-km-deep hinterland comprising well-wooded hills and narrow river valleys and plains. Significant populations of Egyptian vulture (*Neophron percnopterus*), olive-tree warbler (*Hippolais olivetorum*) and Rüppell's Warbler (*Sylvia ruppeli*) are present, while breeding species of birds include *Tachybaptus ruficollis, Pernis apivorus, Circaetus gallicus, Accipiter gentilis, Buteo buteo, Falco subbuteo, Apus affinis, Hippolais olivetorum, Emberiza cia* and the only colony in Syria of *Larus cachinnans. Falco eleonorae* is a non-breeding summer visitor in small numbers.
Latakia Beach	6.1	KBA	Located south of Latakia, this stretch of beach coastline supports significant populations of globally threatened nesting loggerhead turtles (*Caretta caretta*; vulnerable) and green turtles (*Chelonia mydas:* endangered).
Nahr al Hawaiz River	68	KBA	Located between Latakia and Tartus, this river KBA has been identified based on the presence of significant populations of globally threatened species and/or endemic species of fauna: the Syrian spotted bleak (*Alburnus qalilus*: endangered), the Turkish red damsel (*Ceriagrion georgifreyi*: vulnerable), the Syrian bluet (*Coenagrion syriacum*: near threatened) and the loggerhead turtle (*Caretta caretta*: vulnerable).
Northern El Kabir River	110	KBA	Located on the border with Lebanon, this predominantly terrestrial KBA has been identified based on the presence of significant populations of globally threatened species and/or endemic species of plants: *Isoetes olympica* (critically endangered), *Vicia hyaeniscyamus* (endangered) and *Vicia kalakhensis* (endangered).
East Levantine Canyons	>10,000	EBSA	The Syrian coastline (and Lebanese coastline) are encompassed by the East Levantine Canyons EBSA, a system composed of deep canyons as well as hydrothermal vents, and submarine freshwater springs, and is of particular biological importance. The coastal areas of the eastern Mediterranean host one of the largest areas of Opisthobranch formations and its waters experience the highest winter temperatures, allowing it to act as a refuge and spawning ground for many biologically important species of chondrichthyes, marine mammals, reptiles and teleosts (many of which are listed as vulnerable/endangered on the IUCN Red List).

Source: BirdLife International (2019); IBAT (2019)

Sensitive social receptors along the Syrian coastline include the following:

- Fisheries: Syria's fisheries are dominated by artisanal small-scale catches (67%) despite a substantial contribution from industrial fisheries (bottom trawlers) since the 1990s. Fisheries productivity in Syria is much lower than in the neighbouring countries of Lebanon and Turkey suggesting overexploitation. Reported catch in 2014 was just over 2000 tonnes and the fisheries sector in Syria accounts for less than 0.002% of Gross National Product (Ulman et al., 2015).
- tourist beaches: There are several tourist beaches along coast. The most popular ones are north of Latakia and include Ras al Basit, Wadi Quandil and Al-Samra (Kassab). In general, tourism in Syria is under-developed.
- ports and shipping: There are key shipping routes accessing the main ports of Latakia and Tartus, see Figure 6.29.
- coastal communities: Most of the population lives in a narrow strip of land between the Mediterranean Sea and the coastal mountain range. Population densities are highest in Latakia (405 people/km^2) and Tartus (370 people/km^2) (UNEP, 2009).

Social sensitivities in the offshore waters of Cyprus predicted to be impacted by the spill modelling are anticipated to be limited to shipping (several major shipping routes pass through this area, see Figure 6.29) and potentially fisheries.

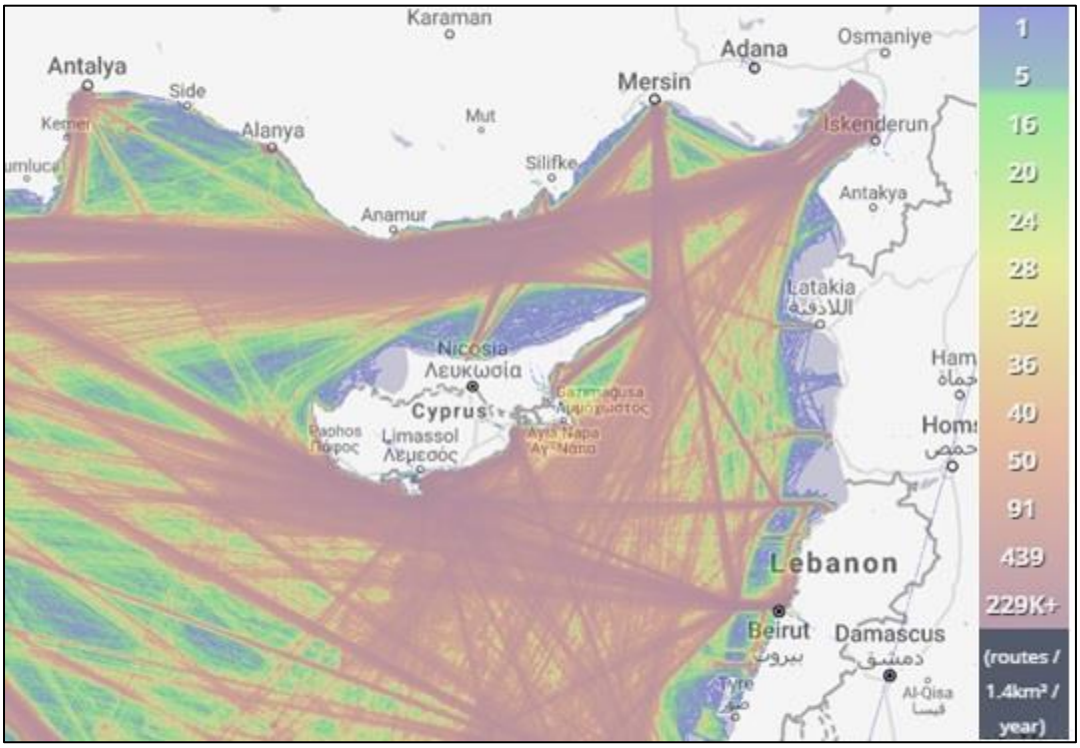

Figure 6.29: Densities of shipping lanes in Eastern Mediterranean (2017)

Source: Marine Traffic (2019)

6.5.4.1 Mitigation measures

The coastline of Syria includes areas of environmental and social sensitivity that need to be taken into consideration in the development of oil spill response. As stated previously, the TEP Liban OSCP and BOCP will focus on optimising response at sea to minimise transboundary impacts. Coordination of responses in any potentially affected neighbouring countries will also be taken into consideration.

Transboundary impacts will be communicated to Lebanese authorities so that they can notify, exchange information, and consult in the assessment of impacts on neighbouring countries whose coastal zones may be impacted by the project. Requirements for transboundary cooperation are included in the Barcelona Convention – Protocol of Integrated Coastal Zone Management in the Mediterranean. Under this Protocol, Parties shall endeavour to coordinate where appropriate their national coastal strategies plans and programmes related to contiguous coastal zones. In accordance with Article 29 Parties shall before authorising or approving projects that are likely to have a significant adverse effect on the coastal zones of other Parties, cooperate by means of notification, exchange of information and consultation in assessing the environmental impacts of such projects. It will be the responsibility of the Lebanese government to inform potentially impacted neighbouring countries, as required.

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7 ANALYSIS OF PROJECT ALTERNATIVES

The following project alternatives were presented in the Block 4 Scoping Report and have been carried forward for further discussion in this section of the EIA:

- exploration well site location
- drilling unit type and specifications
- crew transfers to the rig
- drilling fluid selection
- treatment/disposal of drill fluids and cuttings
- scheduling of the drilling programme for the first well
- no-project option.

7.1 Exploration well site location

Under the Exploration and Production Agreement, TEP Liban has analysed seismic survey data provided by the Lebanese government with the aim of identifying possible hydrocarbon-containing formations in Block 4. This data indicates areas where hydrocarbons are potentially trapped in geological structures. However, without exploratory drilling, geophysical data alone is not enough evidence to confirm the presence of oil or gas. Neither can it show whether the deposits are commercially viable, nor the extent of the deposits.

The B4-1 exploration well site location has been selected based on the most direct drilling route to promising hydrocarbon reserves (essentially a near vertical well trajectory from the seabed above the target location), using the seismic survey data available. Other seabed locations could have been selected for well spud positions. However, to reach the target area of the reservoir, the well would then need to be more 'deviated'[1] taking longer to drill and generating more drill cuttings (with a subsequent increase in environmental impact and waste management implications).

The selected location of B4-1 has been validated through a geohazard assessment that confirms the area is free of shallow gas. In addition, a site-specific drill site assessment has been carried out, involving detailed review of high-resolution bathymetric data and 3D/2D high-resolution seismic datasets, in order to precisely locate the well in an area free of other drilling hazards. The drill site assessment concluded there were no geohazards for B4-1 that would affect drilling. Any future exploration and appraisal wells in Block 4 are also anticipated to be non-deviated and similar drill site assessment for them will be submitted to the MoEW as part of the Application for Drilling Permit (two months before drilling begins).

[1] A deviated well is one with an inclination other than zero degrees from vertical. In practice, deviated wells are usually more than 10° from vertical.

Summary of optimum solution – exploration well location	
Optimum solution taking into consideration environmental and socio-economic sensitivities	The optimum solution is a non-deviated well comprising most direct drilling route to promising hydrocarbon reserves. This will result in the generation of the minimum amount of cuttings and discharges.
Compliance with local regulations	TEP Liban has an exploration and production agreement for petroleum activities in Block 4, which allows for exploration drilling.
Good international industry practice	Directional drilling only recommended to avoid sensitive surface areas and gain access to the reservoir from less sensitive surface areas. No sensitive benthic habitats identified in the vicinity of the B4-1 well site.
Cost effectiveness	A non-deviated well will take less days to drill and will therefore be more cost effective, in addition waste generated will be minimised with resulting lower costs for disposal.

7.2 Drilling unit type and specifications

Considering the deep-water conditions in the Block 4 priority area (1450–1760 m water depth), the type of MODU that can be utilised is limited to a

- semi-submersible rig – a mobile offshore drilling unit with a platform-type deck that contains drilling equipment and other machinery supported by pontoon-type columns that are submerged into the water. The semi-submersible is maintained in position by anchors (some semi-submersibles employ dynamic positioning systems (using thrusters) to replace or supplement the mooring system and possibly a combination of dynamic positioning and anchors)
- drillship – marine vessel specifically designed for offshore drilling in deep and ultra-deep waters. Dynamic-positioning thruster systems maintain the vessel's position.

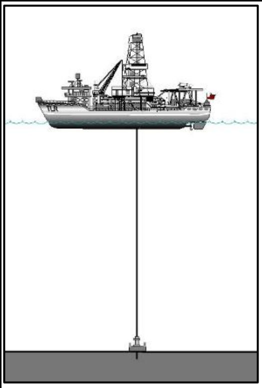
Table 7.1 summarises the environmental impacts of the different drilling facilities.

Based on the environmental impacts presented in Table 7.1, there is no clear benefit of a semi-submersible versus a drillship.

In the offshore environment of the B4-1 well site, no sensitive deep-water benthic communities have been identified. The benthic faunal assemblage is considered relatively impoverished in terms of species abundance and diversity, reflecting the low levels of organic matter and nutrient enrichment. Anchoring impacts if a semi-submersible rig is selected are therefore considered negligible (use of a drillship would not require any anchoring). Any future exploration and appraisal wells in Block 4 are anticipated to be in areas which have a similarly impoverished benthic faunal assemblage.

In terms of atmospheric emissions, there is no clear benefit of a semi-submersible over a drillship. MODU energy saving studies (e.g. RSK, 2016) conclude that energy consumption is seen as inherently linked to drilling efficiency. It is generally considered that the best way to save energy is to do the rig's work as quickly and efficiently as possible and the strong cost (and safety) drivers for this have the naturally complementary effect of affecting energy efficiency in the same positive direction. Selecting the most efficient MODU for the work is therefore the main objective for achieving a reduction in emissions.

Table 7.1: Summary of environmental impacts of different MODU options

Rig type	Schematic	Water depth	Weather conditions	Environmental impact
Semi-submersible	 Source: Rigzone (2019a)	Deep (to 3000 m)	Moderate – Hard	Possible physical impact on seabed sediments from anchoring. Air emissions from tugs used in mob / demob and anchor-handling operations (if semi-submersible has dynamic positioning to replace or supplement the mooring system air emissions from thrusters)
Drillship	 Source: MMS, 2000	Deep to ultra-deep (to 3800 m)	Moderate	No impact on seabed from anchoring Emissions from dynamic positioning thruster systems.

Source: Adapted from Khoury et al. (2019)

A sixth-generation dynamically positioned drillship has been selected for drilling of the B4-1 exploration well. If further exploration or appraisal wells are drilled in Block 4 the option of using a semi-submersible will still be considered.

In all events, the MODU selected will be designed specifically to operate in a deep-water environment. It will be MARPOL 73/78 compliant, and the design and capacities of the MODU will include features for high-efficiency operation.

Summary of optimum solution – drilling unit type	
Optimum solution taking into consideration environmental and socio-economic sensitivities	No clear advantage of a semi-submersible versus a drillship
Compliance with local regulations	MODU selected will be a sixth-generation facility that will operate in accordance with applicable national and international regulations
Good international industry practice	No clear recommendations in GIIP for use of drillships over semi-submersibles

Summary of optimum solution – drilling unit type	
Cost effectiveness	Anticipated that the cost of hiring both MODUs will be similar

7.3 Crew transfers to the rig

Two options were considered for crew transport to the rig, namely

- transfer by supply vessel
- transfer by helicopter.

Although helicopters are the most common way of moving personnel to and from offshore installations, particularly in the UK, other regions use marine transfer by crew boat. At the end of the marine transit, passengers are usually transferred in a carrier (i.e. a net, basket or capsule) which is lifted by crane onto the installation. Both options involve some element of safety risk.

Transfer by helicopter to the MODU is TEP Liban's preferred option due to the shorter transfer times and the increased suitability for medevac of personnel in an emergency situation.

Summary of optimum solution – crew transfers to rig	
Optimum solution taking into consideration environmental and socio-economic sensitivities	Transfer by helicopter preferred due to the shorter transfer times and the increased suitability for medevac of personnel in an emergency situation. Emissions to air associated with helicopter transfer are low (see Tables 4.11 and 4.12). Underwater noise impacts are not anticipated from helicopters. Airborne noise impacts anticipated to be negligible / minor for environmental and social receptors (see Tables 6.9 and 6.10). Reduced onshore transportation as MODU crew likely to arrive at airport from international destinations and will not need to transit through Beirut to the port.
Compliance with local regulations	Option dependent on authorities granting the project a license to operate helicopters. Approval from authorities has been received.
Good international industry practice	Personnel transfer to and from offshore facilities typically occurs by helicopter. Safety procedures for helicopter transport of personnel are required. Passengers will systematically receive a safety briefing and safety equipment as part of helicopter transport.

7.4 Drilling fluid selection

As stated in Section 4.4.4, the functions of the drilling fluid are to

- control formation pressure and prevent well control issues
- transfer cuttings from the wellbore to the surface
- preserve wellbore stability
- minimise formation damage and seal permeable formations
- cool and lubricate the drill string

- provide information about the wellbore
- minimise risk to personnel, the environment, and drilling equipment (well barrier).

There are two main types:

- water based drilling fluid (WBDF) – fluids for which the continuous phase and suspending medium for solids is seawater or a water-miscible fluid. There are many WBDF variations, including gel, salt-polymer, salt-glycol and salt-silicate fluids
- non-aqueous drilling fluid (NADF) – the continuous phase and suspending medium for solids is a water-immiscible fluid that is oil based, enhanced mineral oil based or synthetic based.

It should be noted that oil / diesel based NADFs will not be used in the Block 4 exploration drilling programme. This type of drilling fluid is therefore not considered in the discussion below.

Table 7.2 summarises the key benefits and disadvantages of WBDF and synthetic NADF.

Table 7.2: Key differences between WBDF and synthetic NADF

Water-based drilling fluid	Synthetic non-aqueous drilling fluid
Advantage: Lower environmental impact if discharged to sea	Disadvantage: Potential for increased environmental impacts if discharged to sea Synthetic NADF: Non-toxic and quickly biodegrades
Disadvantage: Generally lower drilling performance, may not be compatible with drilling through particular geological formations	Advantage: Increased lubricity, enhanced shale inhibition, prevention of hydration and dispersion of clays, increased borehole stability, more tolerant to high temperature and high-pressure conditions
Disadvantage: WBDFs cannot be reused in subsequent wells	Advantage: Synthetic NADFs can be reused in subsequent wells
Advantage: Lower cost than NADFs	Disadvantage: More expensive than WBDFs

The choice between WBDF and NADF drilling fluid is related to the trade-off between improved drilling performance, borehole stability and cost. Typically, a synthetic-based mud would be preferred owing to its superior performance and characteristics. However, modern water-based muds are approaching the performance levels of synthetic-based muds, meaning that the difference in performance is not as high as it used to be.

There are currently two options for the Block 4 wells:

- Option 1 (base case): Use of a seawater-based system (WBDF) in the upper-hole sections (top-hole and next section; 36 in. and 26 in. respectively) and a NADF in the lower-hole sections. The NADF base fluid will be an EDC[2] fluid, which is a synthetic-based fluid approved by OSPAR that has an extremely low aromatic content and is readily biodegradable. EDC base fluids are classified as Group III non-aqueous drill fluids according to IPIECA's OGP classification with a much lower aromatic content than this category requires (Group III classification: <0.5% aromatic content and polycyclic aromatic hydrocarbons lower than 0.001%).

[2] EDC – TOTAL's Environmental Drilling Compound range.

- Option 2: Use of a seawater-based system (WBDF) in the upper-hole sections (top-hole and next section; 36 in. and 26 in. respectively) and high-performance water-based drilling fluid (HPWBDF) in lower-hole sections.

Option 1 has been selected for drilling of the B4-1 exploration well as the geological formations downhole are currently not well known and NADF provides enhanced borehole stability. Well logging from the first exploration well will increase TEP Liban's knowledge of subsurface conditions and use of a HPWBDF may be a possibility for the lower-hole sections of any future exploration and appraisal wells.

Summary of optimum solution – drilling fluid selection	
Optimum solution taking into consideration environmental and socio-economic sensitivities	WBDF will be used in the riserless top-hole sections of the Block 4 wells NADF will be used in the lower-hole sections of well B4-1 The use of HPWBDF will be considered for the lower-hole sections of any future exploration and appraisal wells (based on well logging info obtained from B4-1)
Compliance with local regulations	Use of WBDFs and NADFs permitted in Lebanese waters Recommendations in the draft Update of the SEA for Exploration and Production Activities Offshore Lebanon (2019): • Operators should always use water-based fluids unless safety of well could be jeopardised (maintaining well integrity and safety supersedes environmental protection objectives in this case). • Where the need to use synthetic based drilling fluids cannot be avoided, operators should demonstrate that they can achieve maximum separation of drilling fluids from cuttings, and a maximum rate of reuse of drilling fluids within a single drilling operation, and where possible unused drilling fluids are used for the drilling of subsequent well(s).
Good international industry practice	Both WBDF and synthetic NADFs routinely used worldwide in drilling projects
Cost effectiveness	WBDFs generally lower cost than synthetic NADFs

7.5 Treatment/disposal of drilling fluids and cuttings

The generation of drill cuttings is an unavoidable result of drilling and creates a waste stream that can be managed in several ways. For drill cuttings generated from offshore wells, there are three main options:

- ship to shore for onshore treatment and disposal
- offshore discharge
- cuttings re-injection into existing or new wells.

It should be noted that re-injection of drilling fluids and cuttings would only be possible during development drilling (during exploration drilling, there are no existing wells into which cuttings could be re-injected). Such an option is therefore not discussed in any more detail below.

7.5.1 Ship to shore for onshore treatment and disposal

This option involves the processing of drill cuttings on the rig, storage and transportation to shore for disposal and involves a substantial amount of additional equipment, facilities and cost. On the rig, equipment requirements are primarily associated with storage containers such as skips or cuttings boxes to hold the cuttings for transport.

The option typically involves

- cuttings from the shale shakers being stored in containers on the MODU
- storage containers being offloaded by crane to a supply vessel
- a supply vessel transporting the cuttings containers to shore
- containers being offloaded from the boat to the logistics base
- trucks transporting cuttings containers from the logistics base to a land treatment/ disposal facility.

In Lebanon, the final step is more complex as treatment/disposal facilities for cuttings and associated drilling fluids are not currently available in country. Onward transportation of the cuttings to another country, with suitable treatment/disposal facilities, is therefore a requirement.

Shipping of drill cuttings onshore for treatment and disposal is expected to have limited impacts on the marine environment. Impacts from this option are mainly concerned with transport vessel movements such as impacts on air quality and greenhouse gas emissions and increased risk of vessel collision. As the cuttings require ongoing transportation to another country for this project, these impacts will be more significant. There is also the potential for impacts on terrestrial ecology and community nuisance impacts from onshore disposal (such as increased traffic during truck transportation of cuttings, and emissions from the treatment/disposal facility).

7.5.2 Offshore discharge

The offshore discharge option is relatively straight forward and in most offshore operating areas around the world discharge of cuttings associated with WBDF is normal practice, except in highly sensitive areas. Cuttings associated with synthetic-based muds are discharged offshore in several geographic locations (subject to local regulations), while discharge of oil-based muds is generally prohibited. Recommendations for drill cuttings disposal in the draft 'Update of the Strategic Environmental Assessment (SEA) for Exploration and Production Activities Offshore Lebanon' (2019), are included in Section 7.5.3.

No temporary storage of cuttings is required for this option, and modern drilling rigs have solids control equipment designed to treat drill cuttings to recover drilling fluids before the cuttings are discharged.

To address the identified impacts from the disposal of cuttings, there have been developments in drilling fluids and treatment / disposal technology and options. For marine discharges, the main advances have been in the development of readily biodegradable and low-toxicity drilling fluids, reducing the concentration of drilling fluids on cuttings and optimising dispersion of cuttings.

The principal disadvantages of discharge of cuttings at sea are potential impacts on sediment and seawater quality, impacts on benthic communities and, to a lesser extent, impacts on other marine faunal groups such as plankton, fish, etc.

In Lebanon, the draft 'Update of the Strategic Environmental Assessment (SEA) for Exploration and Production Activities Offshore Lebanon' (2019) states that drilling fluids and cuttings should not be discharged to sea; ship to shore for treatment or, shipment outside Lebanon are acceptable options; Section 7.5.3 describes B4-1 preferred option and project options for potential additional wells.

Table 7.3 summarises a comparative assessment of these two disposal options.

Table 7.3: Comparative assessment of cuttings disposal options

Criteria	Onshore disposal	Offshore discharge
Environmental and social	No marine impacts	Potential impacts on sediment and seawater quality, benthic communities and other faunal groups No onshore impacts
	Potential onshore impacts on terrestrial ecology and community nuisance impacts. Takes up landfill space onshore	
	Increased air emissions (and greenhouse gases) from vessel movements and cuttings treatment, as well as onshore transportation	
Cost	High cost	Low cost
Safety	Increased safety risk from additional lifting operations and increased collision risk associated with vessel movements and potential onshore traffic incidents	Low safety risk
Technical	No onshore treatment and disposal facility currently available in Lebanon will involve transportation of cuttings to another country (Cyprus)	Technically uncomplicated

7.5.3 Preferred option

Top-hole sections of well (36 in. and 26 in.)

Discharge of WBDF and cuttings to sea from upper-hole sections (top-hole and next section; 36 in. and 26 in respectively) of B4-1 (and any future exploration / appraisal wells in Block 4) is the only feasible option as the marine riser to the rig will not be in place during the drilling of these two sections. For this reason, all drilling chemicals selected for these sections are HQ Band Gold, OCNS Group E or PLONOR for lowest toxicity, lowest bioaccumulation potential and highest biodegradation (see Table 4.3). Cuttings discharge modelling conducted for the project demonstrates that potentially significant environmental risk to sediments is limited to 100 m from the discharge point mainly due to increases in sediment thickness and grain size variation (see Section 6.3.1.2). Significant environmental risk to the water column is more extensive (up to 25 km from the discharge point) but only for a small number of days during the discharge period and is associated with increases in turbidity from bentonite and barite release (see Section 6.3.1.2).

Lower-hole sections of well (17½ in., 12¼ in. and 8½ in.)

For the lower-hole sections of the B4-1 well (and any future exploration / appraisal wells in Block 4), the marine riser will have been installed and drilling fluids and cuttings will be transferred up to the MODU. The onboard solids control equipment (shale shakers and centrifuges) will separate the cuttings from the drilling fluids (it is estimated that the solids control equipment on the MODU will be capable of recovering around 95% of the drilling fluids from the cuttings). The separated drilling fluids will be reused when drilling subsequent well sections.

Option 1 utilises NADF in lower-hole sections (selected for well B4-1) with cuttings transferred direct from rig to treatment facility in Cyprus (in line with Basel Convention requirements), see Section 4.6.5.2.

Option 2 utilises HPWBDF in lower-hole sections with cuttings discharged to sea in line with normal practice in the majority of oil and gas operations worldwide. HPWBDF may be used with future exploration and or appraisal wells in Block 4. Cuttings discharge modelling for Option 2 demonstrates that significant environmental risk to sediments is limited to 1.5 km from discharge point due to grain size variation and sediment thickness (see Section 6.3.1.2). Significant environmental risk to water column extends up to 12.5 km from discharge point and is associated with increased turbidity from barite and bentonite discharge (see Section 6.3.1.2). If Option 2 is selected for a future well in Block 4, cuttings dispersion modelling that is specific to the new well location will be conducted and the MoE informed of results.

Summary of optimum solution – treatment/disposal of drilling fluids and cuttings	
Optimum solution taking into consideration environmental and socio-economic sensitivities	Discharge of cuttings and WBDF from upper-hole sections (top-hole and next section; 36 in. and 26 in. respectively) sections of well during riserless drilling. Ship to shore of cuttings if NADFs used in lower-hole sections of well (this is the case for well B4-1). Discharge of cuttings if HPWBDFs used in lower-hole sections of well. For the discharge to sea options, cuttings discharge modelling indicates that environmental risk to sediments is relatively localised. Benthic faunal assemblage in vicinity of B4-1 well site is considered impoverished in terms of species abundance and diversity and, therefore, a low sensitivity receptor. Environmental risk to the water column is more extensive, but very short term (limited to the actual discharge period) and is associated with increases in turbidity from insoluble barite and bentonite release. For the ship to shore option (NADFs used in lower-hole sections) increased emissions associated with transport of cuttings to Cyprus for treatment and disposal, see Tables 4.11 and 4.12.
Compliance with local regulations	Recommendations in draft Update of the SEA for Exploration and Production Activities Offshore Lebanon (2019): • Water based and synthetic based drill cuttings - acceptable options for the management and disposal of cuttings (providing necessary approvals are in place) are: 1) processing of drill cuttings (stabilisation / solidification) followed by controlled disposal offshore; 2) ship to shore for treatment and controlled disposal at sea of stabilised residues; 3) shipment outside Lebanon for treatment / disposal (as per Basel Convention requirements). • Direct disposal of water based and synthetic based drill cuttings to sea is not allowed. • Direct discharge of synthetic based drilling fluids to sea is strictly prohibited.
Good International Industry Practice	In most offshore operating areas around the world, discharge of cuttings associated with WBDF is normal practice. Discharge of cuttings to sea from wells drilled with NADF should be avoided.
Cost effectiveness	Discharge of cuttings to sea is considerably lower cost than transport of cuttings to shore and onshore treatment and disposal.

7.6 Scheduling of drilling programme for the first well

Drilling of well B4-1 is scheduled to begin in February 2020 and will take around two months. This start date was influenced by the following factors:

- timings indicated as an objective in the Block 4 exploration plan
- availability of the MODU
- environmental and social sensitivities.

The environmental baseline in Chapter 5 identifies the winter months as a period of relatively low sensitivity, particularly with respect to plankton productivity, fish spawning and turtle nesting. This is supported by proposed mitigation measures in the draft 'Update of the Strategic Environmental Assessment (SEA) for Exploration and Production Activities Offshore Lebanon' (2019), which recommends offshore drilling during the non-productive low waves–high current season of December to March.

B4-1 drilling is being initiated within the low-sensitivity environmental period and no other options are currently being considered.

7.7 No project option

A no project alternative would avoid all potential environmental and social impacts from the Block 4 exploration drilling campaign. However, this alternative would preclude the evaluation and possible future development of hydrocarbon resources in the area. This alternative could have security of energy supply issues for Lebanon, and significant economic consequences due to the loss of any associated direct revenue to the government and the national economy, in addition to employment and loss of potential for ancillary industries if the field goes on to production stage.

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8 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLANS

8.1 Introduction

This chapter outlines the framework for environmental and social management of the Block 4 exploration drilling programme. Environmental and Social Management Plans (ESMPs) have been developed by TEP Liban, as part of the project's HSE plan, and submitted to the MoE.

The ESMPs conform to environmental and social requirements in

- national policy, legislation and regulations
- relevant international treaties and agreements to which Lebanon is a party
- Total's corporate requirements
- international good practice
- applicable and feasible mitigation measures and recommendations in the SEA for Petroleum Activities in Lebanese Waters (2019).

The specific objectives of the ESMPs are to

- describe how the project's environmental and social impacts will be minimised and positive impacts enhanced during project planning and implementation
- provide a framework for the project team to comply with environmental and social policies, commitments and legal, contractual and other requirements applicable to the project
- provide a framework for the development of detailed implementation plans by contractor(s)
- describe the key roles and responsibilities
- detail the programme that will monitor and report the project's effects and its compliance with regulatory and corporate requirements
- describe the system of verification, oversight and assurance.

TEP Liban's ESMPs are for well B4-1 and will be updated for any future Block 4 exploration or appraisal wells.

8.2 TEP Liban's HSE management system

TEP Liban has a health, safety and environment management system (HSE MS) in place that contributes to controlling the HSE risks of its activities. It encompasses the organisational structure; planning activities; responsibilities; and practices, processes, procedures and resources utilised in maintaining conformance with the HSE policy (see Figure 8.1) and achieving continuous HSE performance improvement.

TOTAL

TOTAL E&P LIBAN

HEALTH, SAFETY AND ENVIRONMENT POLICY

THE TOTAL GROUP AND TOTAL E&P LIBAN HAVE A NON-COMPROMISING ATTITUDE TOWARDS HEALTH, SAFETY, ENVIRONMENT AND QUALITY.

IN ORDER TO ACHIEVE OUR STANDARDS WE SHALL:

- Maintain a strong, visible and supportive management involvement in all HSE matters and promote HSE as a core value of our business.
- Comply with National Acts and Regulations and with TOTAL Group policies.
- Maintain a culture in which each person is clearly aware of his or her own responsibility in HSE matters, and acts in accordance with our Golden Rules.
- Develop ambitious, measurable HSE objectives and key performance indicators as a means of measuring and improving our performance.
- Perform appropriate HSE assessments in order to identify, minimize and manage the risks to personnel, the environment and assets.
- Plan and supervise the execution of all our activities taking into account HSE aspects as an utmost priority.
- Favour the selection of industrial and business partners on the basis of their own HSE Management System and of their ability to comply with our HSE policy.
- Commit ourselves to an open, honest and long-term dialogue with our stakeholders.

AS A RESPONSIBLE AND CONSCIENTIOUS COMPANY,

We will work as an integral part of the Lebanese society to achieve continuous improvement and sustainability in respect to HSE, quality and reliability.

We consider a high standard of HSE performance by everyone who works for or with us, as critical to the success of our business. Accordingly we expect our suppliers and partners to share our values and goals.

I trust that all employees will familiarize themselves with the content of our policy and work together to reach our objectives in relation to health, safety and environment.

May 08th 2019

Ricardo DARRE
General Manager

Figure 8.1: TEP Liban HSE policy

The TEP Liban HSE MS is composed of 10 Common Principles, transposed into 55 Expectations and further elaborated into HSE specific rules.

The Common Principles are as follows:

- Principle 01 – Management, Leadership, Communication and Engagement
- Principle 02 – Compliance with Laws, Regulations and Group Requirements
- Principle 03 – Risk Management
- Principle 04 – Operations, Reliability and Efficiency
- Principle 05 – Contractors and Suppliers
- Principle 06 – Competence and Training
- Principle 07 – Emergency Preparedness
- Principle 08 – Incident & Accident Management and Information Sharing
- Principle 09 – Monitoring, Audit and Inspection
- Principle 10 – Performance Improvement.

The Common Principles are organised in line with the plan–do–check–act improvement cycle as shown in Figure 8.2.

Figure 8.2: Organisation of the Common Principles in the plan–do–check–act improvement cycle

In general terms, TEP Liban's HSE MS comprises a set of components that includes

- HSE policy
- HSE objectives
- planning of activities to attain the HSE goals
- identification of the risks involved in TEP Liban's activities
- the organisation within which the HSE responsibilities are clearly defined
- competent, trained personnel
- internal and external communication
- practices and processes formally defined in controlled documentation
- the emergency response system
- evaluation of HSE performances and regular review of those performances
- corrective action plans
- an internal control programme
- periodic management reviews of the action plans.

8.3 Organisational structure and responsibilities

TEP Liban will manage the project.

The TEP Liban General Manager has overall responsibility for HSE. He will be assisted by the heads of department, who are responsible for applying the HSE MS in their areas of responsibility, and by the persons responsible for safety and environment on site.

All TEP Liban personnel and contractors participate in the application of the TEP Liban HSE MS.

Individual responsibilities and accountabilities will be defined through position descriptions and conditions of employment contracts. Environmental and social responsibilities will also be written into the service agreements of TEP Liban's contractors.

8.4 Commitments register and ESMP matrix

Management controls (design controls, regulatory requirements, mitigation measures and monitoring requirements) have been described in various chapters of this EIA document, particularly Chapter 6 Potential Impacts of the Project.

To assist authorities, stakeholders and TEP Liban employees and contractors, Appendix 8.1 provides a list of management controls for the drilling campaigns in the form of a commitments register; Appendix 8.2 is termed the ESMP matrix and includes all content of the commitments register with additional information addressing performance indicators, monitoring frequency and impact to be managed as mandated by MoE. This commitments register will, where applicable, be the principal link between the EIA and the environmental and social management plans (see section 8.5) whilst the ESMP matrix will provide guidance with regard to monitoring.

The Commitments Register has been developed in accordance with the requirements of the draft EIA guidelines (MoE and LPA, 2019). Mitigation identified during the EIA process is listed in the commitments register together with the following mitigation-specific information:

- unique identification number (UID), an alphanumeric code identifying the type of mitigation such as monitoring and reporting, training, pollution prevention, etc., and a sequential unique number
- ESIA section reference
- the project activity and or aspect to which mitigation is associated
- receptors that mitigation is designed to protect
- mitigation measure
- responsible party
- project documentation (ESMP sub-plan, standards, etc).

The ESMP matrix includes the following information additional to that presented in the commitments register:

- performance indicators
- monitoring frequency
- impact to be managed by relevant mitigation.

Each mitigation in the commitments register and ESMP matrix is designed to address multiple, different impacts associated with all project phases; i.e., mitigation is not repeated within the commitments register or ESMP matrix while multiple project phases, receptors and impacts are associated with each mitigation. This approach to the commitments register and ESMP matrix facilitates physically smaller documents that are inherently more user-friendly than if each mitigation was repeated for every impact in every project phase.

8.5 Environmental and social management plans

The following ESMPs have been developed by TEP Liban:

- waste management plan
- chemicals management plan
- pollution prevention and environmental monitoring plan
- social management plan
- oil spill contingency plan.

These are discussed in more detail below. The plans include the minimum issues specified in the draft EIA Guidelines for Oil and Gas Reconnaissance and Exploration Activities in Lebanon (Appendix D) and mitigation measures listed in the commitments register (the last column of the commitments register identifies the relevant plan).

To facilitate tracking of mitigation from the EIA commitments register to the relevant ESMP the unique identifier (UID) from the commitments register is provided as appropriate against each commitment in the plans.

8.5.1 Waste management plan (WMP)

The WMP describes how waste will be managed in accordance with relevant local regulatory requirements, applicable international conventions and corporate requirements.

The WMP's purpose is to safeguard the health of people whose work may require them to handle waste (or be exposed to waste), to protect the public, and to preserve the environment around the MODU and the support sites and facilities.

The plan includes

- waste management planning (waste management hierarchy and waste management streams / contracts)
- waste identification, segregation, storage, transport and treatment (waste identification and classification; waste segregation, storage and handling; waste transportation; waste treatment and disposal and waste quantification)
- drill cuttings (cuttings waste management; contractor responsibilities; NORM management)
- waste traceability and reporting (site waste register; waste transfer notes; waste reporting)
- waste continual improvement, audits, inspections and reviews
- waste management awareness
- roles and responsibilities.

This WMP will apply to all TEP Liban activities and locations and to all waste management services performed on behalf of TEP Liban by its contractors.

Waste management contractors working for TEP Liban have their own WMP that is consistent with this plan.

8.5.2 Chemicals management plan (CMP)

The CMP describes how chemicals will be managed in accordance with relevant local regulatory requirements, applicable international conventions, and corporate requirements.

The purpose of the CMP is to safeguard the health of personnel working on the site, to protect the public, and to preserve the environment around the MODU and the support sites and facilities.

The plan includes

- chemical identification and selection process (OSPAR recommendation 2017/1; nationally restricted chemicals; corporate requirements, MSDS; Block 4 chemicals)
- incompatibility of chemicals
- chemicals management (chemicals purchasing; transport of chemicals; warehousing of chemicals; storage of chemicals; handling and use of chemicals; reporting of effluents; management of chemical waste)
- chemical protection and preventative measures (personal protective equipment; emergency response; information and training)
- roles and responsibilities.

8.5.3 Pollution prevention and environmental monitoring plan (PPEMP)

The PPEMP describes the methodology adopted to implement good practices regarding management of emissions and discharges associated with the Block 4 exploration drilling programme.

Environmental monitoring is essential to assess the effectiveness of mitigation measures and ensure that project-related impacts are detected. Where necessary, corrective action will be taken, should monitoring indicate that management measures are not effective.

The plan includes measures to manage

- air emissions from MODU, vessels and helicopters
- drilling discharges from the MODU (drill cuttings and fluids; cementing discharges; pipe dope; BOP testing discharges)
- offshore routine wastewater discharges (sanitary wastewater; food waste; desalination unit discharges; drainage discharges; cooling water; ballast water)
- physical presence of the MODU (light spill)
- underwater noise (MODU; vessels; and vertical seismic profile activities)
- logistics base operational emissions and discharges
- energy efficiency and greenhouse gases
- accidental events

It also includes

- auditing requirements
- reporting and follow up
- awareness initiatives
- roles and responsibilities.

8.5.4 Social management plan (SMP)

The objective of the SMP is to ensure that project activities comply with Lebanese regulations, TEP Liban corporate standards and good international practice in relation to the mitigation of social impacts.

Social commitments related to the following are addressed in the SMP:

- general economy including local employment and procurement of goods and services
- education and training
- social conditions including security, road safety and congestion
- public health, including quality of air and airborne noise
- archaeological and cultural resources (including a Chance Find Procedure)
- infrastructure
- shipping
- fisheries
- tourism.

The SMP explains roles and responsibilities of both TEP Liban and its contractors as well as compliance assurance and monitoring activities to ensure implementation of project-related social commitments. The SMP includes reference to TEP Liban's drilling operations stakeholder management plan (DOSMP) and grievance management procedure (described in Sections 8.6.3 and 8.6.4 respectively).

8.5.5 Oil spill contingency plan (OSCP)

The purpose of the OSCP is to assist TEP Liban personnel in dealing with any unexpected spills and releases of hydrocarbon in the environment (at sea or on land), related to their offshore operations and associated logistical support.

Its primary objective is to set in motion the necessary actions to minimise the effects of any discharge of oil and it:

- provides an emergency notification system, including a standardized format for oil spill notification
- describes the escalation process from Tier 1 to Tier 2 and Tier 3 incidents
- outlines the system for command and control of the oil spill response operations
- provides checklists of actions for key personnel during an oil spill
- provides strategy and tactics to respond to the different types and levels of oil spills.

The OSCP is in three parts as described below:

8.5.5.1 Introduction

This part of the document provides generic management information and an overview of the OSCP for all users.

8.5.5.2 Volume 1 – Action Plans

This operational volume is designed for use by personnel involved in the response and aims at assisting them by defining 'what to do'.

Volume 1.1 is intended for personnel mobilised by TEP Liban for Tier 2 and 3 spills.

Volume 1.2 is intended for personnel on the MODU and provides:

- a description of the organisation on the MODU for dealing with offshore spills
- guidelines on initial actions to be undertaken
- a summary of spill response strategy, according to the Tier levels of the incident (Tier 1, 2 and 3)
- responsibilities of the Local Incident Command team on the MODU.

Volume 1.3 is intended for personnel at the logistics base, with the same objectives as Vol. 1.2, applied to the logistics base.

Operational supports are provided to assist personnel on sites and at the head office by defining 'how do to it'.

8.5.5.3 Volume 2

This document presents the justification of TEP Liban oil spill response strategies, by following a methodology advocated by TOTAL and compliant with internal guidelines that takes into account:

- the legal context (international, regional and national)

- an analysis of the environmental context, leading to the identification of the most sensitive areas on the coastline of Lebanon, translated into coastal sensitivity maps.

Is based on a risk analysis which leads to:

- the identification of possible oil spill scenarios
- the analysis of the fate and behaviour of hydrocarbons which could be spilled
- the identification of 3 levels of seriousness of potential incidents (Tier 1, 2 and 3), requiring increasing mobilisation of resources and calling for the involvement of emergency response.

8.6 Associated plans

In addition to the ESMPs listed above there are other associated plans developed by TEP Liban that support the environmental and social management plans. These are outlined in Sections 8.6.1 to 8.6.4.

8.6.1 Emergency response plan (ERP)

The ERP provides guidelines related to emergency management and response which can be deployed by TEP Liban when a significant incident or accident has occurred, or is likely to occur, during drilling activity operations.

The ERP details the processes and resources that may be utilised in response to reasonably foreseeable emergency situations. It also defines the location and composition of the emergency response room. It will cover unexpected events likely to endanger the health of employees, visitors and/or contractors; threaten the environment; or create a risk for the integrity of the installations. The document includes

- basic principles – general organisation, alert procedure, emergency organisation, liaison between different entities during a crisis, medevac procedure, media management, next of kin information, telephone calls management, and briefing and updates
- roles and responsibilities
- specific scenarios and emergency responses – fire/explosion, illness/casualty/ death, road traffic incident, helicopter crash, oil/chemical spill, gas release, loss/ damage to radioactive source, vessel collision, vessel in distress, mass casualty incident, earthquake, terrorism threat and refugees boarding
- forms for recording incidents
- management – training and exercises, update of the plan
- layout and data – charts, maps, layout of facilities, distances between facilities, MSDS
- resources – communication directory, internal emergency resources inventory, external emergency resources inventory.

8.6.2 Blowout contingency plan (BOCP)

The BOCP is an operational document identifying the key points for response to a well blowout, or other significant well control incident. As per TOTAL corporate rule (CR EP FP 270 Rule 1) all wells, unless temporarily or permanently abandoned, shall be covered by a BOCP.

The BOCP

- addresses the activities that need to be carried out before, during and after a blowout event to minimise the impact on health of personnel and the environment
- proposes actions to regain well control
- describes the technical aspects of recovery from loss of control of the well
- highlights the emergency response regime during the first 48 hours of the initial crisis
- identifies the principal parameters which constrain the time to regain control of the well in blow out and aims to develop all preparations and measures needed to reduce the time of control to as low as reasonably practical.

8.6.3 Drilling operations stakeholder management plan (DOSMP)

Stakeholder engagement is an integral component of the EIA process and the foundation for developing and maintaining the project's social licence to operate. It provides opportunities to inform stakeholders about the project and for feedback from stakeholders to be taken into account in project activities. This plan describes the routine engagements with stakeholders during the actual drilling campaign.

It includes

- EIA stakeholder engagement commitments
- stakeholder engagement methods (formal engagement, informal engagement, project information and communication materials, community liaison committee, recording methods)
- additional stakeholders (stakeholder analysis)
- grievance mechanism
- monitoring and reporting
- roles and responsibilities.

8.6.4 Grievance management procedure

The grievance management procedure describes the process, roles and responsibilities for registering, investigating, resolving and remedying local stakeholders' grievances received at operational level.

The steps in the grievance mechanism are as follows:

- **Receive** – grievances have to be submitted to TEP Liban office by letter or by mail (EP.TEPL-Info@total.com). If the Community Liaison Officer (CLO) receives a grievance verbally, she/he fills out the grievance form in front of the person making the complaint and reads it back to him/her. All grievances received are recorded, filed and entered in a database.
- **Record, assess and acknowledge** – a CLO, with the assistance of the HSE manager, establishes if the grievance falls within the scope of the procedure. If the grievance is unfounded, a letter is sent to the complainant indicating the reasons why the grievance was rejected. If the grievance is legitimate, a letter (or mail) is sent to the complainant within seven days acknowledging receipt of the grievance and proposing a date to start the investigation phase.
- **Investigate** – during the investigation, the CLO may provide regular status updates to the complainant by letter, telephone, meeting or email.
    - Level 1: immediate resolution through dialogue.

  - o Level 2: solution requiring validation from the General Manager.
  - o Level 3: solution requiring the intervention of an outside mediator.

  If the complainant does not accept the third solution offered, the HSE manager informs Total Liban's legal service that there is a potential risk of legal proceedings. From that point, the grievance is handled by the legal service.

- **Resolve and respond** – if the complainant accepts the solution offered (level 1, 2 or 3), the first part of the grievance acceptance and closure form is signed, in the presence of a witness or not.
- **Close** – a grievance is considered closed if the solution is effectively implemented (works are carried out, the disturbance is removed or mitigated etc.). The complainant must sign the second part of the grievance acceptance and closure form. The CLO registers the grievance as closed in the database tool.

8.7 Contractor plans and procedures

The ESMPs described in Section 8.5 provided the basis for subsequent, more detailed management plans prepared by TEP Liban's key contractors. The MODU contractor, drilling fluids contractor, cementing contractor, logistics base contractor and supply vessel contractor will be contractually obliged to comply with the relevant environmental and social requirements, specifications and procedures set out in TEP Liban's ESMPs (see Figure 8.3: Project ESMP linkages) including relevant mitigation and monitoring requirements detailed in the commitments register and the ESMP matrix.

Contractors will be required to have their own HSE management systems. Examples of environmental and social related plans/procedures required from the key contractors are listed below.

- HSE plan
- waste management plan
- chemicals management plan
- social management plan
- spill response plan.

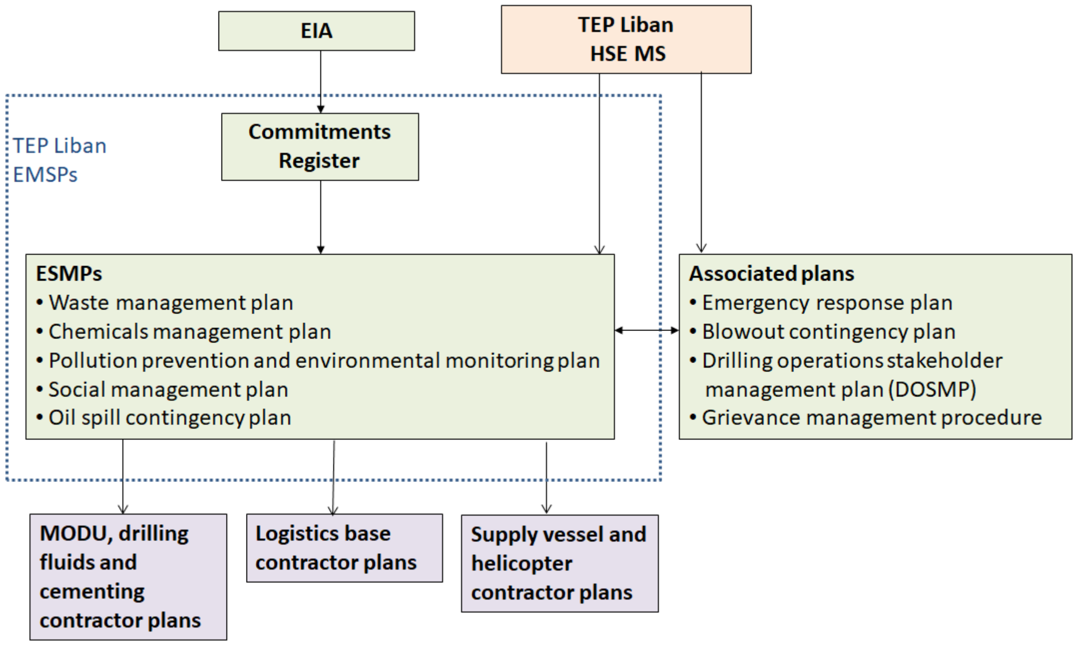

Figure 8.3: Project ESMP linkages

9 CONCLUSIONS

9.1 Introduction

This EIA has been undertaken to identify and evaluate the potential impacts of the TEP Liban offshore Block 4 exploration drilling activities (exploration well B4-1 and potentially a second exploration well and subsequent appraisal well) on environmental and social receptors. It has been carried out in accordance with national policy, legislation and regulations (in particular the Lebanese Environmental Impact Assessment Decree No. 8633/2012); applicable international treaties and agreements; and TOTAL's corporate requirements.

The EIA has also taken into consideration the draft 'sector-specific EIA guidelines for oil and gas reconnaissance and exploration drilling activities in Lebanon' (MoE and LPA, 2019) and recommendations from the March 2019 draft 'Update of the Strategic Environmental Assessment (SEA) for Exploration and Production Activities Offshore Lebanon (ToR 11)' (MoEW, 2019).

This EIA has identified and assessed the impacts of routine project activities and potential accidental events on environmental and social receptors. Potential impacts may be negative or positive/beneficial, direct, secondary or indirect. A comprehensive, systematic review and scoring of all potential impacts was undertaken in Chapter 6. A range of mitigation measures have been developed and incorporated into the Environmental and Social Management Plans for the project.

9.2 Summary of potential routine impacts

Routine activities may have an impact on the following environmental and social receptors:

- air quality
- climate change
- sediment quality/composition
- water quality
- benthos
- fish
- plankton
- seabirds
- cetaceans, turtles and seals
- sensitive marine habitats
- sensitive coastal habitats
- terrestrial ecology
- archaeological and cultural resources
- infrastructure
- social conditions (including security/safety)
- education and training

- general economy
- fisheries
- shipping
- tourism
- public health.

Mitigation measures based on international standards, best practice and Lebanese legislative requirements have been proposed to avoid or reduce potential impacts. The potential significance of impacts before and after mitigation are summarised in Chapter 6.

Most residual environmental impacts are of negligible to minor significance and restricted to the area in close proximity to the B4-1 well location, transfer routes and logistics base location (the same applies to any future exploration / appraisal wells drilled within the Block 4 priority area). One activity has the potential to present a residual negative impact of moderate significance: discharge of water-based cuttings and drilling fluids at the seabed during drilling of the Block 4 upper well sections[1]. Cuttings and fluids cannot be returned to the rig during this part of the work as these well sections are drilled without a marine riser in place. Modelling predicts that the material will disperse in a plume that travels mainly in a north-easterly direction from the well, remaining close to the seabed. There is a risk of effects on water quality from this plume. The risk is mainly a result of the inert, insoluble drilling products barite and bentonite in the water-based mud, and therefore the impact is assessed as moderate.

All negative social and socio-economic impacts are of negligible to minor residual significance. Two socio-economic impacts of the project are identified as positive: the potential for skills development for the local workforce during the logistics base operation, and the potential for positive impacts from employing a local workforce and providing services such as catering, cleaning, security and logistics. However, it should be noted that opportunities are limited at this exploration phase.

9.3 Summary of accidental events

The 12 representative potential accidental event scenarios identified and assessed are listed below, along with the scenario number (AE1–AE12):

- dropped object from MODU (AE1)
- loss of chemical containment onboard MODU (AE2)
- radioactive source lost in hole (AE3)
- riser rupture – release of drilling fluid to sea (AE4)
- shallow gas blowout – release of gas into water column (AE5)
- blowout – release of condensate and gas (AE6)
- collision of third-party ship with MODU – release of third-party fuel inventory, possible damage to MODU and riser (AE7)
- helicopter crash on MODU deck – release of aviation fuel to sea (AE8)

[1] There is also an option for future wells in Block 4 to use high-performance water based drilling fluids (HPWBDF) in the lower-hole well sections. In this case there will be discharge of water-based cuttings and drilling fluids from the riserless top-hole well sections, plus discharge of HPWBDF cuttings from lower-hole well sections. This option has also been assigned a moderate residual impact significance.

- loss of containment during offshore materials transfer to MODU – release of drilling fluids or marine diesel to sea (AE9)
- loss of rig stability (rig capsize) due to severe metocean conditions with release of fuel inventory (AE10)
- earthquake resulting in loss of well integrity and release of hydrocarbons to sea (AE11)
- loss of containment during materials transfer to supply vessels at logistics base quay side – release of drilling fluids/diesel to sea (AE12).

Mitigation and control measures are proposed to prevent and reduce the risk to 'as low as reasonably practicable'. These measures include both preventative actions and reactive responses. The residual significance of impacts from scenarios AE1, AE3, AE8, AE9 and AE12 are broadly acceptable (low), while scenarios AE2, AE4, AE5, AE6, AE7, AE10 and AE11 are assessed as moderate.

The accidental event with the highest possible significance/risk level is a blowout causing the release of gas and condensate from the well (AE6). Oil spill modelling of the blowout scenario was carried out and for a 90-day release scenario, with no well capping, modelling indicates that offshore and coastal waters and the shoreline of Lebanon would be likely to be affected, as well as some parts of the Syrian coastline. The oil spill contingency plan and the blowout contingency plan (see Sections 8.5.5 and 8.6.2 respectively) will reduce the impact of a blowout (AE6), should such an event occur.

9.4 Summary of cumulative and transboundary impacts

Cumulative impacts are not anticipated from the offshore drilling exploration activities.

Modelling of routine discharges from the project (e.g., cuttings dispersion modelling, underwater noise modelling) indicates that transboundary impacts are not anticipated owing to the area affected being relatively localised. The potential for transboundary air quality impacts from routine project activities is also negligible, owing to the transient, localised and relatively low volumes of such emissions.

Transboundary impacts are possible as a result of a large-scale accidental event. Modelling of spill scenarios show the potential for effects in the offshore waters and shorelines of Lebanon and Syria. The project risk assessment indicates that the chances of such an event happening during the Block 4 drilling campaign is considered very unlikely, in the order of one chance in ten thousand.

9.5 Management and implementation of mitigation measures

A commitments register has been compiled that lists mitigation identified in the EIA. These commitments have been tracked through to Environmental and Social Management Plans (ESMPs) developed for the drilling campaign.

TEP Liban's ESMPs are as follows:

- waste management plan
- chemicals management plan
- pollution prevention and environmental monitoring plan
- social management plan

- oil spill contingency plan

The ESMPs form the basis for subsequent detailed management plans prepared and implemented by TEP Liban's contractors who are required to comply with the relevant environmental and social requirements, specifications and procedures set out in TEP Liban ESMPs.

9.6 Conclusion

This EIA report has provided an assessment of environmental and social impacts associated with TEP Liban's offshore exploration drilling activities in Block 4.

Alternatives to proposed project activities have been considered and the proposed location of the B4-1 exploration well has been selected based on the most direct drilling route to promising hydrocarbon reserves. Drilling methods and type of drilling units will be designed specifically to operate in a deep-water environment, appropriate for Block 4. Drilling activities will be MARPOL 73/78 compliant, and the design and capacities of the MODU will include features for high-efficiency operation.

The location of the onshore project logistics base has been selected based on the principle of minimal disruption to existing infrastructure, with the Port of Beirut being the closest and most suitable choice offering the required capacities without further extending its footprint.

During the EIA, all applicable environmental and social receptors have been identified, their sensitivity towards proposed project activities assessed and mitigation measures proposed where impact avoidance was not feasible. All identified routine and accidental impacts in this EIA are expected to be manageable with acceptable residual effects after mitigation measures are in place.

The proposed offshore exploration drilling project proposed by TEP Liban is the first project of this type submitted for approval in Lebanon. If exploration is successful, it may have potential beneficial impacts on the national economy of Lebanon. A further EIA would be required for the production phase.

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