Environmental and Social Impact Assessment

Prepared for:

ENERGEAN OIL & GAS

Karish Development

December 2017

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Karish Development
Environmental and Social Impact Assessment

Energean Israel Ltd

December 2017

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1 INTRODUCTION

This ESIA Report has been prepared to meet the requirements of both international lenders and the Israeli EIS process. Per guidance received by the Ministry of Environmental Protection (MoEP) and the Ministry of Energy (MoE), their preference is to receive a document whose structure and scope is exactly as set out in 'Guidelines for the Preparation of the Environmental Impact Document in the Economic Waters for Development of Karish and Tanin fields (Leases I/17 and I/16)' (1). Because the scope of assessment is inherently different between Israeli and lender requirements, it is not possible to have a document that meets both sets of standards and also follows the report structure proposed by the ministries fully. For this reason, Energean has agreed with the ministries (2) to prepare an initial version of the ESIA Report (this version) that will meet the lender requirements, as well the majority of the content required by the ministries. When the results of the offshore Environmental Baseline Survey become available, likely in March 2018, Energean will update the ESIA Report and restructure to follow the ministry guidance and limited scope (e.g. exclude all content related to nearshore and onshore activities). This revised report will be the document that is used to fulfil the Israeli EIS process requirements.

This ESIA Report is structured as follows:

- *Section 1: Introduction* (Purpose of this report)
- *Section 2: Project Description* (A description of the project activities proposed)
- *Section 3: ESIA Project Standards* (What standards have been applied as part of the impact assessment process)
- *Section 4: ESIA Methodology* (The systematic approach has been used to evaluate potential impacts)
- *Section 5: Scope of the Assessment* (The area of influence of impacts from the project)
- *Section 6: Baseline Conditions* (A description of the current environmental and social conditions in the area of influence of the project)
- *Section 7: Stakeholder Engagement* (A summary of the consultation that has been conducted)
- *Section 8: Assessment of Potential Impacts* (The assessment of potential impacts and the mitigation measures that will be applied to manage them)
- *Section 9: Environmental and Social Management* (A summary of how the project will manage potential environmental and social impacts)

Annex A: Topic Specific Methodologies
Annex B: Alternatives Assessment
Annex C: Supporting Information on the Air Dispersion Modelling Conducted
Annex D: Environmental and Social Management Plan (ESMP)
Annex E: Stakeholder Engagement Plan (SEP)
Annex F: Oil Spill Modelling Report

(1) 'Guidelines for the Preparation of the Environmental Impact Document in the Economic Waters for Development of Karish and Tanin fields (Leases I/17 and I/16)', State of Israel, August 2, 2017.
(2) Meeting between Energean, MoE and MoEP in November 2017.

As a precursor to the restructured ESIA Report to just meet the Israeli scope, *Table 1.1* maps the content of this report against the elements required in ‘‘Guidelines for the Preparation of the Environmental Impact Document in the Economic Waters for Development of Karish and Tanin fields (Leases I/17 and I/16)’.

Table 1.1 Alignment with 'Guidelines for the Preparation of the Environmental Impact Document in the Economic Waters for Development of Karish and Tanin fields (Leases I/17 and I/16)'

Heading from the Guidelines	Heading from ESIA for Karish Development	Comments
1. Description of the current Marine Environment to which the Application relates	Section 6.2 - 6.3	Because the ESIA covers both the offshore and onshore environment, it is impossible to structure the chapter exactly as set out in the guidelines; however, Section 6, is structured to allow the reader to only focus on the offshore/coastal environment.
1.1. General	Section 6.1	
1.2. Boundaries of the application and area of influence	Section 5	Because area of influence is determined by considering both the receptors present and the project's activities, we feel that having a separate section for this useful.
1.3. Maps and orthophoto	Included throughout the relevant subsections of Section 6.2 and 6.3	
1.4. Geological, seismic and sedimentological characteristics	Section 6.2.3	
1.5. Geological hazards	Section 6.2.5 (deepwater) Section 6.3.1 (nearshore)	
1.6. Hydrodynamic regime	Section 6.2.4	
1.7. Nature and ecology values	Section 6.2.8 (deepwater) Section 6.3.3, 6.3.5	
1.8. Seawater and Sediment Quality	Section 6.2.6 (Seawater, deepwater) Section 6.2.7 (Sediment, deep water) Section 6.3.1 (Seawater and Sediment, nearshore)	
1.9. Culture and heritage sites	Section 6.3.4	
1.10. Meteorology and Air Quality	Section 6.2.1	
1.11. Noise	Section 2.5.3	
1.12. Infrastructure and marine transportation system	Section 6.4.5, Infrastructure and Public Services	
2. Location and Technology Alternatives and Reasons for Priority the proposed alternative	Section 2.9 and Annex B	The location alternatives assessment was included in the Scoping Report and will be attached as an Annex and referenced in Section 2.9. The Technology Alternatives have been evaluated through a Best Available Techniques (BAT) Assessment that will also be attached as an Annex and referenced in Section 2.9.
2.1. General	Section 2.9	
2.2. Location Alternatives	Annex B	
2.3. Technology Alternatives	Annex B, Appendix B1	
2.4. Summary	Section 2.9	
3. Description of the resulting actions from the	Generally Chapter 2	

implementation of the application		
3.1. General	Section 2.1 and 2.2	
3.2. Description of the Application	Section 2.1 and 2.2	
3.3. Noise and Light Hazards	Section 2.5.3	
3.4. Air quality	Section 2.5.1	
3.5. Hazardous materials	Section 2.5.5	
3.6. Streaming Sources to the sea	Section 2.5.2	
3.7. Geological and Seismic Risk Assessment	Section 2.10.3	
3.8. Waste	Section 2.5.4	
3.9. Infrastructure Abandonment and Dismantling	Section 2.4.8	
4. Assessment of expected environmental impacts due to the implementation of the application and measures to prevent / minimize them	Section 8	
4.1. Assessment of potential impacts on the marine environment	Section 8.2	
4.2. Environmental impacts of oil pollution incident according to extreme scenario	Section 8.12 and Annex F	An oil spill is an unplanned event, so it is covered as one of the events in the unplanned events section. A report summarising the detailed oil spill modelling that was conducted is attached as an Annex.
4.3. Light	Section 8.2.1. and Section 8.6.5	Potential impacts from light on marine fauna are captured in Section 8.2.1 and potential impacts from light on terrestrial fauna are captured in Section 8.6.5.
4.4. Noise	Section 8.2.2, Section 8.4 and Section 8.6.5	Potential impacts from noise on marine fauna are captured in Section 8.2.2, potential impacts from noise on people are captured in 8.4 and potential impacts from noise on terrestrial fauna are captured in Section 8.6.5.
4.5. Natural values and ecology	Section 8.2. and Section 8.6	Potential impacts on nature/ecology for the marine environment are presented in Section 8.2 and for the terrestrial environment in Section 8.6.
4.6. Cultural and heritage sites	Section 8.10	
4.7. Air quality	Section 8.3	
4.8. Waste	Section 8.11	
4.9. Hazardous substances	Section 8.12	The only potential impacts will be from unplanned spills, so this is covered in the unplanned events section.
4.10. Measures to reduce geological and seismic risks	Section 8.12	The only potential impacts will be from unplanned spills, so this is covered in the unplanned events section.
4.11. Fishing and Marine Agriculture	Section 8.7	
4.12. Safety and Protection	Section 2.10.2 and Section 8.8	Section 2.10.2 Covers occupational H&S measures and Section 8.8

		evaluates community health
4.13. Monitoring and Control Plan	Section 9 and Annex D	The ESMP (*Annex E*) is the primary document that sets out all of the monitoring that will be used.
4.14. Infrastructure Abandonment and Dismantling	Section 2.4.8	Because the field life is approximately 35 years, potential impacts from decommissioning, including infrastructure dismantlement and abandonment, cannot be accurately predicted. Additional, good practice measures for decommissioning may change within the next 35 years. For this reason, indicative measures have been included in Section 2.4.8; however, Energean will prepare a more detailed decommissioning plan that applies the latest good practice approach towards the end of the field life.
5. Proposed Instructions for Plan for Preservation and Prevention of Harm to the Environment of the Application	Section 9 and Annex D	The ESMP (Annex D) is the primary document that sets out all of the measures that will be used to mitigate the significant environmental and social impacts.

2 PROJECT DESCRIPTION

2.1 INTRODUCTION AND BACKGROUND

Energean secured the rights to the Karish and Tanin development leases in December 2016. These leases contain two existing discoveries as well as a number of additional undrilled exploration prospects.

- The Karish lease contains the Karish field (discovered by Noble in 2013, also referred to as 'Karish Main') and separate undrilled exploration prospects called Karish North and Karish East.

- The Tanin lease contains the Tanin field (discovered by Noble in 2012) and two smaller undrilled prospects located to the northeast of the Tanin field. The southwest of the Tanin field includes a significant hydrocarbon resource (C block).

In parallel to securing the leases, Energean has defined a scheme to develop the resources within them. Concept engineering for development commenced in January 2017 and a Field Development Plan (FDP) was submitted to the authorities in June 2017. The FDP covered both the Karish and Tanin fields.

The base case is to first develop the Karish field and then the Tanin field 7 to 15 years later. However, it is possible that the development of Tanin may be brought forward if the gas market develops; conversely Tanin may be delayed in the event that other discoveries made closer to Karish are developed in the interim period. For this reason, this ESIA, and therefore the description in this chapter, will focus on the base case development of the Karish Main field **only**. If and when additional fields or prospects are pursued, Energean will prepare separate ESIAs/EISs for these activities and the FDP for the Karish and Tanin Fields will be updated.

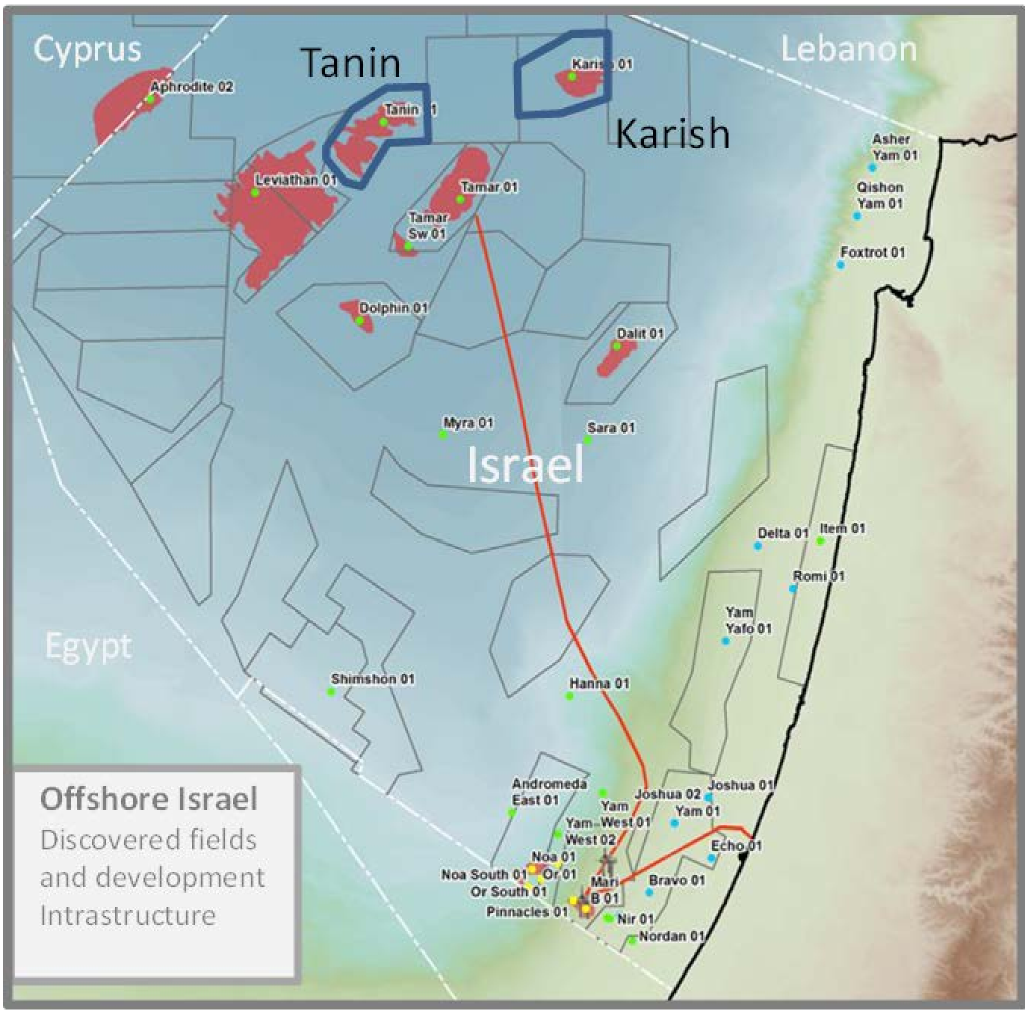
The base case of the development includes three production wells tied back to a Floating Production Storage and Offloading (FPSO) vessel with full offshore processing of the reservoir fluids. Conditioned gas will be exported to shore and will tie-in to the Israeli gas distribution grid (INGL) and the associated light oil will be exported offshore by tandem offloading to a shuttle tanker.

2.2 PROJECT OVERVIEW

2.2.1 *Location*

The location of the Karish Main field in relation to other oil and gas fields offshore Israel is shown in *Figure 2.1*. The field is approximately 75 km from shore in 1,700 m water depth and covers an area of approximately 42 km^2. The FPSO is planned to be located immediately south of the field (E 620305 m, N 3674670 m). The position of the FPSO has been selected taking into consideration known geohazards, bathymetry, mooring requirements and metocean data.

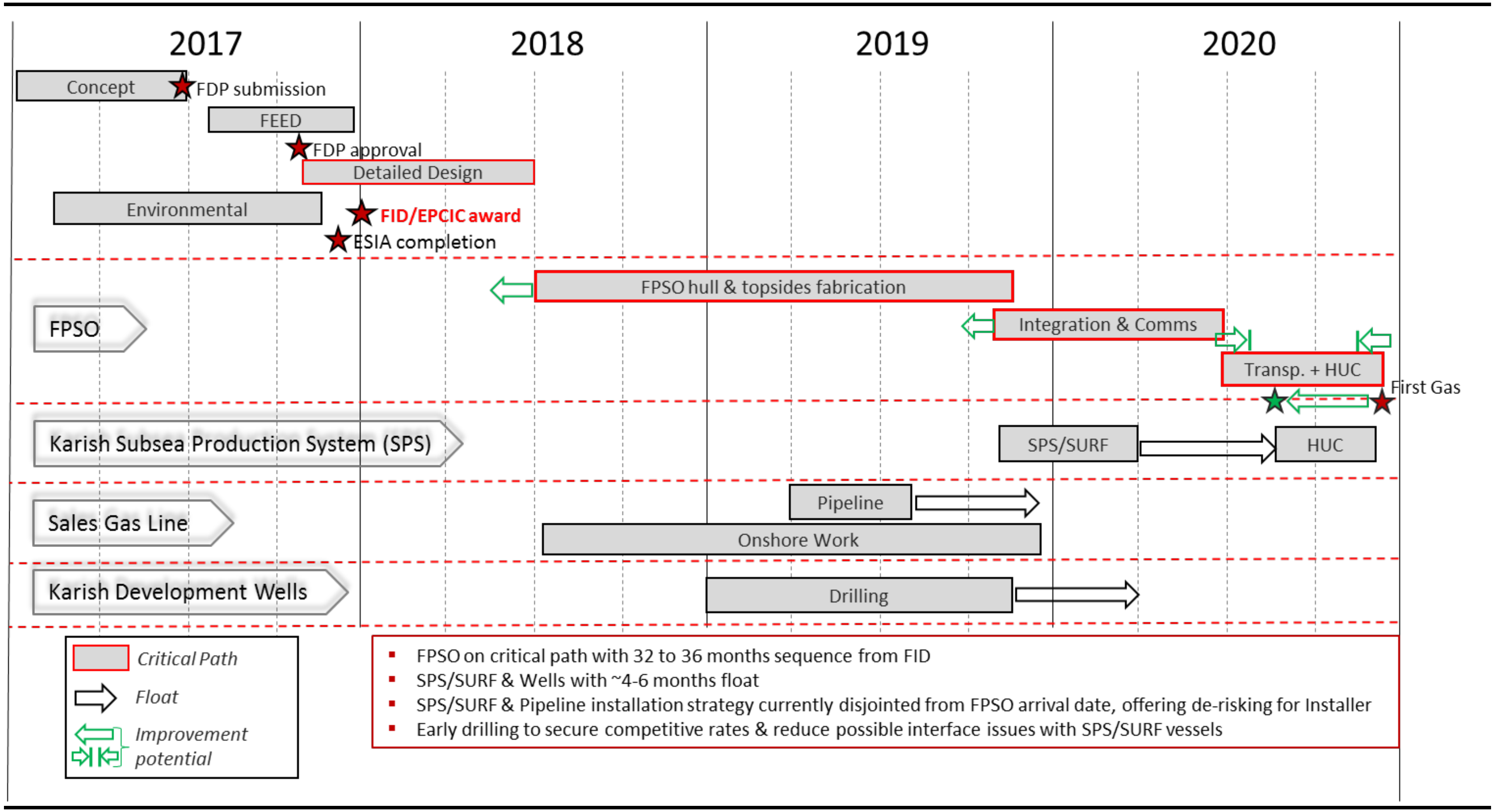
Figure 2.1 Offshore Israel Field Developments and Licence Blocks



2.2.2 ***Project Schedule***

A provisional schedule is provided in *Figure 2.2*, which assumes a target date for first gas is late 2020. The programme may change subject to detailed scheduling of fabrication times of the various elements and the availability of specialist vessels.

Figure 2.2 Provisional Schedule



2.2.3 *Production Rates*

The Karish Main field's average gas production rate is expected to be stable at approximately 400 MMscfd in Phase 1 and the average liquid hydrocarbon production rate at 6,900 barrels of oil per day (bpd). Should the Tanin field be developed in the future, gas production from Tanin is expected to be approximately 800 MMscfd in Phase 2.

The base case gas production profile assumes a flat 4 billion m^3/year; approximately 400 million scf/day. This will initially be produced from three wells completed for the C sand reservoir depth. After 10 to 15 years these initial wells will no longer be viable due to produced water content. At this point, the Karish C reservoir wells will be worked over and recompleted on the B reservoir (shallower). Consequently the production rate is expected to be approximately 100 million scf/day (with another 300 million scf/day production estimated from 2 to 3 wells in Tanin).

There is flexibility built into the production system to allow rates to increase above 4 billion m^3/year; however, production would only be increased if the market develops in Israel and additional gas volumes are identified in the Karish and Tanin Leases. The production system has been designed to allow production rates to be built up to 8 billion m^3/year given further gas discoveries and sales demand; however, any expansion of the production system or additional wells would be subject to further environmental impact studies.

2.3 KEY PROJECT COMPONENTS

The base case for the Karish Main development will be comprised of the following components:

- a new-build, spread moored Floating, Production, Storage and Offloading (FPSO) vessel located in approximately 1,700 water depth;
- a subsea production system including three new production wells (KM-1, KM-2 and KM-3), a single four-slot production manifold, spools, riser bases, umbilicals and infield flowlines;
- a new well at Karish North (KN-1) with subsea flowline to the Karish Manifold;
- a 90 km long 24" dry-gas export pipeline (increasing to 30" in the shallower water section) connecting to the existing national network (INGL) at an 'interface' located in approximately 60 m water depth;
- a Coastal Valve Station (CVS); and
- a new Dor Valve Station (DVS).

These components are illustrated in *Figure 2.3*. The INGL interface has been developed in order to allow 3rd party pipelines to tie-in to avoid construction of further nearshore or onshore pipelines and beach crossings.

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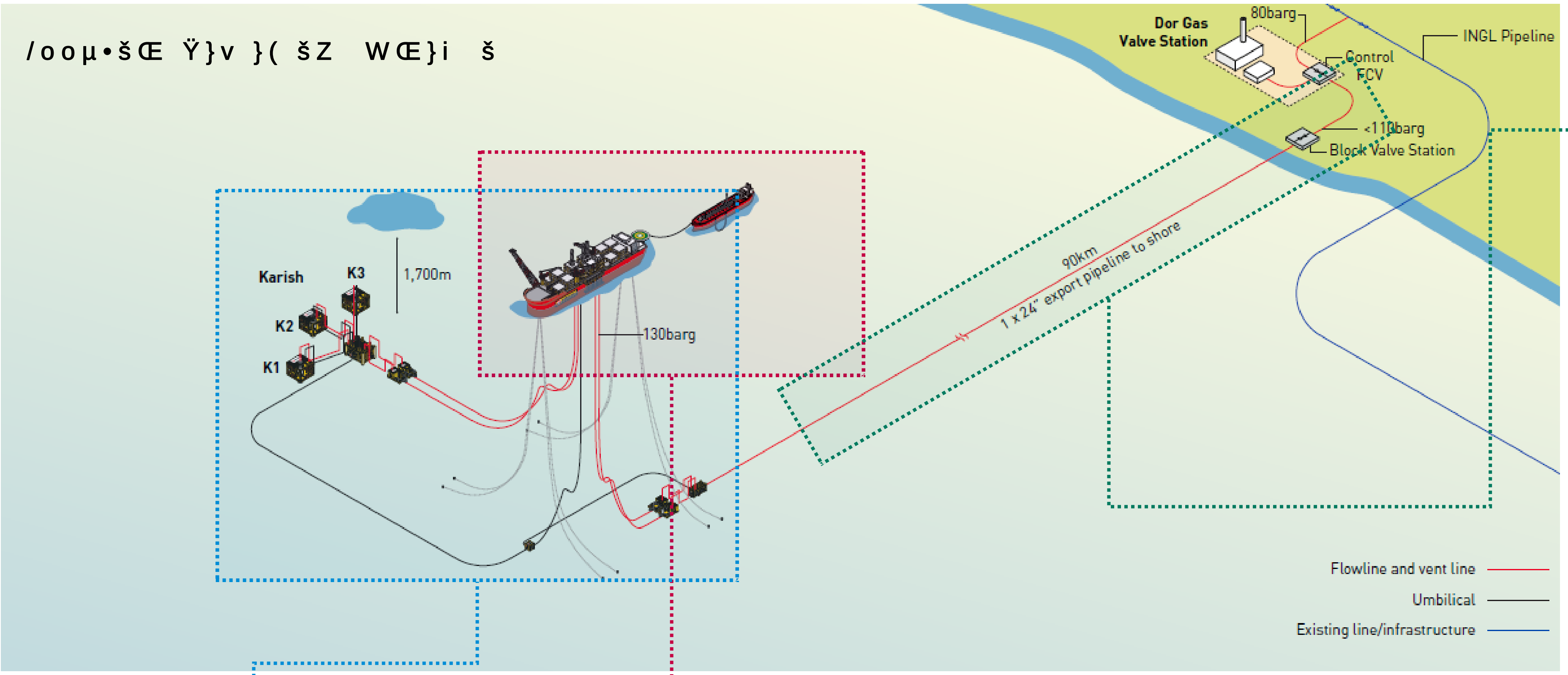

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2.3.1 *Subsea Production System*

The base case development will comprise an initial three well development drilled in the Karish Main (KM) reservoir namely KM-1, KM-2 and KM-3. These wells will be drilled from a single drill centre with deviated wells that will cluster around and be tied into a single, 4- slot manifold called the Karish Manifold. These tie-backs will be via multi-bore rigid horizontal spools.

Provision will also be made within the Karish Manifold for the future tie-back of one or more wells from the Karish North (KN) and Karish East (KE) exploration prospects should they be drilled as discoveries. At this stage tie-back of a single well drilled in the Karish North reservoir namely KN-1 is included as part of the base case development.

From the manifold, two 10" NB steel catenary risers will be installed in a lazy wave configuration. The risers will be installed with buoyancy modules and strakes. The risers will be terminated at the FPSO starboard balcony. A Pipeline End Termination (PLET) will be installed at the end of each riser with mono-bore spools connecting the risers to the manifold.

An umbilical will be installed from the starboard side FPSO balcony. The umbilical will supply the Karish Manifold with power, communications, hydraulics, and chemical injection facilities from the FPSO topsides. At the manifold the various umbilical cores will be distributed to the three initial KM wells via the multi-bore spools. Provision will also be made in the manifold for a future umbilical towards the KN-1 well.

2.3.2 ***FPSO***

Hull and Layout

The hull of the Karish FPSO will be a new-build based upon an existing design that has been classified by DNV-GL. The FPSO will have an overall length of 227 m and breadth of 50 m. It will have accommodation for a maximum of 120 persons on board (POB) during normal production operations. The accommodation will be positioned at the bow of the vessel and the flare at the stern, providing the maximum amount of separation which is not always possible with converted FPSO hulls.

The FPSO deck area is split into three sections of roughly equal dimensions. The third nearest the accommodation module will be for utilities, including power generation. The mid-ship will be dedicated to further growth opportunities and will essentially be empty at start-up. The gas and oil processing equipment will be located at the stern of the FPSO near to the associated risers.

Production risers will land on the northern (starboard) side of the FPSO; the more sheltered southern (port) side being used by supply vessels for routine operations. The development will comprise two risers to convey produced fluids from the subsea system to the FPSO and a dry-gas riser to convey sales gas from the FPSO to the sales gas export pipeline.

Figure 2.4 3D Illustration of the Karish FPSO

Topside Interface

The subsea control module will be supplied to be installed on the FPSO. The Master Control System (MCS) will be routed to the Subsea Power and Communication Unit (SPCU), Subsea Data Processing Unit (SDPU) and Hydraulic Power Unit (HPU). These units will be routed to the Topside Umbilical Termination Unit (TUTU) for distribution subsea.

Mooring

The mooring will consist of a 14 point spread moored system. The FPSO heading is 280° in an east-west direction. The mooring lines will be a combination of a chain top segment, polyester rope middle segment and a chain bottom segment connected to a suction pile anchor.

Processing

The FPSO topside processing capacities are provided in *Table 2.1.* Both Train 1 and Train 2 will be in operation from the start of production.

Table 2.1 FPSO Processing Capacities

Component	Train 1	with Train 2
Gas throughput	400 mmscf/day	800 mmscf/day
Topsides	400 mmscf/day	800 mmscf/day
Infield pipelines	400 mmscf/day	800 mmscf/day
Stabilised light oil	8,960 bpd	18,400 bpd
Produced water	2,000 bpd	4,000 bpd

The Karish Main fluids will be processed through a single gas and a single oil train. The gas processing train will comprise a two-stage Joule-Thomson process with Monoethylene Glycol (MEG) loop to prevent hydrate formation. The dry gas will be transferred to the sales pipeline system by two 100% capacity single stage compressors. The oil stabilisation train will comprise 4-stages of two-phase separation (gas/liquid) with associated flash gas recovery compression. Water/oil separation is performed in dedicated storage cells.

The flash gas generated during the oil stabilisation process is estimated to represent approximately 3% of the total gas. It will be compressed using an electrically driven 3-stage reciprocating engine. Approximately 50% of the compressed flash gas will be used as fuel gas and the remaining will be sent to the dry gas pipeline system.

Storage

The FPSO hull includes storage capability for bulks, including diesel fuel, potable water, Rich and Lean MEG. The FPSO storage capacities are provided in *Table 2.2*.

Table 2.2 FPSO Storage Capacities

Tank	Capacity
Cargo	127,120 m^3 (800,000 bbl)
Topside	15,000 tonnes
Produced water	15,890 m^3 (100,000 bbl)
Slop tank	2,884 m^3
Fuel oil	3,034 m^3
Fresh water	1,105 m^3

The FPSO's oil storage will be located in 15 storage tanks (also referred to as 'cells') built into the hull. These will be used as follows.

- export crude in five central tanks, ready for offload to an export / sales tanker.
- crude undergoing final polishing (water removal) in four side tanks.
- mixed crude / water discharged at 10 psi from the topside crude stabilisation system. Water and crude will be separated by gravity, with crude extracted via the bottom of the tank.
- produced water undergoing final polishing (oil removal). This water will either be recycled back into the processing system, to the oil-centrifuge package or pumped over board if it meets the discharge specification.

Storage for MEG, diesel, slops from machinery spaces and open drains, etc. will also be provided in the hull. Ballast tanks will be provided between the skins of the double hull (side and bottom).

Flare

The flare system consists of a high pressure (HP) and a low pressure (LP) flare system to protect the topsides. Atmospheric vents are provided for the disposal of non-hydrocarbon vapours.

Short term flaring is anticipated during start-up, shutdown and some upset conditions. However, there will be no routine discharge of production hydrocarbons to the flare or vent. There will be a continuous low-level purge of the flare headers and flare tips with hydrocarbon gas to ensure the flare system remains lit in all weather conditions.

Power Generation

The FPSO power will be provided by a central power plant (CCP) including three dual fuel (fuel gas and diesel) turbines and Waste Heat Recovery Units (WHRUs) for heat supply to FPSO heating medium. The CPP shall provide all electrical power generation and distribution to support the process, utility, subsea and hull requirements over the design life of the field.

The CCP will normally be supplied by the fuel gas system and the facility to run on diesel fuel is available should there be no fuel gas available.

Cooling System

A closed-circuit inhibited-freshwater cooling system will provide all cooling to the topsides. The water in the closed-circuit will be cooled indirectly by seawater lifted from approximately 80 m below the sea surface. This seawater will be lifted using seawater lift pumps, electro-chlorinated to treat seawater of bacteria and marine growth, and coarse filtered to remove large particles prior to being supplied to the cooling system via the seawater distribution system.

Utilities

Utilities are sized for a production capacity of 800 mmscf/day. The main features include:

- a closed-loop hot-oil heating medium system with energy recovery from the main power generation turbines;
- a closed-loop fresh-water cooling medium system; and
- a centralised hydraulic power system to support the cargo pump system.

2.3.3 *Gas Sales System*

The gas sales pipeline will consist of a single 16” NB steel catenary riser installed from the port side FPSO balcony to the PLET, in a lazy wave configuration. The riser will be installed with buoyancy modules, strakes and a Flex Joint which forms the topside battery limit of the sales gas riser system. A Subsea Insolation Valve (SSIV) will be installed subsea with the provision for a future 16” riser tie-in.

Rigid mono-bore spools shall be used to connect the SSIV to the 16” NB PLET and the 24” NB PLET. A dedicated umbilical will be installed from the portside FPSO balcony, where the umbilical will be terminated at a TUTU. This umbilical will provide the means for controlling the SSIV from the FPSO topsides.

The equipment will be supported by skirted mud mats unless suction piles are required because of sediment conditions.

A 24” NB gas sales pipeline will be routed towards shore and the DVS for notionally 79.2 km. The line is split into the following three sections.

- **Deep water section:** Approximately 80 km long from the riser base structure up to the planned INGL “interface facility” location, located within 60 to 100 m water depth. This section of the line will be 24” until it passes on to the continental shelf and then increase to 30” diameter. The exact location of the diameter change has yet to be confirmed.

- **INGL-owned shallow water section:** Approximately 10 km long up to the coastal valve station (CVS) and including the beach crossing. This section of the line will be 30” (ND). The “interface facility” will be a manifold that allows for third party suppliers to access the shallow water section at approximately 10 km from shore. Ownership of this section will be transferred to INGL post commissioning and start-up.

- **Onshore section:** Approximately 1.4 km long from the CVS to the DVS through a corridor delineated by the TAMA 37/H. The pipeline will be trenched and buried for the entire route between the 2 valve stations including two major crossings: the Haifa-Tel Aviv railway and the Coastal Highway 2. This line section will be 30” ND. This section will be built by Energean and then transferred to INGL during the operations phase (production).

2.3.4 *Coastal Valve Station*

The Coastal Valve Station (CVS) will be equipped with minimal facilities to maximise the ability to isolate the onshore and offshore sections in case of emergency situations. The CVS will comprise an isolation valve, manual valves and bypasses, external power and communication links.

2.3.5 *Dor Valve Station*

The Dor Valve Station (DVS) will have pig reception/launching capabilities. It will provide process flow metering and a control valve that can be used to either manage flow of dry-gas into the INGL transmission system or the pressure upstream of this valve. Two gas heaters are provided for final gas conditioning when required, to satisfy the final gas temperature specification and the predicted pressure drop over the flow/pressure control valve.

2.4 MAIN PROJECT ACTIVITIES

2.4.1 *Overview*

Project activities are divided into the following phases:

- fabrication;
- drilling and completions;
- offshore installation;
- onshore construction;
- pre-commissioning and commissioning;
- production; and
- decommissioning.

These phases are described in the following sections.

2.4.2 *Fabrication*

The FPSO hull will likely be fabricated in a major shipyard in China and the FPSO topsides modules fabricated in Singapore. Integration of the FPSO hull and topsides and onshore commissioning will also take place in Singapore. The pipeline sections will also be manufactured outside of Israel.

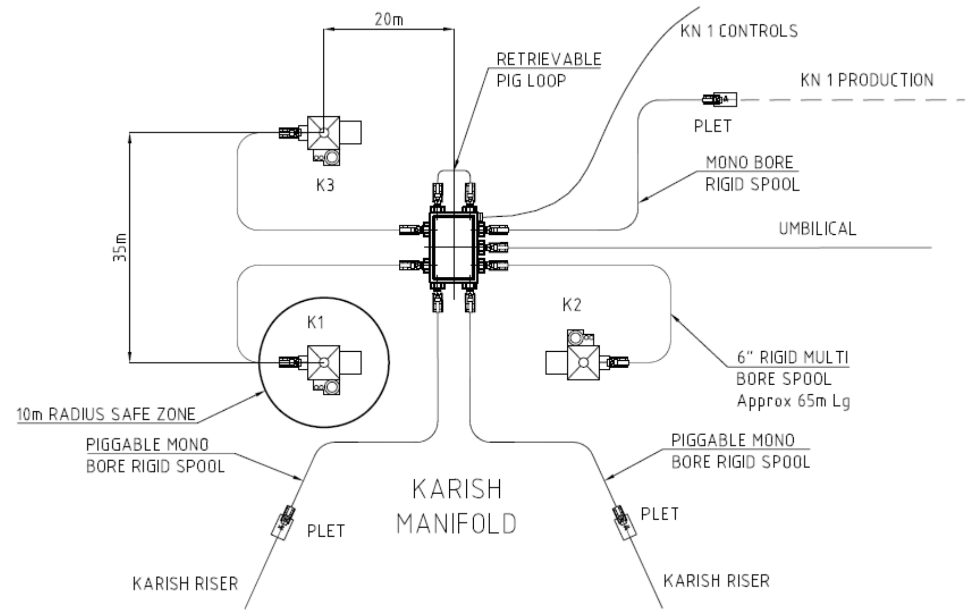
Note: these fabrication facilities are not considered within the area of influence per IFC Performance Standard 1; however, they will be considered primary supply chain facilities per IFC Performance Standard 2.

2.4.3 *Drilling and Completion*

Well Design and Schedule

The new production wells will be drilled from a single drill centre. *Figure 2.5* illustrates the well locations next to the Karish manifold. The target depth will be approximately 4,500 m below the seabed. An FMC EHXT (Enhanced Horizontal Christmas Tree) and blowout preventer (BOP) will be installed on top of the wells during drilling and well completion activities. Each well will comprise a number of intervals ('well sections') of varying diameter and length.

Figure 2.5 Well Layout in relation to the Karish Manifold



Drillship

Drillships are either purpose built or heavily modified vessels that contain all of the equipment normally found on a conventional offshore drilling rig. A specific drillship has not yet been contracted; however, one likely option is the Stena Forth. The Stena Forth was built in 2009. As the drillship activities and emissions are not dependent on the specific vessel design, this ESIA has assumed that the Stena Forth is a representative case of the drillship to be used. A single drillship is required and the wells will be drilled by batching similar phases of operations on all three wells to provide increased efficiencies and performance.

The drillship will enter Israeli waters using its own engines. Given that a drillship has not been identified at this stage the location of its previous assignment is unknown. However, it is likely to come from the same marine area (i.e. within the Mediterranean Basin or Black Sea) and will take all necessary precautions to prevent the transport of potentially invasive species.

The drillship will remain on station during drilling using a system of dynamic positioning (DPS-3) rather than being fixed or anchored to the seabed. Thrusters and propellers will be controlled by a computer system to automatically maintain position and compensate for wind and wave action.

The equipment on board the drillship, including waste incinerator and slops oil in water separators, will comply with the requirements of the International Convention for the Prevention of Pollution from Ships 1973, as amended by the Protocol of 1978 (MARPOL 73/78).

Figure 2.6 Drillship (Stena Forth as Indicative Vessel)

Supplies and spent materials will be transported between the selected onshore logistics base at the port of Haifa and the drillship using supply vessels, such as the MV Ocean Endeavour and MV Rig Supporter.

No dedicated security vessels are envisaged. Crew transfers will be by crew-boat and helicopter.

Drilling Process and Schedule

Before drilling commences, the drillship will undertake several pre-drill activities including establishing a safety exclusion zone and inspection of the drill centre by a remotely operated vehicle (ROV).

The drilling process is summarised in *Figure 2.9* and involves:

- spudding and drilling of initial well sections including cementing of surface casings;
- discharge of drilling fluids and cuttings to the seabed (for the initial well sections);
- installation of the Blow Out Preventer (BOP) and attaching the marine riser to allow for the circulation of drilling fluids and cuttings between the drillship and well;
- drilling of the remaining well sections including running and cementing the intermediate and lower casings and production liners; and
- cuttings disposal will be via a cuttings chute into the sea.

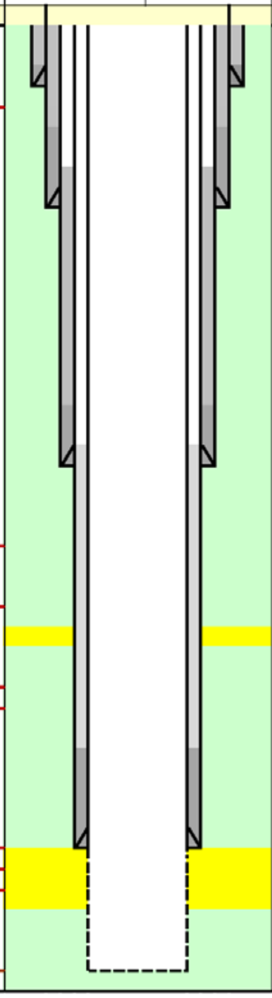
A BOP is installed onto the well(s) to prevent uncontrolled flow of gas from the reservoir. BOPs typically consist of a series of rams (pipe, blind, shear and blind shear) that extend toward the centre of the wellbore to prevent flow during emergency situations.

Figure 2.7 illustrates the generic well design for the wells including the depth of each of the sections, target formations, casing sizes, cement and mud type.

Figure 2.7 Well Design

Casing / Liner Details							
Size	Wgt (lbs)	Grade	Connection	Drift (in)	Cement Wt/Type Planned TOC	Mud Weight / Type	FIT / LOT (ppg)
36"	552.6	X56	TBC	28.88	Class G / Seabed	Seawater and sweeps	NA
21" 15ft ext joint x 20"*	21" 263 20" 147	K55	TSH Blue QS	18.5 18	Class G/ Seabed	Seawater and sweeps	12.0 LOT
13 5/8"	88.2	Q125	TSH Blue	12.375	Class G / Top Salt	11.4 / SS WBM	12.4 LOT
9 5/8"	53.5	Q125 / TN125Cr13S	TSH Blue	8.535	Class G /~3000m TVD	11.7 / SS WBM	13.2 LOT

Formation	TVD SS m	MD BRT
Top Evaporite/Salt	2108	
Base Salt	3555	
Tortonian Sands	3577-3751	
Serravallian Hard Stre	4130	
Mid Miocene UC	4200	
A Sand	4316	
B Sand	4381	
C Sand	4436	
Well TD	4476	
D Sand	4574	



Description	m MD BRT	m TVD ss
36" Shoe	1834	1810
20" Tail TOC	2460	2428
(150 m above shoe)		
13 5/8" Lead TOC		2108
20" Shoe	2602	2578
26" Rathole	2605	2581
13 5/8" Tail TOC		2990
(150 m above shoe)		
9-5/8" Lead TOC		3040
13 5/8" Shoe		3140
17 1/2" Rathole		3143
(150 m above shoe)		
9 5/8" Tail TOC		4169
(150 m above shoe)		
9 5/8" Shoe		4319
12-1/4" Rathole		4322

Figure 2.8 estimates the length of time to drill each interval assuming there are no delays to drilling operations. This estimate could increase if bad weather conditions are encountered.

Figure 2.8 Estimated Drilling Times for Well Drilling

<table>
<tr><th>WELL 1</th><th>WELL 2</th><th>WELL 3</th><th>TOTAL DAYS</th></tr>
<tr><td colspan="3">TRANSIT TO LOCATION</td><td>14</td></tr>
<tr><td colspan="3">PREPARE TO SPUD</td><td>17</td></tr>
<tr><td>JET CONDUCTOR, DRILL 26", RUN & CMT 20"</td><td></td><td></td><td>22</td></tr>
<tr><td></td><td>JET CONDUCTOR, DRILL 26", RUN & CMT 20"</td><td></td><td>27</td></tr>
<tr><td></td><td></td><td>JET CONDUCTOR, DRILL 26", RUN & CMT 20"</td><td>32</td></tr>
<tr><td colspan="3">RUN BOP & RISER</td><td>33</td></tr>
<tr><td>DRILL 17.1/2", RUN 13.5/8" CSG</td><td></td><td></td><td>40</td></tr>
<tr><td>DRILL 12.1/4" PILOT HOLE - 2X CORE RUNS, WIRELINE, P&A.</td><td></td><td></td><td>64</td></tr>
<tr><td>DRILL 12.1/4", RUN 9.5/8" CSG</td><td></td><td></td><td>76</td></tr>
<tr><td colspan="3">HOP BOP & TEST</td><td>77</td></tr>
<tr><td></td><td>DRILL 17.1/2", RUN 13.5/8" CSG</td><td></td><td>85</td></tr>
<tr><td></td><td>DRILL 12.1/4" PILOT HOLE - WIRELINE, P&A.</td><td></td><td>85</td></tr>
<tr><td></td><td>DRILL 12.1/4", RUN 9.5/8" CSG</td><td></td><td>97</td></tr>
<tr><td colspan="3">HOP BOP & TEST</td><td>98</td></tr>
<tr><td></td><td></td><td>DRILL 17.1/2", RUN 13.5/8" CSG</td><td>105</td></tr>
<tr><td></td><td></td><td>DRILL 12.1/4" PILOT HOLE - WIRELINE, P&A.</td><td>105</td></tr>
<tr><td></td><td></td><td>DRILL 12.1/4", RUN 9.5/8" CSG</td><td>117</td></tr>
<tr><td colspan="3">UNLATCH BOP</td><td>118</td></tr>
<tr><td></td><td></td><td>RUN EHXT & LAND BOP</td><td>120</td></tr>
<tr><td></td><td></td><td>DRILL 8.1/2" X 12.1/4"</td><td>128</td></tr>
<tr><td></td><td></td><td>RUN & INSTALL LOWER COMPLETION</td><td>136</td></tr>
<tr><td colspan="3">UNLATCH BOP</td><td>137</td></tr>
<tr><td></td><td>RUN EHXT & LAND BOP</td><td></td><td>140</td></tr>
<tr><td></td><td>DRILL 8.1/2" X 12.1/4"</td><td></td><td>148</td></tr>
<tr><td></td><td>RUN & INSTALL LOWER COMPLETION</td><td></td><td>156</td></tr>
<tr><td colspan="3">UNLATCH BOP</td><td>157</td></tr>
<tr><td>RUN EHXT & LAND BOP</td><td></td><td></td><td>159</td></tr>
<tr><td>DRILL 8.1/2" X 12.1/4"</td><td></td><td></td><td>167</td></tr>
<tr><td>RUN & INSTALL LOWER COMPLETION</td><td></td><td></td><td>174</td></tr>
<tr><td>RUN & INSTALL UPPER COMPLETION</td><td></td><td></td><td>180</td></tr>
<tr><td>WELL TEST FLOW TO CLEAN-UP</td><td></td><td></td><td>184</td></tr>
<tr><td colspan="3">SUSPEND &</td><td>186</td></tr>
<tr><td></td><td>RUN & INSTALL UPPER COMPLETION</td><td></td><td>192</td></tr>
<tr><td></td><td>WELL TEST FLOW TO CLEAN-UP</td><td></td><td>196</td></tr>
<tr><td colspan="3">SUSPEND &</td><td>198</td></tr>
<tr><td></td><td></td><td>RUN & INSTALL UPPER COMPLETION</td><td>203</td></tr>
<tr><td></td><td></td><td>WELL TEST FLOW TO CLEAN-UP</td><td>208</td></tr>
<tr><td colspan="3">SUSPEND &</td><td>210</td></tr>
<tr><td colspan="3">MOVE OFF LOCATION</td><td>211</td></tr>
<tr><td colspan="3">Contingency</td><td>42</td></tr>
<tr><td colspan="3">Total</td><td>253</td></tr>
</table>

Drilling Fluids

Drilling fluids are formulated according to the well design and geological conditions anticipated in the formation. The exact mix of the drilling fluid is therefore specific to each well. Drilling fluids comprise a base fluid, weighting agents and a variety of chemicals that are used to give it the properties required to make drilling as safe, efficient and problem-free as possible. Drilling fluids have several functions including:

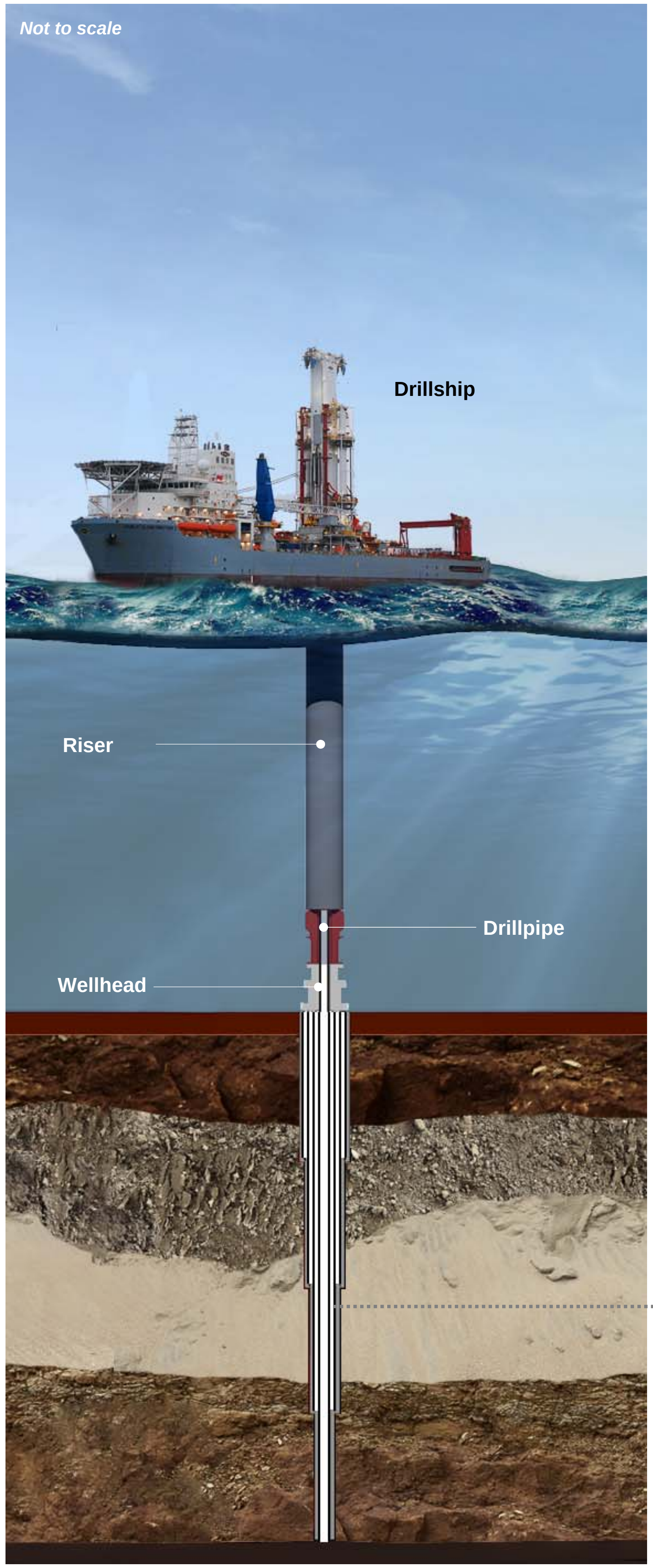
- removing cuttings from the hole as they are produced;
- providing a barrier for well control;
- transmission of power to the drill bit;
- cooling and lubricating the drill bit; and
- maintaining formation stability.

The drilling fluids will be pumped down the drill string and out through the bit. The fluids and cuttings will then be circulated up the annulus (the void between the drill string and the casing) back to the drillship where they will be separated, thereby allowing re-use of the fluids in the drilling process. During this process the drilling mud becomes contaminated with fine drilled cuttings, which need to be removed by the onboard treatment unit.

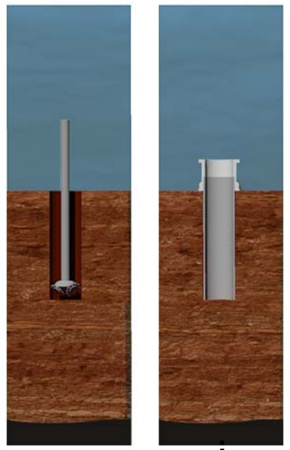
There are typically two types of muds used for drilling: water-based muds (WBMs) and non-aqueous (i.e. oil based muds). Only WBMs will be used for the development, which are primarily (approximately 75%) made up of water. Bentonite clay and barium sulphate (barite) are added to control viscosity and mud density respectively. Other substances are added to produce the required drilling properties, for example, viscosifiers, thinners, filtration control agents and lubrication agents. The constituents of WBMs are essentially non-toxic and studies [(1)] have shown that the chemical effect on marine life is slight to none when drill cuttings generated with WBMs are discharged overboard. The vast majority of spent WBMs discharged are classified under Annex 6 of the OSPAR Convention [(2)] as substances which are considered to 'Pose Little Or No Risk' to the environment (PLONOR chemicals).

(1) E&P Forum Report 2.72/254, 1997. Environmental management in oil and gas exploration and production – An overview of issues and management approaches.
(2) The Convention for the Protection of the Marine Environment of the North-East Atlantic, known as the 'OSPAR Convention'

Subsea Drilling Overview

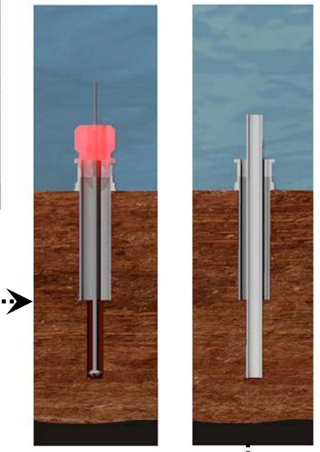


Subsea Drilling Process



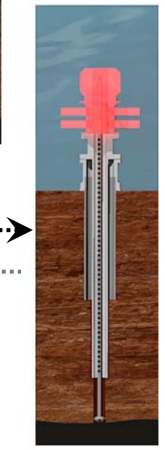
First Stage

The first stage in drilling (known as 'spudding') is to place the largest diameter casing into the seabed. This conductor casing, together with the surface casing, provides the support for subsequent stages of the well and drilling continues once it is in place. Initial sections of the well are jetted/drilled with sea water and returns are released to the seabed.



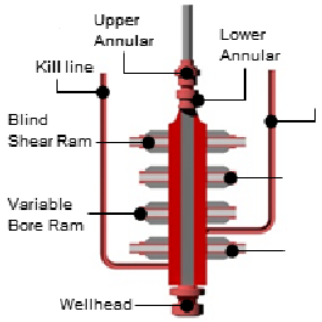
Second Stage

Once the initial sections of the well have been drilled and the steel casing cemented into place down the hole, the BOP is secured on top of the wellhead. As well as providing containment for the well in the case of an emergency or abnormal event, installing the BOP allows a riser to be set between the top of the well and the drillship, through which the drilling fluids and drilling cuttings are returned.



Final Stage

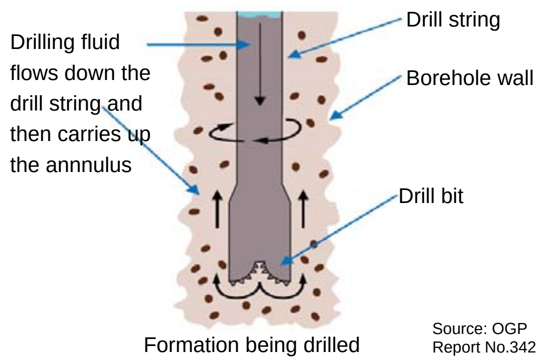
Drilling continues using a series of progressively smaller diameter drill bits and casings as the well is drilled deeper. The casings are lowered down the hole through the previous larger diameter casing section and cemented into place.



Blow out Preventers (BOPs) are designed to 'shut in' a well by means of rams and annular preventers that physically close off the well aperture.

Drilling Fluids and Cuttings

The rotating drill bit breaks off small pieces of rock (called drill cuttings) as it penetrates rock strata. Drilling fluids (also called drilling muds) are pumped down the drill string during drilling to maintain positive pressure in the well, cool and lubricate the drill bit, protect and support the exposed formations in the well and to lift the cuttings from the bottom of the hole to the surface.



Drilling fluid contains various solids and additives used to control the fluid's functional properties such as density.

The composition of the drill muds will be largely dependent on location-specific conditions. Depending on the subsurface properties encountered, the Project will utilise only water-based muds (WBM) during drilling. Once the BOP is in place, the drilling fluids will be routed to the drillship for treatment.

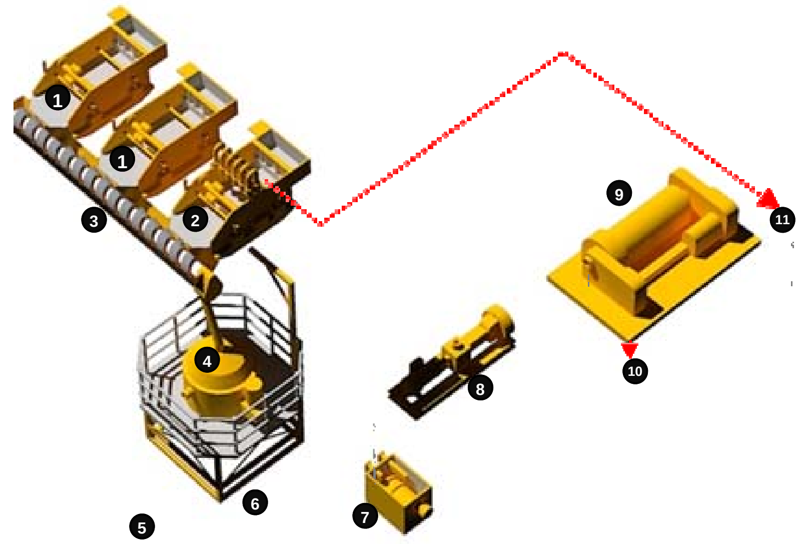
Drill Cuttings Treatment

Shale Shakers, Centrifuge and Dryer

The drillship will be equipped with a drill cutting treatment system. As the specific drillship to be used is not yet fixed, the treatment system illustrated here is considered as indicative.

This example drillship is equipped with shale shakers, centrifuge and dryer equipment for cuttings treatment.

The Karish development will be drilled with water based drilling fluids to allow discharge of drill cuttings on location after separation from the drilling fluid.



1. Flow-line shaker
2. Mud cleaner
3. Screw conveyor
4. Cuttings dryer
5. Cuttings discharge
6. Recovered mud
7. Catch tank
8. Centrifuge feed pump
9. Centrifuge
10. Solids discharge
11. Clean mud to active

Figure 2.9 Overview of the Drilling Process

Size: A3

Date: Feb 2016

Environmental Resources Management
2nd Floor, Exchequer Court
33 St Mary Axe
London, EC3A 8AA
United Kingdom

Well Completions and Testing

After wells have been drilled a process known as completion is undertaken to prepare the wells for their operational function and to install a number of safety and operational controls. However, before the wells are completed each of them will be cleaned and suspended with completion fluid. Well testing will comprise unloading and clean-up to remove as much of the completion fluid and debris from the well as practical, and testing of the formation properties and initial gas rate potential. The unloading and clean-up will last for between 12 and 24 hours and the testing for approximately 18 hours.

The lower completion design is planned to be single-zone, conventional water packed, Open Hole Gravel Packs (OHGP) completions with the C Sand as the primary target. The B Sand will be targeted later and the wells re-completed with a single zone Cased Hole Gravel Pack (CHGP). The D Sand package(s) will be logged and evaluated for further assessment. It is envisaged that the D sand volumes will be produced whilst producing the C volumes due to the presence of many faults that are not expected to seal. The OHGP design is a continuation of the highly engineered and successful Tamar design, which was implemented offshore Israel in 2012.

The upper completion design will include two segments. The upper segment will be equipped with a surface controlled subsurface safety valve (SCSSV) and a chemical injection mandrel (CIM) just below for the injection of scale inhibition. The lower segment will be equipped with a downhole permanent pressure and temperature (DHPT) gauge for real-time downhole surveillance. A CIM is provided at the Christmas Trees for injecting MEG into the flowlines between the production wing valve and the choke valves.

Well Clean-up Flow

Well clean-up will be via an initial flow through the drillship rather than waiting until the FPSO and subsea facilities are installed and commissioned.

Workovers and Re-Completions: Later B Development

Initially the wells will produce from the C reservoir. After this zone is depleted, the wells will be worked over (expected after 10 to 15 years) to isolate the C section and perforate the shallower B reservoir. The wells will be equipped with an internal gravel pack and smaller production string.

2.4.4 *Offshore Installation*

The number and type of vessels operating offshore will vary during the installation phase. The name, type and purpose of indicative project vessels are listed in *Table 2.3*.

Table 2.3 Indicative Installation Vessels

Name	Type	Purpose
Global 1200	Pipelaying vessel	Dry-gas export pipeline and spool installation, tie-ins, pre-commissioning
Deep Blue	Reel lay vessel	Production riser installation
Skandi Africa	Construction vessel	Umbilical installation, manifold installation

Name	Type	Purpose
EDT M/V EAS	Survey vessel	Survey vessel
Severn Guardian	Nearshore survey vessel	Survey vessel
Odin Viking	Anchor handling tug	Anchor handling, FPSO installation
Sea Panther	Anchor handling tug	Anchor handling, FPSO installation
NOR Captain	Anchor handling tug	Anchor handling, FPSO installation
Maersk Frontier	Supply vessel	Survey vessel
N/A	3 x 300” cargo barge	Transport of materials nearshore
N/A	Dredging vessel	Nearshore dredging

FPSO

The FPSO will be towed between the construction shipyard, a pre-commissioning site and the Karish Main field by anchor handling tugs. Two tugs will be required to manoeuvre the FPSO with one in reserve. The indicative tugs will be the Odin Viking, Sea Panther and NOR Captain. The former two are pictured in *Figure 2.10*.

Prior to the FPSO arriving in field, the first step will be to install four mooring clusters positioned approximately 2 km from the FPSO location. Each of the mooring clusters will comprise suction piles, chain, polyester rope and spiral wire strand. A support buoy will support each segment prior to the FPSO hook-up.

Once the FPSO has arrived in the Karish Main field it will be hooked up to the mooring system by the Skandi Africa. The vessel will pick up the upper end of the preinstalled mooring segments and move toward the FPSO before passing the mooring wire to the FPSO. Winches onboard the FPSO will then be used to pull in the mooring wire until the desired tension is achieved.

Figure 2.10 Indicative Anchor Handling Tugs

Sea Panther *Odin Viking*

Subsea Production System

A pre-installation survey will be performed prior to installation.

The subsea equipment will be installed using a DP construction vessel, the Skandi Africa. A geophysical and geotechnical survey will be conducted prior to mobilisation of the construction vessels to locate areas on the seabed to avoid and understand the seabed conditions, which will determine the types of fixtures that will be used. The current understanding is that only the manifold will be installed on suction piles. The rest of the equipment will be supported using skirted mud mats.

The Skandi Africa will install the Karish manifold using separate single point lifts for the foundation and module. The foundation will first be installed and secured to the seabed using suction pules before the module is lowered into position and connected. The manifold will be equipped with lifting hooks and ROV operable latches for tie-ins. The suction piles are expected to penetrate approximately 3 m below the seafloor depending on the strength of the sediments. The Skandi Africa will also lower the riser bases and pipeline end terminals (PLETs) to the seabed and secure them on mud mats.

Installation of the flowlines and spools will be performed using a pipelay vessel, the Global 1200. The wells will first be connected using spools to the Karish manifold and then the manifold to the PLETs. The flowlines between the PLETs and the riser bases will be laid in a direction towards the FPSO.

The umbilicals will be installed by the Skandi Africa. Each umbilical will be installed using a carousel and a tiltable lay system.

The risers will be installed by the Deep Blue. The risers will be wet stored until the FPSO has arrived in field, so concrete mattresses will be installed to protect the Flex joint whilst on the seabed. Installation will begin by welding the first end PLET onto the riser. The PLET will then be over boarded and secured to the seabed using a suction pile. The Deep Blue will move forward laying out the riser, installing strakes and buoyancy modules as required. At the end of the pipe the Flex Joint will upended and welded to the pipe. The A&R winch will connect to the Flex joint for over boarding and the Flex joint abandoned on the pre-installed concrete mattresses. Once the FPSO has been hooked up, the Skandi Arctic will recover the risers for hook-up. Winches onboard the FPSO will be used to pull the risers in to place to complete the installation.

During the installation several vessels will operate between the Karish Main field and Haifa, transporting equipment to be installed and also conducting crew transfers.

Figure 2.11 Installation Vessels

Skandi Arctic (TechnipFMC)

North Sea Atlantic (TechnipFMC)

Deep Blue (TechnipFMC)

Gas Export System – Deep and Shallow Water

The dry-gas export pipeline will be installed from the FPSO to approximately 120 m water depth by the Global 1200. Another vessel may be used in shallower waters. The Global 1200 will be supported by a spread of anchor handling tugs and supply vessels. A separate vessel will be mobilised to install concrete mattresses should any cable crossing locations be identified along the route.

Installation of pipeline will be performed using the S-laying technique. This method is named after the profile of the pipe as it moves across the bow or stern of the pipelay vessel and onto the seabed. The pipeline sections will be delivered to the Global 1200 by pipelay barges, where they will be assembled into a continuous pipeline and lowered to the seabed. The lay rate is dependent on the weather conditions, water depth and thickness of the pipe but is expected to be about 2.5 km per day. Rock dumping will be used to level some areas of seabed to prevent 'free spans' and also to provide the pipeline with some protection in shallower waters. Upon completion of the pipelay, the Global 1200 will perform an as-laid survey of the pipeline, which will identify and measure any areas of free spans that exceed the allowable limits. The shallower water section will be surveyed by a shallow water vessel.

The INGL interface manifold will be installed on the seabed at 60 m water depth, which is approximately 10 km from shore.

The shallow water pipeline vessel will lay to a water depth of 120 m (see *Section 2.4.5*) where the Global 1200 will recover the abandoned pipe and continuing laying towards the FPSO location. At the termination point the PLET will be installed. An ROV will be used to monitor the position of the pipe during lay.

The Skandi Arctic will be responsible for the installation of the umbilical and SSIV associated with the sales gas export pipeline. Similar to the Karish Main risers, the gas export riser will be installed by the Deep Blue.

Gas Export System – Nearshore

The base case for the nearshore pipeline between the coastline and approximately 10 to 12 m water depth is to be placed in a tunnel. From the tunnel exit location for approximately 200 m the pipeline will be covered by rock dumping to achieve 1.2 m cover as per TAMA 37/H. The pipeline will then be trenched and backfilled for a further 7.5 km to achieve 1.2 m cover as per TAMA 37/H. Cross sections for the microtunnel and nearshore sections are provided in *Figure 2.12* and *Figure 2.13* respectively.

The tunnel will be drilled using a microtunnelling machine. The microtunnelling will start at an onshore location close to the CVS, and progress in a catenary to a point where it breaks the seabed at an approximately horizontal orientation (expected to be approximately 20 m water depth). The length of the borehole is dependent on the microtunnelling equipment used plus the stability of the ground at the exit location but is estimated to be about 1.1 km.

After the microtunnel is completed, the pipeline will be passed through it. This will be achieved by pulling a pipeline laid offshore through the borehole using a winch placed onshore. Alternatively, the line can be fabricated onshore and pushed through the borehole where it is picked up by the shallow water barge. The base case assumes that the pipeline will be pulled through the borehole from offshore. To support this activity a concrete foundation is required to support the pipeline pull-in winch near to the CVS location. The foundation will be connected to two anchoring points via cables located inland of the pipeline pull-in winch foundation.

The pipeline will be laid from the end of the microtunnel exit point to approximately 120 m water depth by a shallow water pipeline vessel using the S-lay technique.

Rock dumping will be required along the pipeline length for approximately 200 m from the microtunnel exit location. This will be performed by a dedicated rock dumping vessel using a side chute.

The pipeline will be trenched and buried for approximately 7.5 km to achieve a cover of 1.2 m. The trench will be dug using a trenching plough. The plough will be lowered to the seabed and positioned over the pipeline at the microtunnel exit point. The plough will then be towed along the length of the pipeline to a point where the pipeline will then be left exposed. A separate plough will be used to backfill the trench.

Figure 2.12 Microtunnel Cross Section

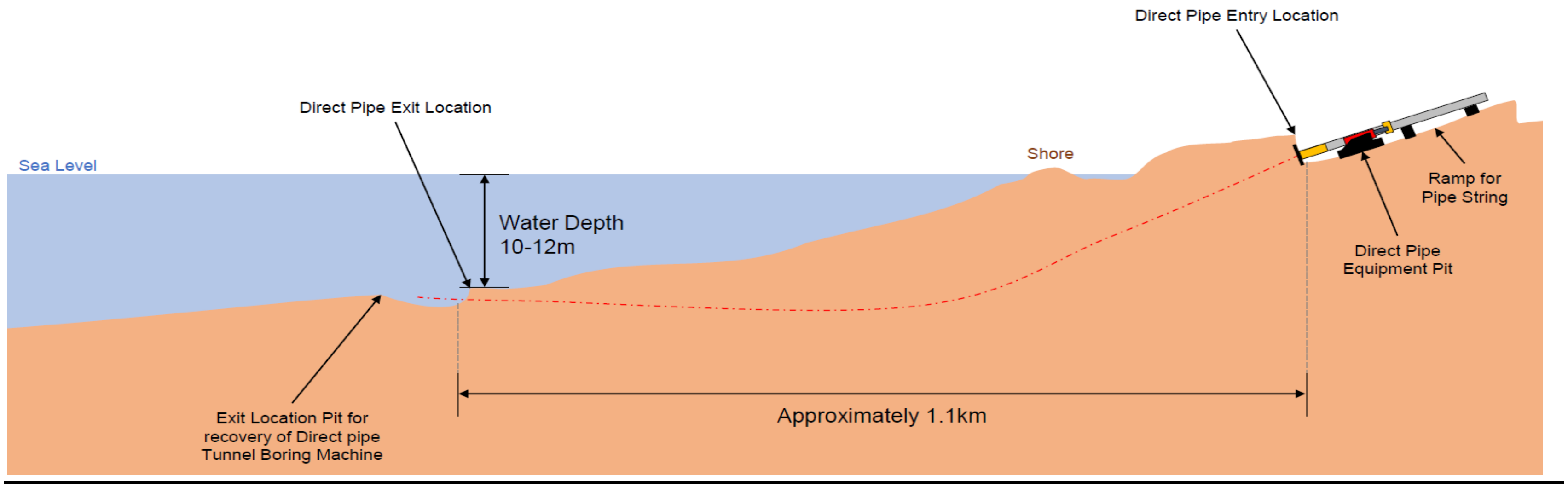
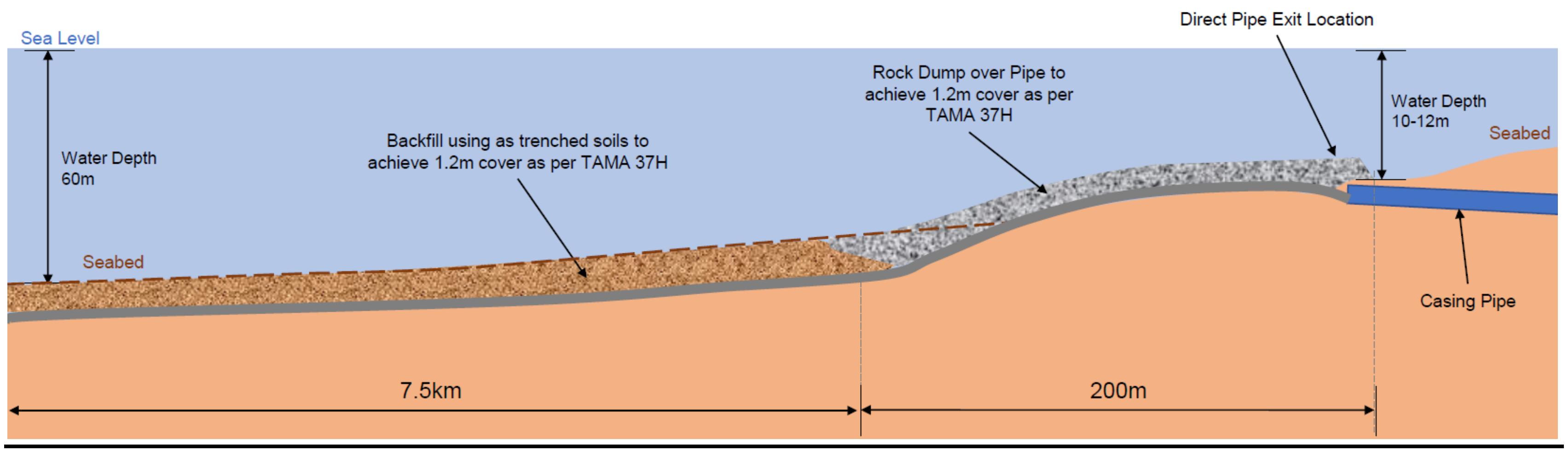


Figure 2.13 Nearshore Cross Section



2.4.5 ***Onshore Construction***

Gas Export System – Onshore

The onshore pipeline route, as defined by TAMA/37/H, is shown in *Figure 2.14*. The pipelay route will be cleared, levelled and excavated to approximately 2 m depth. A secure perimeter fence and signs will be installed to temporarily restrict access during construction.

The pipe will be welded together, lowered into the trench using a crawler crane (or similar) and connected to the CVS and DVS facilities. Should any bending be required this will be undertaken by a pipe bending machine.

Coastal Valve Station and Dor Valve Station

The CVS will be constructed using standard civil construction methods. The sites (including any associated temporary laydown areas) will be cleared, levelled and fenced before construction begins. The estimated land take for the CVS is estimated to be 1,000 m^2.

Concrete will be used to construct the foundations for any permanent structures, pipe supports and bunded areas. Sand will be used to bed the trenches for all the buried pipe work. A permanent fence with a locked gate will be installed around both of the sites and all temporary staging areas will be reinstated.

It is expected that smaller machinery will be used due to the congested nature of the works on the sites. A large portion of the work is expected to be completed with hand tools (e.g. hand held power tools). Construction vehicles including a backhoe loader, compactor, tipper truck, telehandler, excavator and articulated truck will be used for the required earth works to bury pipe work and construct permanent features.

A new DVS will be created adjacent to the existing INGL DVS facilities, to house the Karish and Tanin onshore gas reception facilities, which include gas conditioning/heating, metering and flow control.

Figure 2.14   Onshore Pipeline Construction Corridor

Source: Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

2.4.6 *Pre-Commissioning and Commissioning*

FPSO and Subsea Production System

Commissioning of all FPSO systems will occur to ensure compliance with engineering completions, testing, and commissioning of fire and gas, safety and process control systems. Commissioning and start-up will take approximately five months. Wherever feasible, commissioning of the FPSO will occur at the fabrication yards to limit the extent of onshore commissioning.

Commissioning of the subsea production system will encompass flowlines, spools, umbilicals, manifolds and riser base structures.

Commissioning activities will involve the following.

- Cleaning to remove any construction waste, loose scale and debris prior to hydrotesting.
- Internal gauging to confirm that there are no unintended intrusions (dents, gouges etc.) into flowlines.
- Pressure test using inhibited seawater (i.e. hydrotest).
- Leak testing of spools including seal testing (internal and external) after installation.
- Dewatering and drying of gas export system after hydrostatic testing to remove water from flowlines.
- Testing of the control systems to verify functionality prior to connection with the subsea equipment for commissioning.

Any water rich methanol used to assist with dehydration of the shore based section of the pipeline will be collected and disposed of in accordance with the Israeli requirements and World Bank Guidelines.

A temporary bank of diesel generators and compressors will be installed at the CVS to provide power for pre-commissioning activities. There will be onshore diesel oil storage at the CVS. Storage will be double skinned containers / tanks and will be in a bunded area.

It is anticipated that the compressor spread could be in use for up to about 2 months for dewatering and drying of the offshore and onshore pipeline.

A large dewatering spread will be mobilised at the shore facility to commission the onshore components of the project and will be connected to the pig launcher / receiver (PLR) to facilitate pushing the Pig Train (1) to the subsea end. This area is expected to be approximately two thirds of the size of the one pictured in *Figure 2.15*. The complete pipeline system will be depressurised and as a minimum purged with nitrogen from shore.

(1) Pigs or pipeline intervention gadgets are used during commissioning to remove debris from pipelines and pipe work.

Figure 2.15 Example Dewatering Spread used for Pre-commissioning

Following the completion of commissioning Energean will reinstate the disturbed land surrounding the permanent CVS and DVS facilities and the land above the buried pipeline. This will include infilling any excavated material and planting the area with local grasses.

2.4.7 *Production*

The produced hydrocarbons will be stabilised and separated on board the FPSO. The produced light oil will be stored for subsequent export via sales tankers.

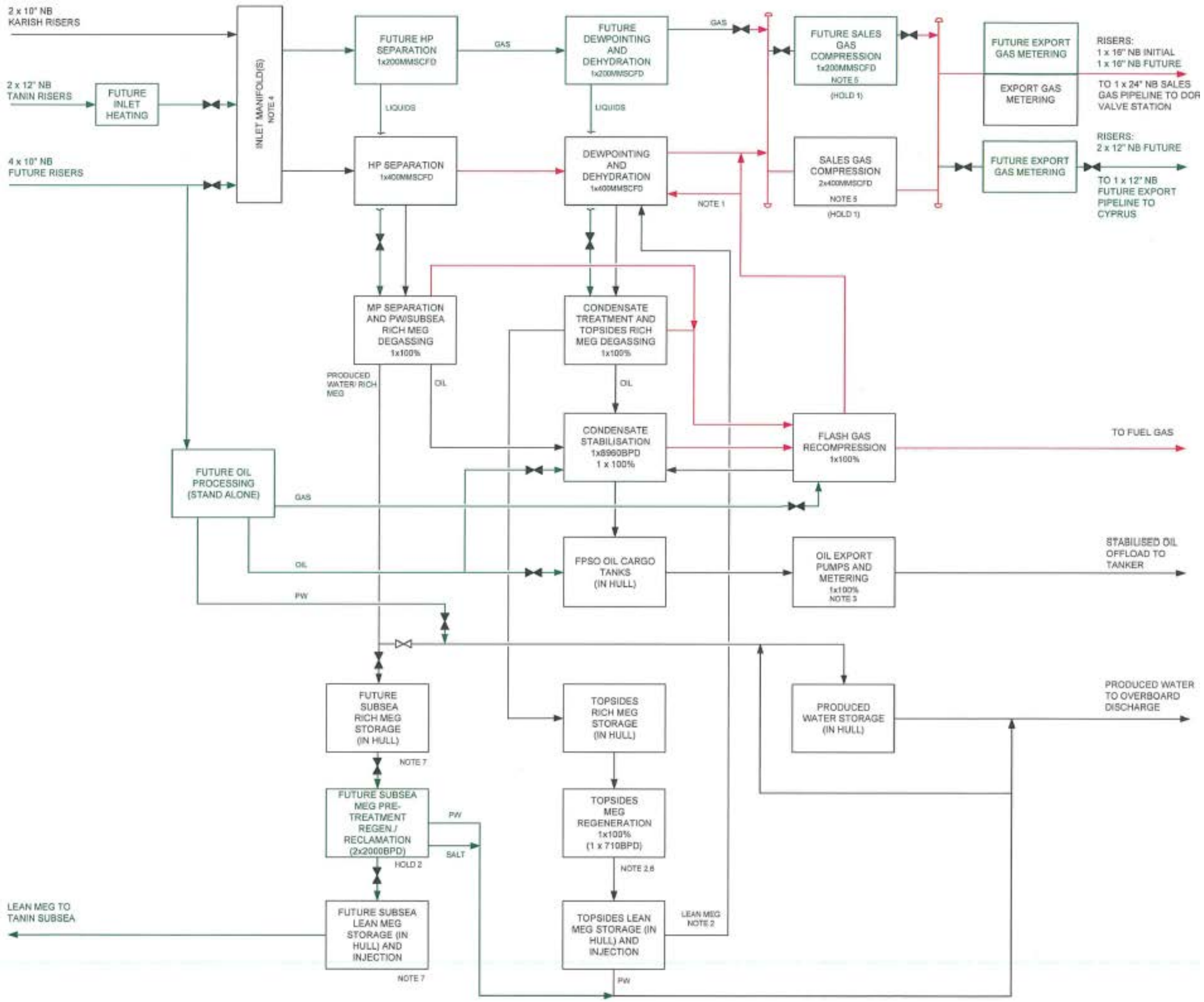
The gas will be processed and exported to shore via the gas export system. A small amount of the gas will be used for on board power generation. The treatment process is illustrated in *Figure 2.16*.

Oil export will be by sales tanker. The FPSO will offload oil in parcels of between 350,000 bbl and 450,000 bbl over a 24 hour period. The storage cells will be equipped with a submerged deepwell pump able to deliver directly to tankers moored in tandem mode. During offload tankers will sit at a distance of around 150 to 200 m and be manoeuvred into position using tugs. The tanker will be connected to the FPSO by a hawser under tension and a reel mounted oil offloading line with quick release couplings. It is anticipated that the FPSO will offload every 6 to 8 weeks but due to the amount of storage available there is flexibility to offload according to operational and market constraints and opportunities.

The FPSO will be supported throughout its operational life by an onshore supply base at Haifa.

Personnel transfers will occur either from high speed crew boats (from Haifa or Hazera Ports) or via helicopter (from the existing airport at Haifa).

Figure 2.16 Process Flow Diagram of Offshore Treatment



2.4.8 *Decommissioning*

After the Karish Main field is depleted, a decision will be made on whether the project will be decommissioned or whether other fields will be tied in to continue to use the FPSO as a production hub.

In either case the subsea production system, or parts of it, are likely to be decommissioned. Energean will dismantle and remove as much of the infrastructure as practicable, however, as is typical in deep water environments, some infrastructure, for example, flowlines will be flushed, cleaned and then abandoned in place.

The following points describe the general approach to decommissioning that currently applies to projects at similar water depth. It should be noted that the field life is approximately 35 years and these approaches may be updated during this time. Therefore Energean will prepare a decommissioning plan that applies the latest good practice approach towards the end of the field life.

- The wells will be decommissioned and abandoned. The purpose of well abandonment is to prevent potential hydrocarbon migration after the field has been decommissioned. Typically abandonment will include removal of downhole equipment such as tubing, displacing any fluids within the well with dense fluid (e.g. weighted brines), and plugging the well mechanically and/or using cement.

- The wellheads will be decommissioned by purging production chemicals and hydrocarbons and abandoned in situ. The Xmas trees will be removed and the casing cut below the seabed.

- Subsea flowlines and the manifold will be purged of hydrocarbons and flushed and abandoned in place, as is typical for deep water developments. The risers will be detached from the riser bases, flushed and lowered to the seabed for abandonment. Umbilicals will be removed as they are fabricated using materials that are not permitted to be abandoned at sea under UNCLOS 82 (e.g. rubber and plastic).

- The FPSO will be disconnected from the risers and the topsides decommissioned offshore. The processing system will be flushed with seawater and the cargo tanks flooded and the resulting oily water will be transported for treatment. Once the processing and offloading systems are confirmed clean, the FPSO will be released from its mooring system so it can be sailed away for decommissioning at a port. The mooring lines and chains will be recovered and the suction piles abandoned in situ.

- The project waste management plan will be updated to include decommissioning wastes. All discharges that occur from vessels involved in decommissioning activities will meet the same discharge criteria that applied during production.

2.5 *EMISSIONS, DISCHARGES, WASTE GENERATION, AND HAZARDOUS MATERIAL USE*

2.5.1 *Emissions*

Project activities including construction, drilling, installation, production and support operations will emit greenhouse gases and varying amounts of other pollutants such as carbon monoxide (CO), oxides of nitrogen (NO_x) and sulphur (SO_x), volatile organic compounds (VOCs) and particulate matter.

All emission sources on the FPSO are designed to be MARPOL compliant.

The gas turbogenerators/turbines will utilise Dry Low Emissions (DLE) technology, to minimise NO_x emissions.

The Karish reservoir fluid is considered to be sweet and the H_2S content of the gas is expected to be less than the export gas sales specification of 8 ppm.

The FPSO will be equipped with a flare system to control emissions to air from two activities: 1) Emergency depressurisation of the FPSO topsides hydrocarbon inventory and 2) Pipeline and flowline depressurisation. There will be a small continuous safety flare (purge) which will ensure that the flare network remains free of oxygen. The system is designed for a maximum of 800 MMscf/day. Flaring will be the subject of a separate permit.

Onshore during the commissioning phase, there will be a number of diesel-fired equipment with potentially significant emission to air including: pumps, air compressors and power generators. During the construction and commissioning phases there will also be mobile emission sources present (i.e. vehicles and mobile plant); however, impacts from these sources of have been scoped out for everything apart from dust emissions.

The offshore and onshore emissions and exhaust characteristics that have been assessed are provided in *Table 2.4* and *Table 2.5*.

Table 2.4 Offshore Facility Emission Source Characteristics

Emission Point	Height (m)	Diameter (m)	Velocity (m/s)	Volumetric Flow Rate (Am^3/s)	Volumetric Flow Rate (Nm^3/s)	Temperature (°C)	NO_x Emission Rate (g/s)
Gas turbine 1	30	2.2	2.18	8.27	9.30	568	0.465
Gas turbine 2	30	2.2	2.18	8.27	9.30	568	0.465
Gas turbine 3	30	2.2	2.18	8.27	9.30	568	0.465
Flare (Intermittent)	Actual: 120 Pseudo(1): 255	Actual: 0.61 m Pseudo(1): 6.02 m	918	-	-	1000	276

Notes:
(1) Pseudo parameters are those that have been calculated using the guidance from *Non-Routine Flaring Management: Modelling Guidance*, by the Alberta Environment and Sustainable Resource Development. (http://aep.alberta.ca/air/air-quality-modelling/documents/NonRoutineFlaringModelling-May09-2014A.pdf) to more accurately consider buoyancy and momentum flux in the air dispersion modelling).

Table 2.5 Onshore Facility Emission Source Characteristics

Emission Point	Engine	Estimated Rating (kW)	Number of Units	Height (m)	Diameter (m)	Volumetric Flow Rate (Am^3/min)	Temperature (°C)	NO_x Emissions (g/s)	PM Emissions (g/s)
Primary air compressor	CAT C18	522	16	3	0.203	110	466	0.290	0.00363
Booster compressor	CAT C18	522	11	3	0.203	110	466	0.290	0.00363
Plant air compressor	John Deere 4IRD5AE	94	1	1	0.113	19.2	450	0.086	0.00065
Utility plant	CAT C13	388	1	3	0.127	54.8	504	0.216	0.00269
Generator	Olympian GEP55	50	1	2	0.0649	10.9	535	0.065	0.00035
Flooding pump	CAT C18	522	2	3	0.203	110	466	0.290	0.00363
Pressurisation pump	CAT 3412	725	2	3	0.203	125	534	0.403	0.00503
Suction pump	CAT C15	433	2	3	0.152	102	497	0.241	0.00301

2.5.2 *Discharges*

The drillship, FPSO facility and associated support vessels and export tankers will produce a series of discharges. FPSO discharges will continue for the life of the development. Discharges from the Project will result from the following activities.

- **Drilling.** Drilling and support vessel operations will result in routine discharges to sea (i.e. sewage, grey water, food waste, bilge water, ballast water and deck drainage). In addition, non-routine discharges will include drill cuttings and fluid that will be discharged at the seabed until the marine riser is fitted between the drill centre / wells and drillship. Once the marine riser is installed cuttings will be separated from the drilling fluid and discharged via a cuttings chute into the sea; the drilling fluids will be reused. After drilling the wells will be completed using completion fluids, which typically include weighted brines, glycols and other chemical systems.

- **Installation.** Installation and pipelay vessels will result in routine discharges during installation and commissioning (i.e. sewage, grey water, food waste, bilge water and ballast water). In addition, non-routine discharges will include pre-commissioning fluids including dye, oxygen scavenger, corrosion inhibitor and biocide. After pipeline pressure testing the pipeline will be dewatered using standard pigging and, most likely, a small methanol swabbing pig train to remove as much residual water as possible. A discharge permit will be obtained to cover the discharge of inhibited seawater and small volumes of methanol offshore.

- **Production.** Routine discharges from the Project will include the following: produced water, black water (sewage), grey water, food waste, deck drainage, bilge water, ballast water, brine, desulphurisation system reject stream, cooling water. Non-routine discharges could also include the hydraulic fluid, workover fluid, Naturally Occurring Radio-active Material (NORM) (potentially) and hydrate inhibitor.

The discharges and treatment systems are discussed below and summarised in *Table 2.7* at the end of this section.

Produced Water

Produced water is a by-product of the processing of hydrocarbons from underground reservoirs. Water is naturally present in these reservoirs is produced as a liquid with the oil or as a vapour with the gas. The produced water arriving at the topside is expected to be entirely composed of water of condensation from the saturated reservoir fluids.

Produced water will be discharged to the sea following treatment. The processing facilities have been designed to meet the following produced water specification under normal operating conditions:

- Mineral Oil (FTIR): 15 mg/l.
- Total Oil (FTIR):

29 mg/l average, with maximum of 42 mg/l for the first 6 months; and

15 mg/l average, with maximum of 21 mg/l after 6 months.

- BTEX: 5 mg/l.
- Total Organic Carbon:

  10,000 mg/l maximum for the first six months; and

  500 mg/l thereafter,
- Total Suspended Solids (105°C): 30 mg/l average, with maximum of 100 mg/l.
- pH: 6.0 < pH < 9.5.

These limits have been agreed with the Israeli MOEP as part of the FPSO Environmental Design Basis.

Produced water will be stored in a dedicated gravity settling tank in the hull prior to overboard discharge. Residence time will be more than adequate to ensure that the discharge meets discharge standards. Volumes of discharged produced water are expected to vary over the field lifetime. The FPSO is designed for a produced water rate of 2,000 bpd initially, with capacity of 4,000 bpd later in field life. During the initial years of production a water production rate of 40 to 50 bpd is expected. Storage will be available for several years of water production.

Black Water, Grey Water and Food Waste

Black water (i.e. sewage or sanitary effluent), consisting of human body wastes from toilets and urinals, will be treated using a marine sanitation device that treats the waste and produces an effluent with a maximum residual chlorine concentration of 1 mg l^{-1} and no visible floating solids or oil and grease. Grey water (i.e. domestic waste) includes water from showers, sinks, laundries, galleys, safety showers and eye-wash stations. According to MARPOL, grey water does not require treatment before discharge.

Low risk food waste from the galleys will be discharged to sea. Organic food wastes generated will be macerated to pass through a 25 mm mesh, comingled with grey water and discharged with no floating solids or foam in conformance with MARPOL requirements.

Cooling Water

The main demand for, and discharge of, cooling water during the life of the development will be from the FPSO topsides and marine systems. Topsides cooling water is utilised for topsides processes and general cooling demands for all utility and anticipated service loads. Marine cooling water is utilised for general cooling demands such as HVAC refrigeration and diesel generators.

The main cooling water intake shall be taken from a depth of approximately 80 m below sea level, where the temperature is consistently lower than near surface. An appropriate screen or similar device will be installed across the intake to prevent the entrainment. Lifted seawater will be electro-chlorinated to prevent marine growth and bacteria entering the system. The level of free chlorine (total residual oxidant) in marine water should be maintained at 0.2 ppm.

The cooling water seawater return shall be discharged beneath sea level. The impact of the cooling water return to sea will be such that the increase in ambient seawater temperature at a distance of 100 m from the discharge point is less than of 3°C.

Deck Drainage

Deck drainage consists of rainfall runoff and runoff from curbs and gutters. The FPSO will have hazardous and non-hazardous open drain systems. Liquid accumulated in the bunded areas on the FPSO (hazardous open drains) will flow via "drain boxes" to the slops tank, where any hydrocarbons present in the drains stream will be separated by gravity prior to discharge overboard. The slops treatment system shall be designed to achieve the following drain water discharge quality in accordance with MARPOL Annex I requirements.

The overboard drain water (non-hazardous) will be continuously monitored for flowrate and oil and grease content. The discharge will be automatically stopped in the event that total oil concentration exceeds 15 ppm oil and grease as agreed with the Israeli MOEP.

Bilge Water

Support vessels will occasionally discharge treated bilge water. These vessels will comply with the requirements of Annex I of MARPOL. Under these regulations, water must be retained onboard until it could be discharged to an approved reception facility, unless it is treated by approved oily water separators and monitoring equipment before being discharged to the sea.

Ballast Water

Ballast water that is discharged will be subject to MARPOL requirements. MARPOL Annex I requires that discharges into seawater outside of special areas contain no more than 15 mgl^{-1} oil and grease. In addition, requirements of the International Convention for the Control and Management of Ships' Ballast Water and Sediments will be adhered to. Ships are required to have onboard and implement a Ballast Water Management Plan.

During normal FPSO ballasting operations, ballast water will be drawn from the sea and transferred to the ballast tanks as required. Spent ballast water will be discharged directly back to sea (above sea level) when not required. Ballast tank vapour space shall be monitored for the presence of hydrocarbon gas, which may indicate a breach in the integrity of the ballast tank walls. Furthermore, ballast water will be sampled and analysis performed to confirm the absence of any hydrocarbons prior to disposal overboard to sea.

Drilling Fluid and Cuttings

The estimated drilling fluid and cuttings are set out in *Table 2.6*.

Table 2.6 Estimated Cuttings and Fluids per Well

Section (inch)	Length (m)	Cuttings (m^3)	Fluid Volume (bbl)	Fluid Type
26	2,522	290	8,075	Seawater, Hi Vis Sweeps
17.5	1,870	97	2,804	Salt Sat. WBM
12.25 (pilot hole)	5,993	153	5,993	WBM
12.25	5,235	133	5,235	WBM
8.5	98	1	84	WBM

All WBM and cuttings from the top well section will be discharged to sea at the seabed. Following the installation of the marine riser, all WBM and cuttings will be circulated to the drillship for separation. WBM will be returned to the mud pit for reuse where possible and treated cuttings will be discharged to sea. This discharge is assumed to include approximately 10% of the WBM volume as residual mud on cuttings.

The majority of chemicals included in WBM are considered PLONOR (considered to pose little or no risk to the environment); all chemicals will be in compliance with 96 hour LC-50 of SPP-3% volume toxicity test[(1)]. Discharges of cuttings will have less than 1 mg/kg of mercury and 3 mg/kg of cadmium in the stock barite. Chlorine in the discharge will be less than four times the ambient concentration. All discharges will be via a cuttings chute.

Completion Fluids

During well completions, various chemicals will be used on the drillship. Completion fluids can typically include weighted brines, methanol and glycols and other chemical systems. Once used these fluids may contain contaminants including solid material, oil and chemical additives. Most of the chemicals used during completions will remain downhole or will be injected into the formation. Some completion chemicals such as upper completion chemicals and flowback fluid chemical will be flared off after use. Returned fluids, such as wellbore clean-up fluids, will be discharged overboard.

Before any completion fluids are discharged overboard they will be tested for total oil and grease (TOG) content and if the TOG content is below the specification then the fluids will be discharged to sea. A discharge permit will be obtained for this discharge. If the TOG content is greater than the specification then the returned fluids will be retained on the vessel in closed systems (such as tote tanks), where this is practical, and shipped for onshore disposal. Any discharges will also be in compliance with 96 hour LC-50 of SPP-3% volume toxicity test [(2)] first for drilling fluids or alternatively testing based on standard toxicity assessment.

(1) 96 hr LC50 (50% lethal concentration) means the concentration of a chemical in air or of a chemical in water which causes the death of 50% (one half) of a group of test animals after exposure for 96 hours.
(2) 96 hr LC50 (50% lethal concentration) means the concentration of a chemical in air or of a chemical in water which causes the death of 50% (one half) of a group of test animals after exposure for 96 hours.

Table 2.7 Summary of Discharges and Treatment

<table>
<tr><th>Discharge and Source</th><th>Treatment</th><th>Discharge Point (s) and Location</th><th>Volume</th><th>Frequency</th><th>Limit</th><th>Standard</th></tr>
<tr><td>Completion and Well Workover Fluids</td><td>x Oil-water separation
x Any acids used will be neutralised to pH 6 or more prior to any discharge</td><td>Single, discharge overboard</td><td>Variable based on individual needs of well. Expected to be several tonnes each.</td><td>Intermittent</td><td>x Maximum one day oil and grease discharge should not exceed 40 mgl^{-1}; 30 day average should not exceed 29 mgl^{-1}.
x Any spent acids will be neutralised (to attain a pH of 6 or more) before testing and disposal.</td><td>IFC (2007) and USEPA (2007)</td></tr>
<tr><td>Riser, Umbilical and Pipeline Commissioning</td><td>None</td><td>Primarily subsea discharge with some near surface discharge</td><td>Variable depending on specific needs.</td><td>Intermittent</td><td>x Treatment chemicals: maximum manufacturers recommended dose or 500 mgl^{-1}
x No free oil</td><td>USEPA (2007)</td></tr>
<tr><td>Drill Cuttings and Fluid</td><td>x Shale shakers</td><td>x WBM and cuttings to the seabed
x Separated WBM cuttings discharged via chute at surface</td><td>Estimated volumes per well:
<table><tr><th>Section (inch)</th><th>Cuttings (m^3)</th><th>Fluids (bbls)</th></tr><tr><td>26</td><td>290</td><td>8,075</td></tr><tr><td>17.5</td><td>97</td><td>2,804</td></tr><tr><td>12.25 (pilot hole)</td><td>153</td><td>5,993</td></tr><tr><td>12.25</td><td>133</td><td>5,235</td></tr><tr><td>8.5</td><td>1</td><td>84</td></tr></table></td><td>Continuous (when drilling)</td><td>x <3% as a weighted average
x Use of Group III NADF
x No free oil
x Limits on mercury (max 1 mg kg^{-1}) and cadmium (max 3 mg kg^{-1})
x Discharge via cuttings chute</td><td>IFC (2007)</td></tr>
<tr><td>Black Water</td><td>Sewage treatment. Treat with approved sanitation unit. Maceration and Chlorination</td><td>Single; holding tank storage; discharge overboard (above sea surface)</td><td>Estimated 170 l (0.17 m^3) of per person per day based on previous offshore development experience. Conservative estimates per phase:

<u>Drilling & Completion:</u> 5,100 m^3
<u>Offshore Installation:</u> 40,375 m^3
<u>Pre-Commissioning and Commissioning:</u> 230 m^3
<u>Production (per year):</u> 4,344 m^3</td><td>Intermittent</td><td>System designed to achieve MARPOL standards:
x Free Chlorine < 0.3 mg/l
x Floating Solids < 50 mg/l
x Total BOD < 50 mg/l
x Turbidity 50 NTU
x pH 6.0 < pH < 9.5</td><td>Annex IV MARPOL</td></tr>
</table>

Discharge and Source	Treatment	Discharge Point (s) and Location	Volume	Frequency	Limit	Standard
Grey Water	None	Single; holding tank storage; discharge overboard (above sea surface)	Estimated 400 l (0.4 m^3) per person per day based on previous offshore development experience. Drilling & Completion: 12,000 m^3 Offshore Installation: 95,000 m^3 Pre-Commissioning and Commissioning: 540 m^3 Production (per year): 10,220 m^3 Low risk food waste will comingled with grey water for offshore discharge. Food waste is estimated at 1 kg per person per day. Drilling & Completion: 30,000 kg Offshore Installation: 237,500 kg Pre-Commissioning and Commissioning: 1,350 kg Production (per year): 25,550 kg	Continuous	xNo visible floating solids or discoloration of surrounding water	Annex IV MARPOL
Produced Water	Oil-water separation.	Single; holding tank storage; discharge 3 m below the sea surface	FPSO: Initial rate expected to be 40 to 50 bpd average with a peak rate of 2,000 bpd.	Intermittent	Oil and grease not to exceed 21 mgl^{-1}daily maximum or 15 mgl^{-1} monthly average.	IFC and USEPA (2007); Also complies with OSPAR (2001) (OSPAR 01/18/1, Annex 5) 30 ppm monthly average oil content and North Sea UK 30 ppm monthly average and 100 ppm daily average oil content
Deck Drainage	Oil-water separation	Single, discharge overboard	Deck drainage water generation variable, depending upon facility and vessel characteristics, rainfall amounts; discharge volumes variable.	Intermittent	xNo free oil; xMineral oil < 15mg/l xTotal Oil & Grease < 30 mg/l x6 < pH < 9.5	Annex 1 MARPOL
Bilge Water	Bilge water separator (HOLD)	Single, discharge overboard (above sea surface)	Bilge water generation variable, depending upon facility and vessel characteristics; discharge volumes variable	Intermittent	xSee above.	Annex I MARPOL

Discharge and Source	Treatment	Discharge Point (s) and Location	Volume	Frequency	Limit	Standard
Ballast Water	None	Single; Discharge overboard (above sea surface)	FPSO: Variable depending on amount on hydrocarbons stored onboard.	Intermittent	xNo free oil; x15 mgl^{-1}instantaneous reading oil water threshold xBallast water exchange at least 200 nmi from nearest land in water at least 200 metres deep. The absolute minimum being 50 nmi.	Annex I MARPOL International Convention for the Control and Management of Ships' Ballast Water and Sediments
Cooling Water (filtered seawater)	Filtered initially. No further treatment	Single; Discharge overboard (above sea surface)	FPSO: 3,200 m^3/hour of filtered seawater maximum.	Continuous	The effluent should result in a temperature increase of no more than 3°C at the edge of the mixing zone or 100 m from point of discharge.	IFC (2007)
Hydrate Inhibitor	None	Single, discharge overboard	Discharge in batch mode only during unplanned and planned system shutdowns.	Intermittent	-	
Hydraulic Fluids	None	Multiple subsurface discharge	Subsea valves: Very small volumes expected.	Intermittent	-	-

Pre-Commissioning, Testing and Line Flushing Fluids

Liquid discharges will result from flowlines, umbilicals and the water treatment facilities during testing and pre-commissioning activities at the offshore location.

Pre-commissioning fluids for subsea infrastructure, flowlines and gas export pipeline will use a seawater soluble additive, containing dye, oxygen scavenger, corrosion inhibitor and biocide in raw seawater. The discharge will be subsea, except for the production flowline volumes which will be produced back to the FPSO and discharged from surface. In addition, deoxygenated and filtered sea water will be pumped through the subsea flowlines and manifolds to flush the subsea system. Pre-commissioning fluids will be subject to a discharge permit.

Production and export flowlines and export pipelines will be dewatered (i.e. water is pumped out), flushed with MEG to remove any remaining water, dried and then filled with nitrogen and left in situ under pressure.

For the long term storage of the umbilical tubing including transportation, installation and post installation testing, an umbilical storage fluid (40% MEG) will be used. The volume within the umbilicals will be discharged at the seafloor once the umbilicals are commissioned.

Hydrate Inhibitor

Gas hydrates form at low temperature and elevated pressure at certain conditions with natural gas and water present. Hydrates are a form of ‘hard ice’ which is difficult to remove if it forms subsea. MEG is used worldwide in the oil and gas industry as the hydrate control chemical of choice for production systems. Alternative chemicals may be used in the future.

MEG is the selected hydrate prevention and control chemical. Portable facilities for injection of methanol will be provided on the FPSO.

Hydraulic Fluid

Subsea hydraulically operated valves will be actuated using an electro-hydraulic subsea control system. Small volumes of water based hydraulic fluid will be vented from the control system equipment when given a command to close. The selected water based hydraulic fluid will have low environmental toxicity.

Naturally-Occurring Radioactive Material (NORM)

NORM is not expected from the Karish Main field.

2.5.3 ***Noise***

FPSO

The FPSO, installation vessels, export tankers and support vessels will introduce sound into the marine environment during their operation. Vessel noise is primarily attributed to propeller cavitation and propulsion engines (i.e. noise transmitted through the vessel hull).

Noise levels on the FPSO will be reduced to 80 dB(A) where reasonably practicable and cost effective to do so. High noise areas are defined as those areas where noise levels exceed 80dB(A) (due to the additive effect of multiple noise sources). Noise attenuation via acoustic insulation or enclosures will be considered for any equipment whose operation results in noise levels in the affected area exceeding 80 dB(A). The maximum peak noise will not exceed 130 dB(A). The maximum continuous noise level from any item of equipment will be less than 115 dB(A).

Onshore

Airborne noise will be generated from vehicles and equipment used for construction activities of the CVS, DVS and pipeline. The number of vehicles and equipment present on site will vary during the construction period. *Table 2.8* sets out the source sound level for each vehicle and piece of equipment split by construction / installation activity.

Table 2.8 Onshore Sound Sources

Activity	**No.**	**Equipment**	**SWL (dB)**	**Quantity**	**% On Time [(1)]**
Construction phase					
CVS construction & DVS modification	1	Backhoe Loader	100	2	83%
	2	Telehandler	106	1	83%
	3	Compactor	110	1	83%
	4	360 Excavator	105	2	83%
	5	Tipper Truck	104	2	83%
	6	Articulated Truck	104	2	83%
				Total SWL/team:	**114**
Horizontal drilling and jacking of 56" casing pipe	1	Power Generator	110	1	100%
	2	Bentonite Pump	97	1	100%
	3	Separation Module	90	1	100%
	4	Mobile Crane	106	2	100%
				Total SWL/team:	**113**
Onshore 24" pipeline installation	1	Backhoe Loader	100	2	83%
	2	Telehandler	106	1	83%
	3	Compactor	110	1	83%
	4	360 Excavator	105	2	83%
	5	Tipper Truck	104	2	83%
	6	Articulated Truck	104	2	83%
	7	Pipe Handling Crane	106	5	83%
				Total SWL/team:	**116**
Sheet piling for installation of onshore winch	1	Vibratory piling rig	116	1	100%

Activity	No.	Equipment	SWL (dB)	Quantity	% On Time (1)
Total SWL/team:					**116**
Shore pull of 30" pipeline using onshore winch	1	Linear Winch	105	1	100%
	2	Diesel Hydraulic Power Unit	110	1	100%
	3	Spooling Winch	110	1	100%
	4	Mobile Crane	106	1	100%
Total SWL/team:					**114**
Dewatering & drying spread of pipelines during S-Lay activities (Contingency)	1	Gas Booster	100	10	100%
	2	Diesel Powered Generator	110	1	100%
	3	Diesel Powered Compressor	90	17	100%
	4	Utility Plant	98	1	100%
Total SWL/team:					**113**
Commissioning phase					
Pipeline flood, clean & hydrotest	1	Diesel Powered Pump	110	5	100%
	3	Diesel Powered Generator	110	1	100%
	4	Diesel Powered Compressor	90	1	100%
Total SWL/team:					**118**
Pipeline dewatering & drying	1	Diesel Powered Pump	110	4	100%
	2	Gas Booster	100	11	100%
	3	Diesel Powered Generator	110	1	100%
	4	Diesel Powered Compressor	90	17	100%
	5	Utility Plant	98	1	100%
Total SWL/team:					**118**

Notes:
(1) Percentage of time that equipment will be operating, out of a 12 hour daytime period and/or (in the case of those activities listed in *Table B4.1* as operating on a continuous 24h basis) an 8 hour night time period.

2.5.4 *Solid Waste*

Operations during the production phase will generate solid waste including paper, plastic, wood, glass and metal. Most wastes are associated with galley and food service operations and with operational supplies such as shipping pallets, containers. The solid waste generated offshore will be segregated offshore and shipped back to shore where it will be reused or recycled where possible or disposed of using approved contractors. This is in accordance with the Barcelona Convention Protocol for the Prevention and elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea.

2.5.5 *Hazardous Material Usage*

Specific chemicals that will be used by the project have not yet been selected and further detail on type and proposed use of these chemicals will be developed during the detailed design phase, which will include the final selection of chemicals, their Material Safety Data Sheets (MSDSs) and relevant information on their environmental toxicity. All chemicals will be stored and handled according to the MSDSs and written pollution prevention measures established by their suppliers.

To control the risks associated with hazardous materials and wastes, all project facilities will be designed to reduce the exposure of personnel and the public to chemical substances, fuels, and products containing hazardous substances. Energean will prepare procedures for the control and management of hazardous materials, wastes and radioactive sources used offshore.

Any offshore hazardous materials that may be discharged to the sea will be evaluated and substituted with less hazardous materials, as appropriate. Additionally, all hazardous materials used will be subject to cooperation with Ministry of Environmental Protection and their permit requirements.

The project will use water based drilling mud and for some of the well sections this will be disposed of at the drilling location as currently permitted by OSPAR Resolution 2000/3. All drillship operators will receive guidelines and training for handling hazardous waste and hazardous waste segregation requirements.

2.6 *OVERALL PROJECT FOOTPRINT*

The offshore components will be installed over an area of approximately 0.061 km^2. Minimal disturbance of the seabed will be caused by the FPSO moorings and the installation of the subsea infrastructure, such as the wells, manifold, riser bases, PLETs, flowlines and umbilicals. The onshore components will be constructed within an area of approximately 0.001 km^2; however an additional 0.203 km^2 will be used for temporary staging areas and the working corridor for the pipeline. A summary of the project's offshore and onshore footprint is set out *Table 2.9*.

Table 2.9 Overall Footprint for the Project

Project Components	**Dimensions (m)**		**Quantity**	**Length (km)**	**Footprint (km^2)**
	Length	**Width**			
Offshore					
Mooring Piles		6	14	-	0.0003
Production Trees	4	4	3	-	0.0000
Karish manifold	16	10	1	-	0.0002
Riser base manifolds	18	9	3	-	0.0005
PLETs	11	5	3	-	0.0002
Flowlines	-	0.254	-	10	0.0025
Umbilicals	-	0.254	-	10	0.0025
Export pipeline	-	0.609	-	90	0.0548
				Offshore Total	**0.0610**
Onshore					
Permanent					
	Length (m)	**Width (m)**			
CVS	41	28	1	-	0.001
DVS	N/A - Existing				
Temporary					
Pipeline corridor	-	60	-	1.4	0.118

Project Components	Dimensions (m)		Quantity	Length	Footprint
Staging areas	-	-	2	-	**0.086**
				Onshore Total (Permanent)	**0.001**
				Onshore Total (Temporary)	**0.203**

2.7 Labour and Security

2.7.1 *Personnel Requirements*

Trained and competent personnel will accompany support vessels under contract to Energean. Similarly, the FPSO will be manned by trained operators, technicians, engineers and vessel crew. *Table 2.10* sets out the estimated personnel requirement for the Project. Note that for the construction phase this estimate is based on the maximum accommodation capacity of the vessels involved.

The personnel requirements will be met by a mixture of local and expatriate workers. The majority of the offshore roles (particularly those during drilling and construction) will be filled with skilled expatriate workers, who will be employees of the offshore contractor companies. It is anticipated that a larger proportion of Israeli workers will be employed for the onshore construction elements of the project.

Table 2.10 Estimated Personnel Requirement by Project Phase

Project Phase	Offshore	Onshore
Drilling	~100	~5
Construction	~950	~100
Commissioning	~15	~15 Energean plus support
Production	60 – 70	~15 Energean plus support

2.7.2 *Security*

Onshore

During the construction of the onshore facilities, appropriate temporary perimeter fences and barriers will be provided to maintain site security and protect the public from the potential dangers associated with construction activities. It is planned to employ security guards to control access to the construction site(s) and to patrol the perimeters.

Both the landfall CVS and onshore DVS will have perimeter security fencing and a locked gate access, which will provide access to authorised personnel only. It is also likely that close circuit television (CCTV) will also be provided to allow remote monitoring of the sites.

As the onshore pipeline will be buried underground, no additional security measures are anticipated other than routine pipeline route surveillance.

Offshore

The FPSO will be subject to a 500 m safety exclusion zone. The project will comply with any additional security measures required by the Israeli Defence Force (IDF).

The offshore installation phase will involve an array of vessels that will implement appropriate security measures consistent with the outcome of a security risk assessment. It is likely that the larger installation vessels will be International Ship and Port Facility Security Code (ISPS) compliant.

The Karish and Tanin FPSO will be designed to include features required by the ISPS code and will be enhanced by a range of security features specifically required by the Israeli Defence Force (IDF). Additionally, there will be a small team of full time security personnel resident on the FPSO.

2.8 TRAFFIC

Estimated traffic for the onshore activities is provided in *Table 2.11*.

Table 2.11 Estimated Traffic

Activity	Duration (months)	Estimated offsite Vehicular Movement per day	Working Hours
Earthworks associated with CVS construction	12	16	10 h day, 6 day/wk
Earthworks associated with onshore pipeline installation and CVS construction	6	32	10 h day, 6 day/wk
Construction of foundation for onshore winch	< 1	10	12 h day, 6 day/wk
Mobilisation of equipment for shore pull	< 1	6	12 h day, 6 day/wk
Mobilisation and demobilisation of equipment at staging area, for commissioning phase	< 1	40	12 h day, 6 day/wk

2.9 ALTERNATIVES

As included in the Scoping Report for the Karish Development, an assessment has been conducted of potential alternatives to the overall design strategy of the development. This assessment has been updated to include an evaluation of the key technological alternatives that have the potential to significantly affect the environment. The results of both are presented in the *Alternatives Assessment,* provided in *Annex B*. Additionally, an evaluation of what constitutes indicative Best Available Techniques (BAT) per international guidance has also been conducted, and during the detailed design stage these measures will be evaluated.

2.10 MANAGEMENT

2.10.1 *Environmental and Social Management System*

Energean will operate an Environmental and Social Management System (ESMS) for the Project. The purpose of the ESMS is to set out the processes and practices that will be consistently implemented to assist in delivering the project and assessing and controlling risks. The ESMS will include, as commitments, the mitigation measures that are included in this ESIA to avoid, reduce, remedy or compensate for significant adverse impacts and, where practicable, to maximise potential positive benefits and opportunities from the Project.

2.10.2 *Protection of Health and Safety*

As stated in the Energean HSE and Social Responsibility Policy, Energean considers the safety and health of personnel to be of paramount importance.

Energean will operate an HSE Management System that has been developed in accordance with the principles of OHSAS 18001:2007, an internationally recognised British Standard for Occupational Health and Safety Management Systems. The HSE Management System is systematic, comprehensive and robust and is documented in the Energean HSE Management System Manual. The Energean HSE Management System will underpin the Report on Major Hazards being produced for the Karish and Tanin offshore and onshore facilities.

Through effective implementation of its HSE Management System and compliance with the Karish Report on Major Hazards, Energean will ensure that the risk to employees and contractors associated with occupational hazards and the consequences of major accident hazards, are reduced to As Low As reasonably Practicable (ALARP).

2.10.3 *Geological and Seismic Risk Assessment*

A geohazard assessment, including a Probabilistic Seismic Hazard Assessment (PSHA) will be undertaken in order to provide input to the design loads for the subsea infrastructure and pipelines. The results of the PSHA will also be used to assist with the selection of the optimum gas export pipeline route with respect to seismic events, liquefaction potential and seabed mobility in order to avoid areas of higher hazard. These assessments will be carried out after the geophysical and geotechnical surveys have been performed.

2.10.4 *ESIA Mitigation Measures*

The mitigation measures included in this ESIA are either embedded or planned. Embedded mitigation measures are those that have been incorporated into the design of the project. Planned mitigation measures are those that have been identified during the ESIA process to avoid, reduce, remedy or compensate any remaining significant adverse impacts of a project. Some embedded measures have been described in this chapter; however, a complete list of embedded and planned mitigation measures that are included in the project is set out in in the ESMP (See Annex D).

3 ESIA PROJECT STANDARDS

3.1 OVERVIEW

Figure 3.1 sets out the key standards, guidance and requirements which will form the ESIA Project Standards.

ESIA Project Standards

IFC Performance Standards

The Performance Standards specify the IFC's conditions for environmental and social performance for projects seeking external financing. The IFC Performance Standards are divided into eight categories to identify and evaluate the potential environmental and social impacts which may occur as a result of project activities. A summary of the scope of the IFC Performance Standards and the applicability to the Project is provided below.

N°	Title	Scope	Applicable to the Project
1	Assessment and Management of Social and Environmental Risks and Impacts	Defines requirements for ensuring appropriate environmental and social management policy implementaŸon and accountability, including Environmental and Social Impact Assessment requirements	
2	Labour and Working CondiŸons	Defines requirements for ensuring definiŸon and implementaŸon of fair recruitment and workforce management policies	
3	Resource E8 ciency and PolluŸon PreventŸon	Defines requirements for ensuring an appropriate level of polluŸon preventŸon and abatement	
4	Community Health, Safety and Security	Defines requirements for ensuring that adverse impacts from the Project on the receiving community are managed and controlled	
5	Land AcquisiŸon and Involuntary Rese©lement	Defines requirements for land tenure management and community rese©lement as part of Project development	
6	Biodiversity ConservaŸon and Sustainable Management of Living Natural Resource	Defines requirements for ensuring that the Project's impacts on nature, ecosystems, habitats and biodiversity are appropriately managed	
7	Indigenous Peoples	Defines requirements for ensuring that the rights of autochthonous minoriŸes are respected and that indigenous people may beneficiate from the Project	No indigenous peoples are present in the Project area.
8	Cultural Heritage	Defines requirements for managing the Project's impacts on material and immaterial cultural heritage	

IFC/World Bank EHS Guidelines

The EHS Guidelines are technical reference documents, providing general and industry-specific examples of good practice. The EHS Guidelines represent the measures normally considered acceptable by the IFC/World Bank, and generally considered to be achievable in new facilities at reasonable cost by existing technology. When host country regulations differ from the levels and measures presented in the EHS Guidelines, the IFC recommends that projects should achieve whichever is more stringent. The EHS Guidelines include general overarching guidelines as well as industry specific guidelines.

The EHS Guidelines considered relevant to the Project are:

- Environmental, Health & Safety General Guidelines (2007)
- Offshore Oil and Gas Development (2015)
- Onshore Oil and Gas Development (2007)

Israeli EIS Process

The laws and regulations that govern the EIS process are as follows:

- Planning & Building Law 5725-1965 (with amendments)
- Planning & Building Regulations (Environmental Impact Statements) 5763-2003

General Process	
Screening:	The regulations identified certain types of activities that require the project proponent to submit an EIS. P&B Regulations, sec. 2(a). An EIS may be required for any plan that may have a significant impact on the environment. P&B Regulations sec. 2(2), 2(3).
Who Prepares EIA:	Project Proponent (with or without contractor)
EIA Contractor Qualifications:	"The Minister of Environmental Protection shall prescribe for the categories of plans the professions, the education and professional training, the qualifications and the professional experience required of a professional." Planning & Building Act sec. 83(B)(b)
Review Period:	31-60 days
Written Decision:	Written decision is implied in P&B Regulations section 12(d). "The guidelines, the statement, the environmental adviser's opinion and the planning agency's decision shall constitute background documentation of the plan…"
Authority to Impose Conditions:	Yes, the planning agency shall decide which provisions for the prevention of negative environmental impacts (mitigation) shall be included as a condition for approval. P&B Regulations sec. (12)(c).
EIA Content	
Alternatives:	Terms of reference for preparing EIS "may" require project proponent to reference the environmental implications of other alternatives to the plan's proposed location, no action alternative, and technological alternatives. P&B Regulations sec. (8)(b)(2)
Type(s) of Impact Analysis:	Direct environmental impacts, Cumulative environmental impacts
Mitigation:	EIA shall include "proposals for means of preventing negative environmental impacts." P&B Regulations sec. (8)(b)(5)
Monitoring Plans:	EIA shall include "proposals for . . . monitoring or follow up measures or other measures designed to protect the environment." P&B Regulations sec.(8)(b)(5)
Public Disclosure	
Disclosure of EIA:	Scoping - No, Draft EIS - No, Final EIAS-Yes (Agency or ministry office, Internet)
Public Notice of Final EIA Detail:	If the agency accepts the plan, the materials are available to the public. P&B Regulations sec. (12)(d) Although the public has access to the final EIA after it is deposited (approved), the Law and Regulations do not require public notice that the EIA is available.
Public Notice of Final Decision:	Yes, per P&B Regulations sec. (12)(d)
Public Participation	
Public Participation Opportunities:	Review of final EIS
Response to Public Comments:	A Ministry of Interior investigator will conduct public hearings for the objectors. 1525-1965 (107)

Note Israel has adopted a number of international conventions which are applicable to the Project. Some key examples relevant to this ESIA are: International Labour Organization Conventions 182 and 183, MARPOL 73/78, Convention for Protection of the Mediterranean Sea against Pollution (Barcelona Convention), and the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal.

Figure 3.1: Project Standards

Size: A3

Date: May 2017

3.2 *TOPIC SPECIFIC REGULATIONS AND STANDARDS USED IN ASSESSMENT*

3.2.1 ***Air Quality***

Ambient Air Quality Standards

Israel Clean Air Law (1) was introduced in 2008 and sets air quality standards (AQS) for ambient air quality in Israel. The AQS values have been regularly updated since 2008, particularly in 2011(2), 2015 and 2017(3). For particulate matter (as PM_{10}) and nitrogen dioxide (NO_2), the pollutants of interest of this assessment, the values have not changed since 2015 (4).

Table 3.1 presents the AQS values used as criteria for determining the magnitude of impact of the proposed air emissions.

Table 3.1 Israeli Air Quality Standards Values

Pollutant	Air Quality Standard (µg/m^3)	Averaging Period
Nitrogen Dioxide (NO_2)	200	Hourly, with 8 exceedances
	40	Annual
Particulate Matter (PM_{10})	130	Daily, with 18 exceedances
	50	Annual, after removing 18 maximum daily values
Notes: (1) Annual criteria used for offshore assessment only.		

Both PM_{10} and NO_2 have short-term and long-term emission standards which are similar to the levels indicated in the IFC's Guidelines (5). As such, the national Israeli AQS values have been used in this assessment.

For onshore ecological receptors, the limit of 75 µg/m^3 for oxides of nitrogen (NO_x) over 24 hours defined in WHO's Air Quality Guidelines for Europe (6) has been used.

Emission Limits

Israel's legislation requires that the engines used onshore during the pipeline commissioning to be compliant with the stage IIIB oxides of nitrogen (NO_x) and PM_{10} emission limits as set out in the European Directive 97/68/EC (as

(1) Clean Air Law 5768-2008,
http://www.sviva.gov.il/English/Legislation/Documents/Clean%20Air%20Laws%20and%20Regulations/CleanAirLaw2008.pdf, last accessed 7th of November 2017

(2) Clean Air (Air Quality Values) Regulations (Temporary Provision) 5771-2011,
http://www.sviva.gov.il/English/Legislation/Documents/Clean%20Air%20Laws%20and%20Regulations/CleanAirRegulations-AirQualityValues-2011.pdf, last accessed 7th of November 2017

(3) Ambient Air Quality presentation, Ministry of Environmental Protection,
https://www.ehf.org.il/sites/default/files/Ambient_Air_Quality_Levana_Kordova_Biezuner_1.2017.pdf, last accessed 7th of November 2017

(4) Ambient Air Quality presentation, Ministry of Environmental Protection,
https://www.ehf.org.il/sites/default/files/Ambient_Air_Quality_Levana_Kordova_Biezuner_1.2017.pdf, last accessed 7th of November 2017

(5) IFC, General EHS Guidelines: Environmental, Air emissions and ambient air quality, April 2007.

(6) World Health Organization (2000). Air Quality Guidelines for Europe, Second Edition, Chapter 11.

amended) on non-road mobile machinery emissions. Stage IIIB emission limits are presented in *Table 3.2*.

Table 3.2 European Stage IIIB Emission Limits for Engines

Net Power (kW)	NO_x (g/kWh)	Particulates (g/kWh)
130 - 560	2.0	0.025
75 - 130	3.3	0.025
56 - 75	3.3	0.025
37 - 56	4.7 (sum of hydrocarbons and NO_x)	0.025

3.2.2 *Noise*

Israeli Standards

The Israeli noise level regulations and guidance that are relevant to this project are listed below:

- Abatement of Nuisances Regulations (Unreasonable Noise), 1990; and
- Abatement of Nuisances Regulations (Unreasonable Noise from Construction Equipment), 1979.

In the *Abate of Nuisances Regulations (Unreasonable Noise) 1990*, daytime is defined as the 16 hour period from 06:00 to 22:00; and the night is 8 hours from 22:00 to 06:00. Environmental noise levels are expressed in A-weighted decibels (dB(A)). The regulations outline limit values for noise depending on the land use and type of property, which are relevant for the production phase of the project (see *Table 3.3*). It is noted however that these limits do not apply to noise sources such as airplanes, vehicles, railway and non-permanent construction equipment.

The *Abatement of Nuisances Regulations (Unreasonable Noise from Construction Equipment), 1979* stipulate a noise limit for a list of construction equipment types, i.e. sound pressure level of 80 dB(A) as measured at a distance of 15 meters.

Table 3.3 Israeli Indoor Noise Limits

	Indoor noise limit, LAeq, dB(A)	
Structure Type	Daytime 06:00 – 22:00 (1)	Night time 22:00 – 06:00 (2)
A – building used as a hospital, sanatorium, convalescent home, senior citizens home or school	45	35
B –building in a residential zone	50	40
C – building within mixed land use area comprising residential and either commercial, small scale production or entertainment	55	40
D – residential apartment in an area where lands are used for industry, commerce or small scale production purposes	55	40
E – building used for industry, commerce or small scale production purposes in an area used for industrial / commercial / small scale production purposes	70	70

Structure Type	Indoor noise limit, LAeq, dB(A)	
	Daytime 06:00 – 22:00 [1]	Night time 22:00 – 06:00 [2]
Notes: (1) Where duration of noise is more than 9 hours. (2) Where duration of noise is more than 30 minutes.		

International Standards

The IFC has produced guidance for the assessment and management of noise[1], which includes criteria applicable for the production phase of the project, as shown in *Table 3.4*. This applies to stationary noise sources and not transport or mobile noise sources.

Table 3.4 IFC/ World Bank Noise Level Guidelines

Type of Property	Maximum Allowable Ambient Noise Levels, LAeq,1hr, dB(A) free field	
	Daytime 07:00 – 22:00	Night-time 22:00 – 07:00
Residential, institutional, educational	55	45
Industrial, commercial	70	70

The guidance also states that *"impacts should not exceed the levels presented, or result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site"*. Background noise in this context is the noise measured in dB $L_{Aeq,,}$ excluding high noise events such as aircraft flyovers and passing trains. This noise increase criterion only applies when the existing background noise level exceeds the day and night-time standards.

In accordance with IFC General EHS Guidance, when host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent.

There are no IFC noise level guidelines specific to construction activities.

The Israeli regulations stipulate a noise limit at the noise source, i.e. construction equipment. There is no national guidance for noise at the receptor due to construction worksite activities and traffic.

To evaluate the impact of temporary activities, it is necessary to establish criteria above which some significant adverse effect may be experienced. The criteria used for this assessment, as presented in *Annex A,* are not noise limits for construction activities, but are used solely to determine whether significant impacts are expected to occur.

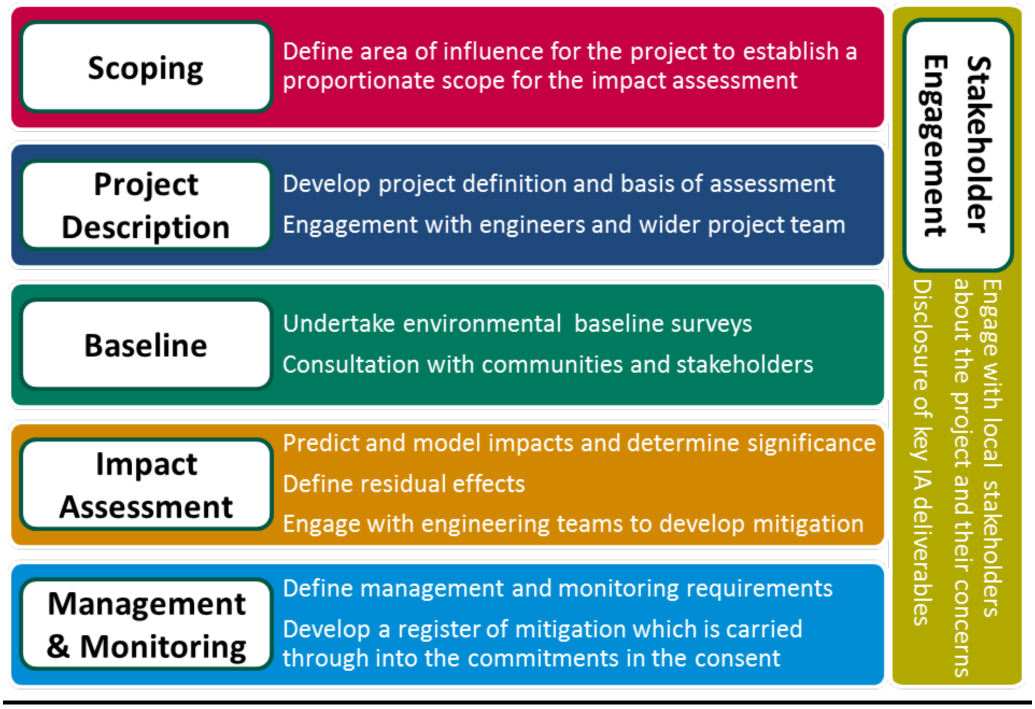
(1) Environmental Health, and Safety (EHS) Guidelines – General EHS Guidelines: 1.7 - Environmental Noise Management, IFC, (2007).

4 ESIA METHODOLOGY

4.1 THE ESIA PROCESS

Impact assessment is the key step in the overall ESIA process (as illustrated in *Figure 4.1*). It draws on the outputs of scoping, uses the results of baseline data collection and provides a central input into the stakeholder engagement process. The impact assessment process identifies the potential significant impacts that may result from the Project. It takes into consideration design measures. The ESIA then identifies mitigation measures that may be used to avoid, prevent, mitigate or compensate for the potential impacts. These mitigation actions will form the basis of long-term management measures.

Figure 4.1 ESIA Process



4.2 IMPACT ASSESSMENT METHODOLOGY

The purpose of the impact assessment process is to identify any likely significant effects on receptors/resources as a result of impacts from a Project and develop appropriate mitigation measures to effectively manage these environmental and social effects. The process is iterative, as summarised in *Figure 4.2*.

The detailed impact assessment methodology that will be used complies with international best practice.

Overview

The purpose of the impact assessment process is to idenŸfy any likely significant e+ects on receptors/resources as a result of impacts from a Project and develop appropriate miŸgaŸon measures to e+ecŸvely manage these environmental and social e+ects. The process is iteraŸve and can be summarised by the figure to the right.

The detailed impact assessment methodology that will be used complies with internaŸonal best pracŸce for impact assessment. The overarching principles of this methodology are illustrated here, but note that each ESIA topic area will have specific criteria for defining receptor sensiŸvity/vulnerability and impact magnitude.

EvaluaŸon of Significance

The significance of the potenŸal e+ect on receptors/resources is determined through the combined consideraŸon of:

x the sensiŸvity/vulnerability of the a+ected environment, and
x the magnitude of the potenŸal impact.

Note that the term 'magnitude' is used as shorthand to encompass various possible dimensions of the predicted impact, such as:

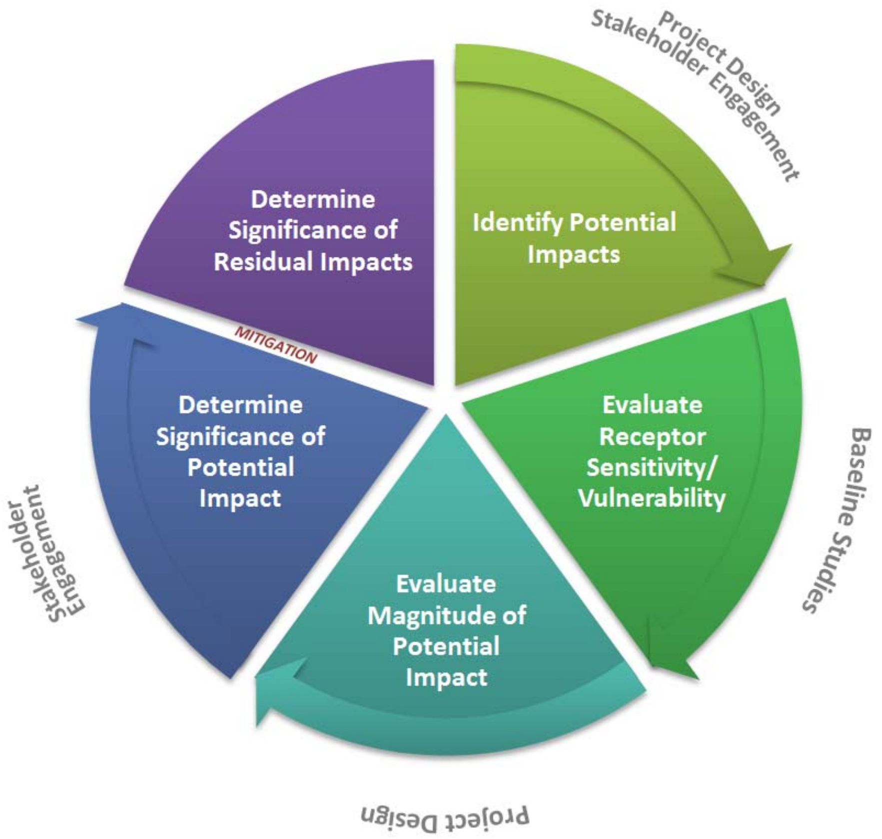
x the nature of the change (what is a+ected and how);
x its size, scale or intensity;
x its geographical extent and distribuŸon;
x its duraŸon, frequency, reversibility ; and
x where relevant, the probability of the impact occurring as a result of accidental or unplanned events.

There is no statutory or agreed definiŸon of significance however, for the purposes of this assessment, the following pracŸcal definiŸon is proposed:

An impact will be judged to be significant if, in isolaŸon or in combinaŸon with other impacts, the e+ects will be a notable change from baseline condiŸons and may require miŸgaŸon to management environmental/social e+ects/risks.

Magnitude and vulnerability/sensiŸvity will be looked at in combinaŸon to evaluate whether an impact is significant and if so its degree of significance. The principle is illustrated here.

The impact assessment process evaluates both beneficial and adverse impacts, however the magnitude raŸng is only assigned for adverse impacts.



Residual Impacts/E+ects

Is it sŸll significant?

Once miŸgaŸon has been idenŸfied, a rerassessment of impacts to determine the magnitude and significance of any residual e+ects (aL er miŸgaŸon) will be undertaken.

The results will be represented in the final ESIA Report and with an explanaŸon of how the impacts have been reduced to as low as reasonably pracŸcable (ALARP) and why further miŸgaŸon of any remaining significant e+ects is not technically or financially feasible.

Figure 4.2: Environmental and Social Impact Assessment Method

4.3 *TOPIC-SPECIFIC METHODOLOGIES*

4.3.1 ***Overview***

Each ESIA topic area has specific criteria for defining receptor sensitivity/vulnerability and impact magnitude. The topic-specific methodologies for each of the subject areas where a detailed impact assessment has been 'scoped in' are provided in *Annex A.*

5 SCOPE OF THE ASSESSMENT

5.1 DEFINING THE SCOPE OF THE ESIA

The scoping process identifies the potentially most important/significant impacts and effects (including secondary, indirect and cumulative) for the assessment to address.

The scope of the ESIA is established by answering the following key questions:

- What? What are the Project components (facilities and activities) being assessed? What are the assessment topics being evaluated?
- Where? What is the physical footprint of the Project for the assessment?
- When? When will the activities occur? What is the temporal footprint of the Project for the assessment?

As presented in the Scoping Report (1), potential impacts were classified as 'scoped in', 'scoped in (limited assessment)' or 'scoped out'. Those potential impacts that were classified as 'scoped in' or 'scoped in (limited assessment)' are assessed in this report.

5.2 PROJECT COMPONENTS

The IFC Performance Standards require project proponents to identify and manage environmental and social risks and impacts within their Area of Influence. The Area of Influence (AoI) is defined in Performance Standard 1 as:

- *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 and that 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 impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted.*

(1) Scoping Report, Karish Development, May 2017.

The appropriate level of assessment and management of risks and impacts is determined by the degree of control that the Project is able to exercise over its facilities or activities; and by the importance of the facilities or activities to the Project's successful operation. The first step in defining the Area of Influence is to classify the facilities and activities ('the project components') that make up the Project. The following project component categories are considered for this Project:

- **Core component.** Facilities constructed and operated by the Project, and activities directly associated with their construction and operation. The Project is expected to have full control of these components in terms of management of risks and impacts.

- **Associated component.** Third party facilities that have been constructed or expanded as part of the Project and that are essential to its successful operation. Activities associated with constructing and operating these facilities are also considered associated components. As the component is dependent on the Project, and vice versa, the Project is expected to have a high level of control. Note that these types of components are considered to meet the definition of an associated facility per Performance Standard 1. No components of the Project have been identified as associated components.

- **Primary supply chain.** Third parties supplying goods or materials that are essential to the successful operation of the Project, on an ongoing basis. The level of control the Project can exercise may be limited, especially for suppliers further along the supply chain. Primary supply chain elements for the Project include quarries providing gravel.

- **Other third party activities.** Facilities constructed or operated by third parties, and associated activities, which are not essential to the successful operation of the Project, for example use of the container port. These are not within the Project's area of influence. A possible exception would be development that occurs as a result of the Project's existence, but that is not part of the Project itself. The potential for this kind of induced development to occur will be considered as part of the impact assessment.

Table 5.1 provides a full list of the components considered in this assessment.

Table 5.1 Classification of Project Components

Project Facilities and Activities	Classification
Wells for Karish	Core component
Umbilicals for Karish	Core component
Subsea infrastructure for Karish	Core component
Export pipeline (Karish to Dor Valve Station)	Core component
Coastal Valve Station	Core component
Dor Valve Station	Core component
FPSO	Core component
Marine transport for Project	Core component
Helicopter transport for Project	Core component

Project Facilities and Activities	Classification
Road transport for Project	Core component
Existing logistics base (Port of Haifa)	None (Outside of ESIA scope)
Operation of tankers offloading oil (unplanned events at the FPSO are included)	None (Outside of ESIA scope)
Fabrication of FPSO	None (Outside of ESIA scope)
Fabrication of pipeline	None (Outside of ESIA scope)

5.3 TEMPORAL SCOPE

For the purposes of the impact assessment the Project has been divided into six phases: fabrication (scoped out), drilling and well completion, pipeline construction, installation, production, and decommissioning (scoped out). The project schedule and further details of the activities occurring within each phase of the Project can be found in *Section 2.2.2.*

5.4 SPATIAL SCOPE

The spatial scope includes all areas within which potentially significant impacts may occur. The spatial scope for each topic area has been illustrated as buffers around the project components, which are the potential sources of impact. The distances for each of these buffers are provided in *Table 5.2* to *Table 5.5*. A composite of these buffers then forms the overall spatial scope of the impact assessment.

Table 5.2 Drilling and Well Completion Spatial Scope

Topic	Spatial Scope Distances
Marine Biodiversity	Within 500 m of wells and subsea infrastructure for impacts on benthic communities Within 2 km of drillship for underwater noise
Social	x Fishermen in offshore area x Marine traffic in offshore area (within 500 m of wells and subsea infrastructure) x Workers
Unplanned Events	Extent variable depending on spill , see modelling report for maps showing scenarios considered

Table 5.3 Pipeline Construction Spatial Scope

Topic	Spatial Scope Distances
Marine Biodiversity	Within 1 km of export pipeline
Terrestrial Biodiversity	2km buffer around onshore footprint of construction works
Air quality (human receptors)	10km from construction sites
Noise and vibration (human receptors)	1km from onshore construction activities
Visual amenity	Dor, Nahsholim Seaside Resort

Topic	Spatial Scope Distances
Social and community health	x Village of Dor, Nahsholim, Maya'an Tzvi, Zichron Ya'akov, and Fureidis x Road users on existing roads used by the Project x Fishermen in offshore area x Marine traffic in offshore area (within 500 m of export pipeline) x Any agricultural users in the vicinity of the pipeline corridor (e.g. fish farms, avocado plantations) x Workers
Visual Amenity	Dor, Nahsholim Seaside Resort
Unplanned Events	Given the volumes and planned prevention measures, any unplanned spills/leaks of oil would be small, with very localised impacts

Table 5.4 Installation Spatial Scope

Topic	Spatial Scope Distances
Marine Biodiversity	Within 500 m of wells and subsea infrastructure
Social	x Fishermen in offshore area x Marine traffic in offshore area (within 500 m of wells and subsea infrastructure) x Workers

Table 5.5 Production Spatial Scope

Topic	Spatial Scope Distances
Marine Biodiversity	Within 500 m of wells and subsea infrastructure
Air quality (human receptors)	Within 200 m of the FPSO
Social	Workers at FPSO
Unplanned Events	Extent variable depending on spill , see modelling report for maps showing scenarios considered

6 BASELINE CONDITIONS

6.1 INTRODUCTION

This chapter provides a description of the current baseline against which the potential impacts of the Project can be assessed. This baseline has been split into three sections:

- the offshore environment including the Karish Main field and the deep water section of the dry-gas pipeline up to the planned INGL interface manifold in approximately 60 to 100 m water depth;
- the nearshore environment covering the shallow water section of the dry-gas pipeline from the INGL interface manifold to shore; and
- the onshore environment including the onshore dry-gas pipeline section, the CVS and DVS.

The information provided in this section draws on a combination of publically available information reviewed during a desk-based study, previous impact assessments prepared by third parties and observations recorded during the onshore site reconnaissance survey conducted in June 2017 by P3EHS Ltd(1). In addition to these data sources, Energean is planning a full environmental baseline survey (EBS) for the offshore and nearshore environments in Q4 2018.

As the results of the EBS were not available at the time of writing, for the offshore and nearshore environment this baseline relies upon information presented in the pre-drilling and post-drilling reports for the Karish-1 exploration well (CSA Ocean Science Inc. 2013 [(2)] and 2014 [(3)]), EIAs for nearby oil and gas development (e.g. Noble's Leviathan EIA 2016 [(4)]) and other publically available sources.

6.2 OFFSHORE ENVIRONMENT

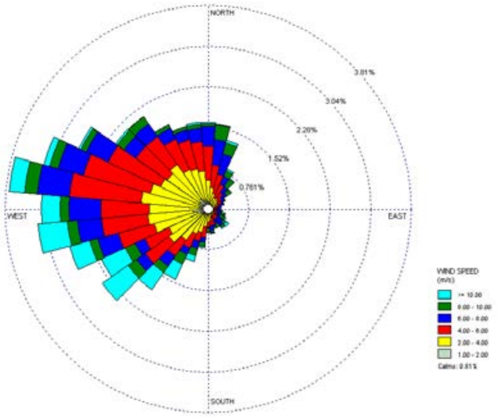
6.2.1 Climate and Meteorology

The Eastern Mediterranean and Levantine Sea is situated between the sub-tropics and mid-latitudes. The climate is characterised by westerly prevailing winds with a monthly average wind speed of 5 ms^{-1}, and a westerly prevailing wave direction with maximum wave heights seldom exceeding 1.5 m. Warm, dry and still summers are contrasted with regular cyclonic storm tracks that occur most frequently between December and April.

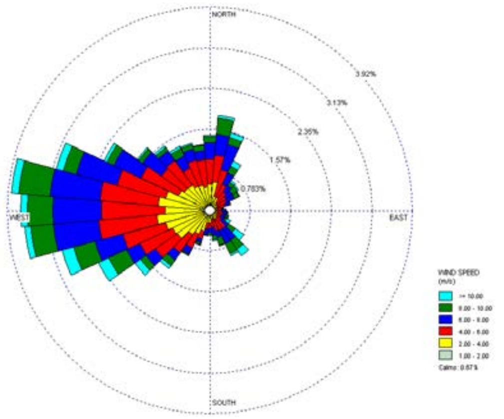
1) Onshore Site Reconnaissance Survey. Energean Oil and Gas. P3EHS Ltd. June, 2017.
(2) CSA Ocean Sciences Inc. (2013) Karish-1 Exploration Program Environmental Impact Assessment.
(3) CSA Ocean Sciences Inc. (2014) Karish-1 Environmental Monitoring Program Post-Drill Survey Report.
(4) CSA Ocean Sciences Inc. (2016) Environmental Impact Report for Production Drilling, Production Tests, and Completion – Leviathan Field

Because there are no monitoring locations offshore, modelled Weather Research and Forecasting data was purchased from Lakes Environmental Software. The meteorological data covers the five most recent years (2012-2016) and in centred on the FPSO's location. The wind roses for the years 2012-2016 are presented in *Figure 6.1* and show that the prevailing wind direction at the FPSO is mainly from the west for all the years.

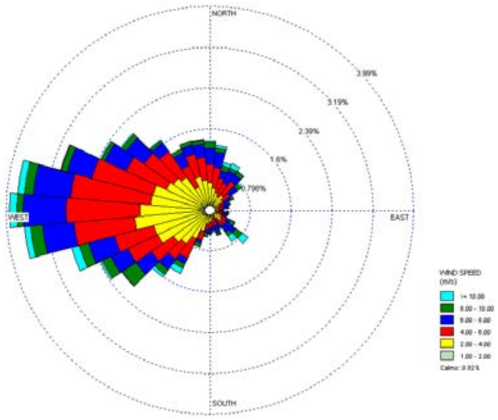
Figure 6.1 Wind Roses at the FPSO Location (2012-2016)



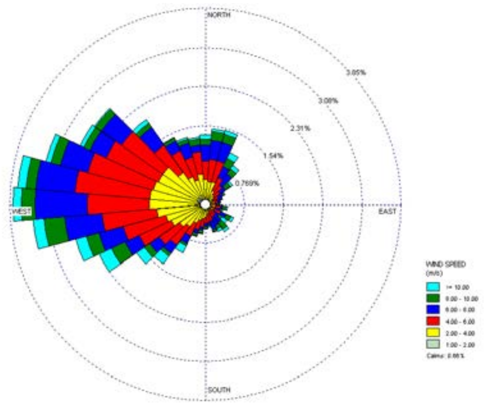
2012



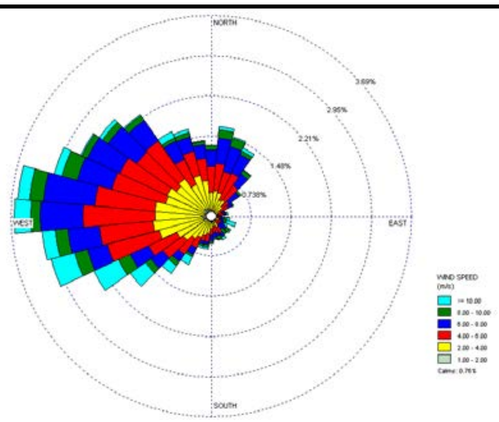
2013



2014



2015



2016

6.2.2 *Air Quality*

There are no site specific air quality data for the Karish Main field offshore area. However, given the absence of constant anthropogenic sources and natural sources of dust, air quality is expected to be very good near the field, decreasing in quality nearer the coast. It is assumed that no air quality standards are exceeded.

6.2.3 *Seismic Activity*

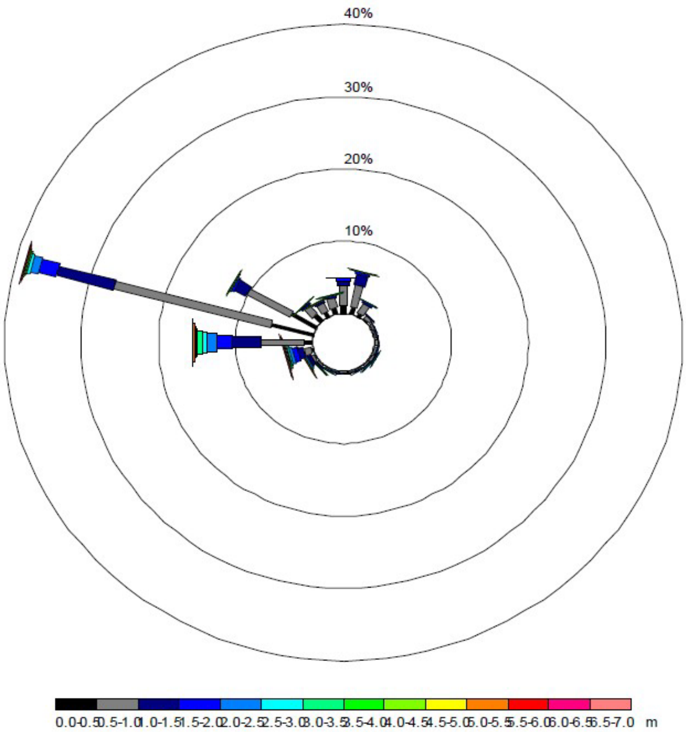
There have been four recorded earthquakes within 25 km of the Karish field since 1988; the largest of the four was magnitude 3.7. There have been no earthquakes of magnitude 6 or greater on the Richter scale within 200 km of the Karish field recorded since 1979.

6.2.4 *Oceanography and Hydrology*

Waves

Wave heights at the proposed FPSO location (1) are less than 1.5 m for approximately 85% of the year. The dominant wave direction is from the west to northwest, which occur for over 70% of the year. These wave conditions are suggestive of a benign offshore environment. Wave heights and direction are illustrated in *Figure 6.2*.

Figure 6.2 Year Round Wave Rose at Karish FPSO Location (from BMT ARGOSS)

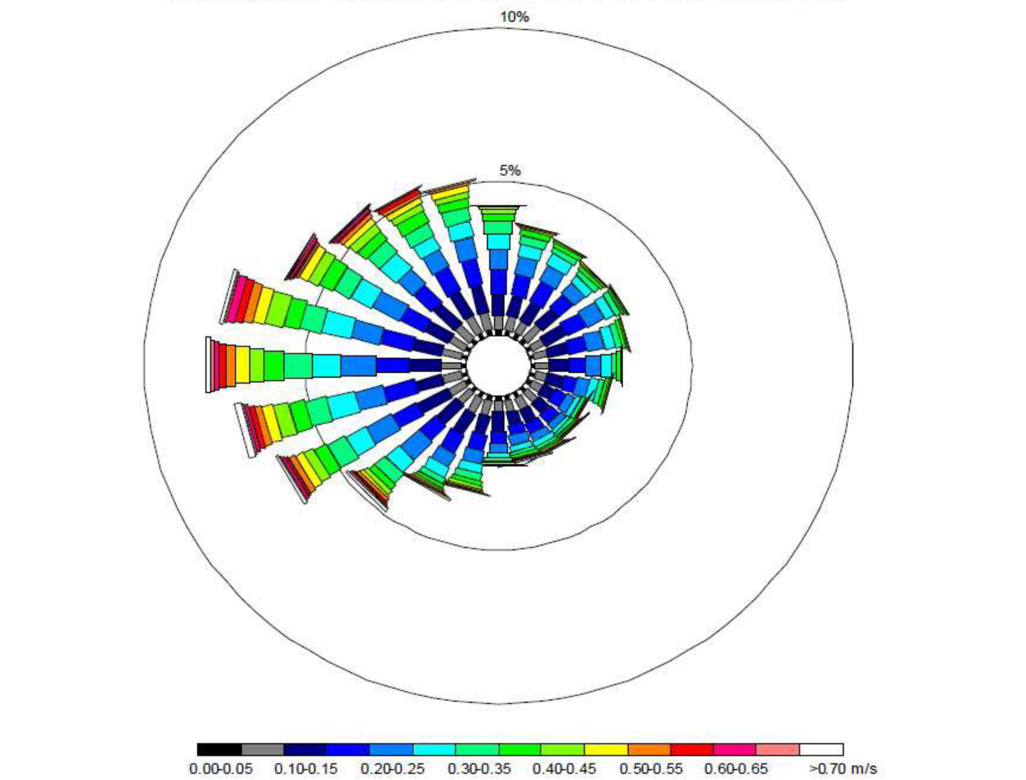


(1) Energean (2017) Karish and Tanin Field Development Plan. ISR-GEN-RP-PJM-0025

Currents

The currents experienced at the proposed FPSO location (1) are very mild, as is generally expected in the Eastern Mediterranean Sea. Surface current speeds are less than 0.5 ms^{-1} for 96% of the year. The predominant current direction is from the west. Currents from this direction prevail for over half the year. The current speed and direction are illustrated in *Figure 6.3*.

Figure 6.3 Year Round Current Rose at Karish FPSO Location (from BMT ARGOSS)



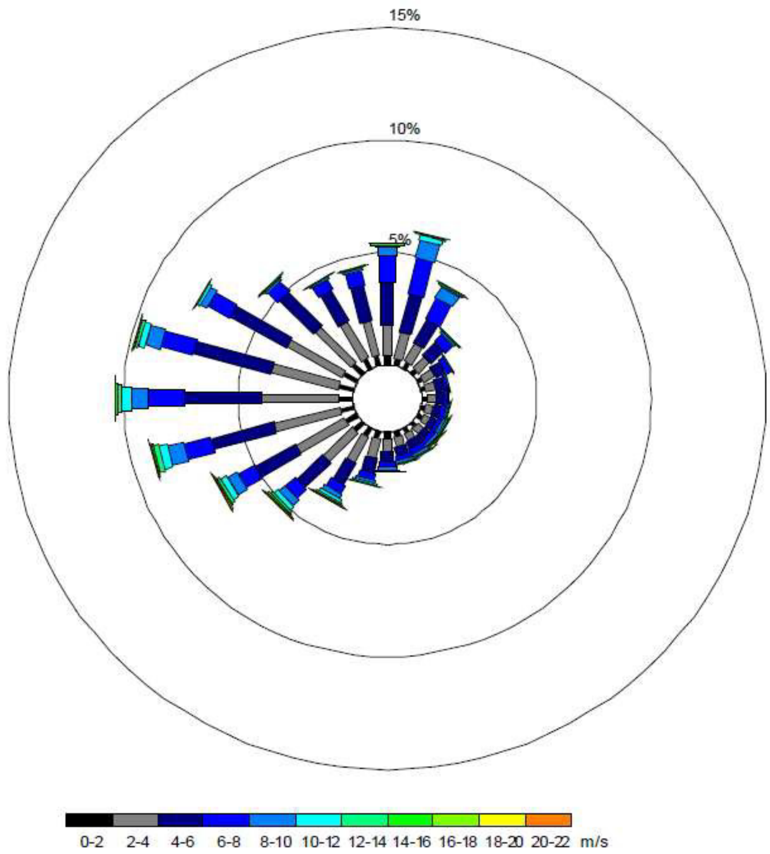
Wind

The direction of the wind at the proposed FPSO location (2) is more scattered compared to that of waves. The direction suggests that only westerly winds and North Eastern winds are able to raise significant waves. The dominant winds are from the southwest and northwest, which occur for 75% of the year. Wind speed and direction are illustrated in *Figure 6.4*.

(1) Energean (2017) Karish and Tanin Field Development Plan. ISR-GEN-RP-PJM-0025

(2) Energean (2017) Karish and Tanin Field Development Plan. ISR-GEN-RP-PJM-0025

Figure 6.4 Year Round Wind Rose at Karish FPSO Location (from BMT ARGOSS)



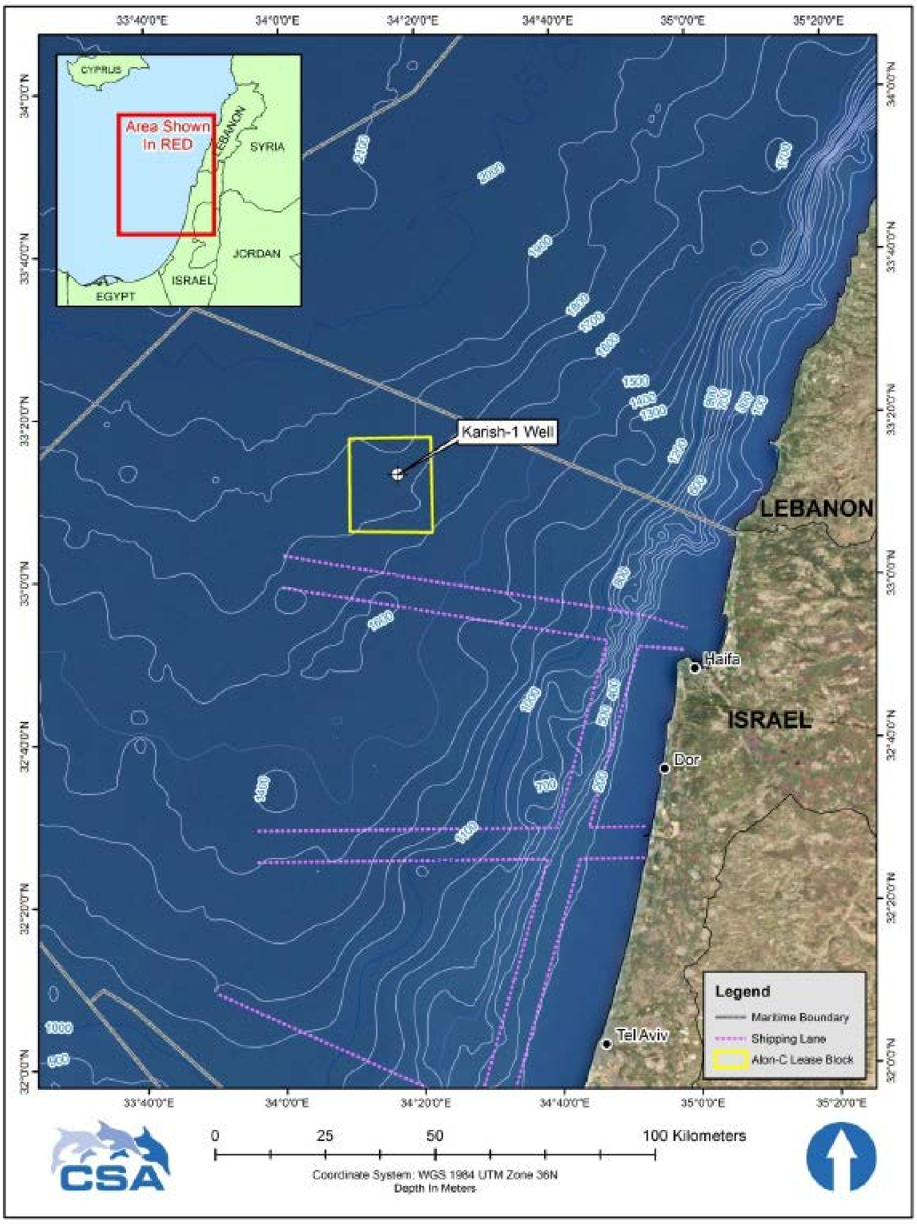
6.2.5 *Bathymetry and Seabed Topography*

The water depth at the proposed Karish FPSO location is approximately 1,700 m and the bathymetry in the Karish Main field is characterised by relatively flat seabed topography and a soft bottom substrate [(1)]. *Figure 6.5* shows the location of the Karish-1 drill site in relation to regional bathymetric contours.

Videography was used to determine topography and bottom substrate during the Post Drill Survey at the Wellsite and within 75m of the wellbore where some disturbance indication was found. No hard bottom substrate or chemosynthetic communities were observed in the survey area.

(1) CSA Ocean Sciences Inc. (2013) Karish-1 Exploration Program Environmental Impact Assessment.

Figure 6.5 Bathymetry Offshore Israel



Source: Karish-1 Environmental Impact Assessment 2013

6.2.6 *Water Characteristics and Quality*

The offshore Environmental Baseline Survey (EBS) for the Project has not yet been completed. The data presented in this section is from the Karish-1 exploration well pre-drilling survey report (1).

Water temperature in the Karish field area ranged between approximately 23°C and 26°C, decreasing with depth to approximately 14°C below 400 m and remaining constant into deeper waters. Salinity was measured between 38.5 and 39.5 parts per thousand (ppt) in surface waters, remaining within this range to a maximum depth of 1,700 m. Dissolved oxygen ranges from 60 to 100% saturation in surface waters, decreasing with depth down to

(1) CSA Ocean Sciences Inc. (2013) Karish-1 Exploration Program Environmental Impact Assessment.

approximately 70% at around 400 m and remaining constant into deeper waters.

Total suspended solid (TSS) concentrations appeared to be slightly elevated throughout the area relative to TSS levels that may be expected in the open ocean environment of the eastern Mediterranean. Average TSS values among samples ranged from 15 to 29 mg L^{-1} at near-surface, 15 to 35 mg L^{-1} at middepth, and 8 to 13 mg L^{-1} at near-bottom. TSS levels recorded from the area were considerably higher than those reported for northeastern Mediterranean surface waters, which ranged from 0.6 to 1.7 mg L^{-1}.

The eastern Mediterranean is known as a highly oligotrophic body of water with high water column transparency. The low TSS levels and high underwater transparency expected in the eastern Mediterranean are attributed to low water column productivity and low terrestrial inputs from riverine discharges. Deep-sea near-bottom water generally has few suspended solids due to few disturbances that stir up the sediment on the seafloor; small particles transported from the surface usually are entrained in subsurface currents or pycnoclines (i.e. density gradient) or dissolved before reaching the seafloor.

The eastern Levantine Basin has extremely low levels of nutrients, and the region is considered “ultra-oligotrophic.” Nitrate and phosphate concentrations in surface waters in the eastern Mediterranean are one-half their concentrations in the western basin. This severe nutrient deficit is due to the very low net supply of nutrients to the Mediterranean Basin, as the Atlantic inflow brings in nutrient-depleted surface waters and there is very little nutrient input from rivers in the eastern Levantine Basin. Total organic carbon (TOC), total nitrogen (TN), and total phosphorus (TP) concentrations in seawater samples were generally low and nearly uniform throughout the water column and Karish area.

All seawater total metal concentrations recorded in the Karish area were below the toxicity reference values (marine Criterion Continuous Concentrations, CCC).

Alkanes and PAHs were not detected in seawater from the Karish area.

6.2.7 *Sediment Characteristics and Quality*

The EBS for the Project has not yet been completed. The data presented in this section is from the Karish-1 exploration well pre-drilling and post-drilling survey reports [1] [2].

Sediments were composed primarily of silt and were generally classified as clayey silt, with several stations classified as sand-clay-silt, sandy-silt, or silt. These grain size characteristics are as expected for deepwater sediments located far from riverine discharges and terriginous sediment sources. There were no major differences in sediment texture based on grain size distributions among the sampling stations. The seafloor within 200 m of the

(1) CSA Ocean Sciences Inc. (2013) Karish-1 Exploration Program Environmental Impact Assessment.
(2) CSA Ocean Sciences Inc. (2014) Karish-1 Environmental Monitoring Program Post-Drill Survey Report.

wellhead was peppered with coarse, unconsolidated sediments; however, the grain size results indicate that these sediments did not substantially alter the seafloor post-drilling.

Sediment TOC concentrations were low (4.2 to 13.9 ppm) throughout the survey area. The low TOC content is reflective of the deep sea environment and oligotrophic nature of the eastern Mediterranean.

Total metals concentrations in the survey area were generally within the range of concentrations found in average marine sediments and the continental crust, with the exceptions of arsenic (As) and copper (Cu). Concentrations of As and Cu in samples from the survey area were higher than the corresponding Effects Range Low (ERL) value for each respective metal. A concentration below an ERL represents a minimal-effects range where biological effects are rarely observed. The metal concentrations that are above ERL values are likely natural since there has been minimal anthropogenic influence in the survey area.

The concentrations of organics (hydrocarbons) in samples were all below the limits of detection indicating that naturally occurring hydrocarbon concentrations within the survey area are extremely low.

6.2.8 *Marine Habitats and Species*

Phytoplankton

Phytoplankton derive energy from sunlight and constitute the base of the food web in marine ecosystems. Production and overall biomass of phytoplankton is restricted by the low nutrient concentration in the water of the eastern Mediterranean. Primary production for the Levantine Basin was estimated to be less than 150 Cm^2 per day (1). This rate represents a third less than primary production found in the Mediterranean waters west of Italy (2) .

Phytoplankton abundance is at its highest between the month of November and March. During this period, storms produce water column mixing, leading to increased nutrients in the surface waters (3). Phytoplankton are most productive in the surface mixed layer, between the surface and 50 m depth (4).

Zooplankton

Zooplankton serve as intermediary between phytoplankton to higher trophic levels. The highest biomass of zooplankton is found in the surface mixed layer (0 to 50 m) (5). Although 80% or more Zooplankton belong to the

(1) Moutin and Raimbault, 2002 cited by CSA Ocean Sciences Inc. (2014) Karish-1 Environmental Monitoring Program Post-Drill Survey Report.
(2) CSA Ocean Sciences Inc. (2016) Environmental Impact Report for Production Drilling, Production Tests, and Completion – Leviathan Field
(3) Krom et al 1991, cited by CSA Ocean Sciences Inc. (2014) Karish-1 Environmental Monitoring Program Post-Drill Survey Report.
(4) CSA Ocean Sciences Inc. (2014) Karish-1 Environmental Monitoring Program Post-Drill Survey Report.
(5) CSA Ocean Sciences Inc. (2014) Karish-1 Environmental Monitoring Program Post-Drill Survey Report.

Copepods taxonomic group [1], at least another twenty-one zooplankton taxa are found in the eastern Levant Basin [2].

Benthic Communities

Benthic communities in the Karish Main field are typical of Mediterranean soft sediment habitats and are dominated by polychaetes such as *Notomastus* sp. and *Paraonidae* sp.; bivalves including *Trichobranchidae* sp.; gastropods such as *Microgloma tumidula*; and shrimp and other crustaceans including Cumacea, Decapods, Isopds and Ostracods. Some areas of bioturbation, including patterned burrows and conical mounds created by infauna, are present.

Fish and Other Nekton

The sea offshore Israel is classed as being ultraoligotrophic. In the easternmost Levant Basin only 350 out of the 664 indigenous fish species are reported [3]. The gradient of abundance in species is believed to be correlated with gradients of increasing temperature and salinity and decreasing productivity. The particularly low productivity of the eastern Mediterranean also leads to a phenomenon referred to as nanism, which describes a phenomena where individuals of certain species mature at smaller sizes than they would elsewhere [4].

The ichthyofauna is mainly composed of species with Atlantic (75%) and cosmopolitan (20%) origins. Indo-Pacific species introduced through the Suez Canal remain important additions in the Levant region. Sixty fish species of Indi-Pacific origin have been introduced in the Levant region and some have become numerically dominant in some habitats, affecting local ecosystems and fisheries [5].

Pelagic Fishes

Pelagic species found off the Israeli coast are represented by sharks (Carcharhinidae), anchovies (*Engraulis* sp.), herrings (*Sardinella aurita*), jacks (*Trachurus* sp. and *Seriola dumerili*), mackerels (*Scomber japonicus*), tunas (*Euthynnus* spp., *Auxis* sp.), mullets (Mugilidae) and barracudas (*Sphyraena* sp.). These species tend to move parallel to the coastline, and respond to vertical and horizontal changes in water temperature and to prey availability.

Demersal Fishes

Demersal fishes in water depths ranging from 1,000 to 4,264 m, a tripodfish (*Bathypterois mediterraneus*) and a grenadier (*Nezumia sclerorhynchus*) dominate [6].

(1) Mazzocchi et al 1997 cited by CSA Ocean Sciences Inc. (2014) Karish-1 Environmental Monitoring Program Post-Drill Survey Report.
(2) CSA Ocean Sciences Inc. (2013) Karish-1 Exploration Program Environmental Impact Assessment.
(3) Golani 2005 cited by CSA Ocean Sciences Inc. (2013) Karish-1 Exploration Program Environmental Impact Assessment.
(4) CSA Ocean Sciences Inc. (2013) Karish-1 Exploration Program Environmental Impact Assessment.
(5) CSA Ocean Sciences Inc. (2013) Karish-1 Exploration Program Environmental Impact Assessment.
(6) Jones et al 2003 and Galil 2004 cited by CSA Ocean Sciences Inc. (2013) Karish-1 Exploration Program Environmental Impact Assessment.

Marine Mammals

The eastern Mediterranean commonly supports four cetacean species and one pinniped (seal) species. Those residing in the Levantine basin are bottlenose dolphin (*Tursiops truncatus*), Cuvier's beaked whale (*Ziphius cavirostris*), short-beaked common dolphin (*Delphinus delphis*) and striped dolphin (*Stenella coeruloalba*). The Aegean Sea to the north supports the largest remaining European population of globally Endangered Mediterranean monk seal (*Monachus monachus*) and it is possible that the species forages in the waters of the Karish field. The monk seal is classified as Endangered on IUCN's Red List of Threatened Species.

Marine Turtles

The Israeli coastline is known to support the nesting of loggerhead turtles (*Caretta caretta*), which are listed by the IUCN as Vulnerable. Nesting is from May to the end of July for loggerheads and from mid-June to mid-August for green turtles (*Chelonia mydas*), which are also known to nest along the coast; green turtles are categorised as Endangered according to IUCN. Leatherback turtles (*Dermochelys coriacea*) are also found in this region. The presence of two other Critically Endangered species, hawksbill (*Eretmochelys imbricate*) and Kemp's ridley (*Lepidochelys kempii*), are considered rare in the Mediterranean.

Birds

Given the distance offshore and the apparently sparse fish distribution in the open seas of the Karish field, seabird abundance is expected to be low. Further studies are required relating to the likely seasonal presence of migratory birds species that may pass over the Karish field. This will also ascertain whether coastal habitats along the gas export pipeline and around the landfall are important areas for feeding and/or breeding birds. Islands near the border with Lebanon are used as a sheltered stopover site for the winter population of great cormorants (*Phalacrocorax carbo*) and by breeding populations of yellow legged gull (*Larus michahellis*).

A variety of species of seabirds and migratory birds are found in the region of the Mediterranean, many which could be present in the area. There are at least 38 seabird species native to Israeli waters; most of those likely to be encountered offshore are pelagic seabirds such as Coy's shearwater (*Calonectric diomedea)*, sooty shearwater (*Puffinus griseus*), yelkouan shearwater (*Puffinus yelkouan*) and Leach's storm petrel (*Oceanodroma leucorhoa*).

Two seabird species are listed as Vulnerable by the IUCN: the dalmation pelican (*Pelecanus crispus*) and the yelkouan shearwater *(Puffinus yelkouan*). Other species present in Israel are shown in *Figure 6.6*.

Figure 6.6 Seabird Species Present in Israeli Waters

Common Name	Scientific Name	IUCN Status[1]	Listed in Annex II[2]	Breeding in Israel[3]
Cory's Shearwater	*Calonectris diomedea*	LC	Yes	--
Black Tern	*Chlidonias niger*	LC	--	--
Caspian Gull	*Larus cachinnans*	LC	--	--
Mew Gull	*Larus canus*	LC	--	--
Lesser Black-backed Gull	*Larus fuscus*	LC		--
Slender-billed Gull	*Larus genei*	LC	Yes	--
Pallas's Gull	*Larus ichthyaetus*	LC	--	--
White-eyed Gull	*Larus leucophthalmus*	NT	--	--
Mediterranean Gull	*Larus melanocephalus*	LC	Yes	--
Yellow-legged Gull	*Larus michahellis*	LC	--	--
Little Gull	*Larus minutus*	LC	--	--
Black-headed Gull	*Larus ridibundus*	LC	--	--
Red-breasted Merganser	*Mergus serrator*	LC	--	--
Northern Gannet	*Morus bassanus*	LC	--	--
Leach's Storm-Petrel	*Oceanodroma leucorhoa*	LC	--	--
Dalmation Pelican[4]	*Pelecanus crispus*	VU	Yes	--
Great White Pelican	*Pelecanus onocrotalus*	LC	Yes	Yes
Great Cormorant	*Phalacrocorax carbo*	LC	--	--
Pygmy Cormorant[4]	*Phalacrocorax pygmeus*	LC	Yes	--
Red Phalarope	*Phalaropus fulicarius*	LC	--	--
Red-necked Phalarope	*Phalaropus lobatus*	LC	--	--
Great-crested Grebe	*Podiceps cristatus*	LC	--	--
Black-necked Grebe	*Podiceps nigricollis*	LC	--	--
Sooty Shearwater	*Puffinus griseus*	NT	--	--
Yelkouan Shearwater	*Puffinus yelkouan*	VU	Yes	--
Long-tailed Jaeger	*Stercorarius longicaudus*	LC	--	--
Parasitic Jaeger	*Stercorarius parasiticus*	LC	--	--
Pomarine Jaeger	*Stercorarius pomarinus*	LC	--	--
Little Tern	*Sterna albifrons*	LC	Yes	Yes
Bridled Tern	*Sterna anaethetus*	LC	--	--
Lesser Crested Tern	*Sterna bengalensis*	LC	Yes	--
Great Crested Tern	*Sterna bergii*	LC	--	--
Caspian Tern	*Sterna caspia*	LC	Yes	--
Common Tern	*Sterna hirundo*	LC	--	Yes
Gull-billed Tern	*Sterna nilotica*	LC	Yes	--
White-cheeked Tern	*Sterna repressa*	LC	--	--
Sandwich Tern	*Sterna sandvicensis*	LC	Yes	--
Brown Booby	*Sula leucogaster*	LC	--	--

Source: Leviathan EIA 2016 (1)

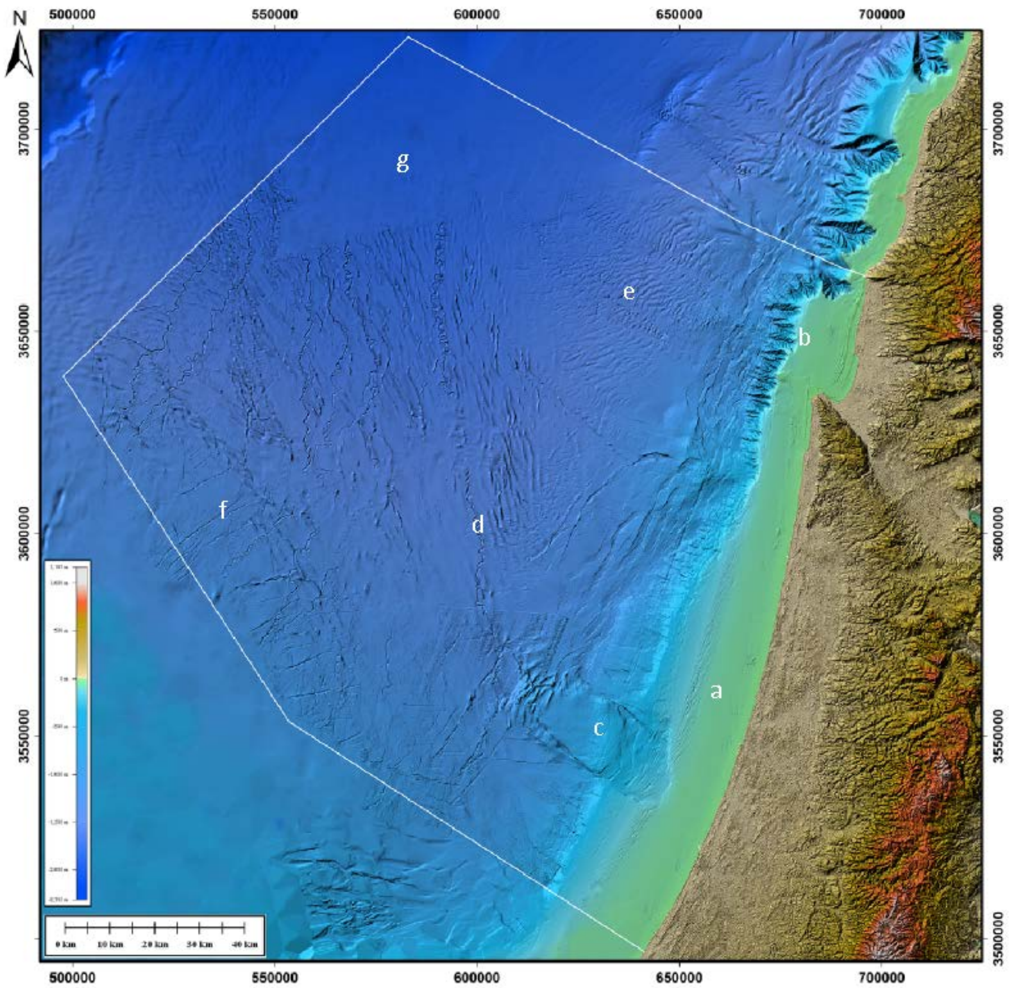
6.3 COASTAL ENVIRONMENT

6.3.1 *Bathymetry and Seabed*

The area along the coastline of Israel shown in *Figure 6.7* consists of a broad and flat submarine continental shelf.

(1) CSA Ocean Sciences Inc. (2016) Environmental Impact Report for Production Drilling, Production Tests, and Completion – Leviathan Field

Figure 6.7 Seabed Characteristics



Source: Ministry of National infrastructure, Energy and Water Resources 2015 (1)

6.3.2 *Water and Sediment Quality*

The National Marine Environmental Monitoring Program (NMEMP) and the Israel Oceanographic & Limnological Research (IOLR) monitoring of Israel's Mediterranean coastal waters in 2005 demonstrate that the overall level of pollution in the area is low with reference to international environmental quality guidelines and criteria. However, Haifa Bay along with other sites along the coastline stands out with instances of metal and organic pollution as well as nutrient over enrichment (2). The main causes of pollution are industrial and urban wastewater (3). *Table 6.1* displays the causes for degraded water quality by area.

Figure 6.8 shows the pollution hot spots and areas of concern along the coast of Israel. Note: the dry-gas pipeline and landfall site are not located within a hot spot area or one that is considered of environmental concern.

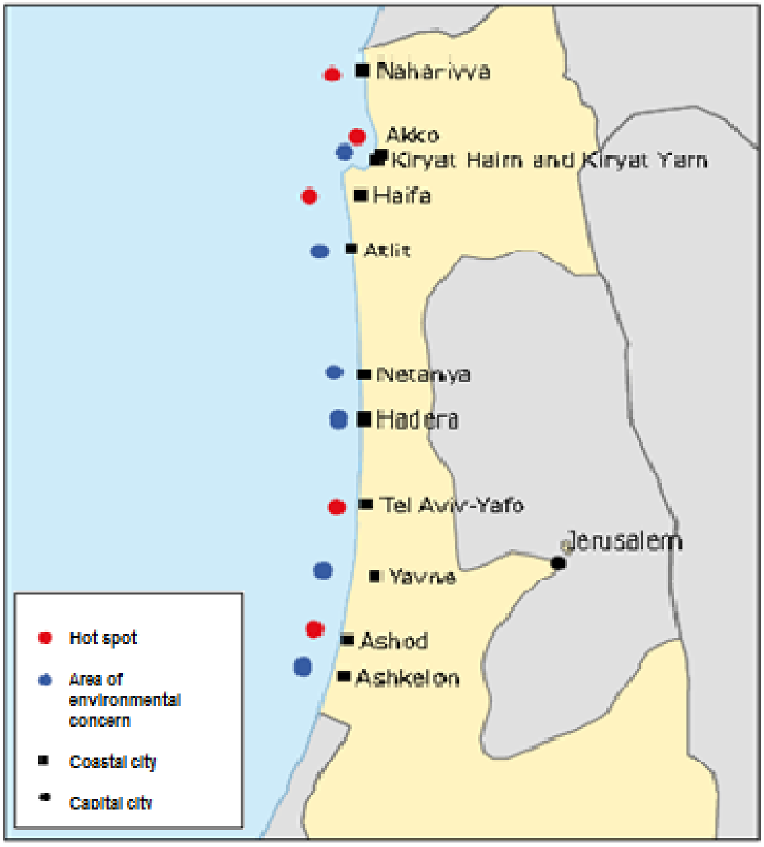
(1) Ministry of National infrastructure, Energy and Water Resources (2015) A New Bathymetric Map for the Israeli EEZ: Preliminary Results.
(2) IOLR (2006) Environmental quality of Israel's Mediterranean coastal waters in 2005
(3) EEA (2006) Priority Issues in the Mediterranean Environment EEA Report No 4/2006.

Table 6.1 Influences on Water Quality by Area

Area	Issues Affecting Water Quality
Haifa	x Urban wastewater. x Industrial wastewater including oil refinery/harbour. x City discharges from Akko, Kiryat Haim, Kiryat Yam. x Cadmium, mercury, lead and zinc accumulating in the sediments of the harbour. x Industrial discharges through the Na'aman River disturbing Haifa Bay.
Hadera	x Urban and industrial wastewater. x Runoffs from agricultural land through the Hadera and Taninim streams.
Tel Aviv – Jaffa	x Urban and industrial wastewater. x Contamination by PCBs and tributyltin (TBT).
Ashod	x Sediments contaminated by organochlorine pesticide, TBT and heavy metals.

Source: Based on information by the EEA 2006 (1)

Figure 6.8 Areas of Environmental Concern



Source: EEA 2006 (2)

(1) EEA (2006) Priority Issues in the Mediterranean Environment EEA Report No 4/2006.
(2) EEA (2006) Priority Issues in the Mediterranean Environment EEA Report No 4/2006.

Table 6.2 Environmental Indicators for Israel's Mediterranean Coastal Waters

Environmental Indicator	Status in 2005	Trends in last decade
Heavy metals in sediments (mercury, cadmium, copper, zinc, lead, nickel, chromium)	**Haifa Bay**: Medium level of mercury pollution in the northern part of the Bay. Medium to low levels of mercury pollution in the Qishon estuary. No change in mercury levels compared to 2004. Low concentrations of other metals.	Mercury pollution decreased. Lead concentrations decreased.
	Coastal rivers: High level of pollution by cadmium, zinc and nickel in the lower reach of the Qishon river; medium level of pollution by mercury, copper, zinc and chromium in Hadera River and by nickel and copper in the Alexander River.	Pollution in the Qishon estuary decreased. No clear trend of change in other rivers.
	Along the coast: In general the concentrations of all metals in shallow areas are at less than harmful levels. High level of mercury pollution and medium level of cadmium pollution in the area of the Tel-Aviv Region Sewage Treatment Plant (TAS). Chromium enrichment along the south coast of Palmachim.	No clear trend in TAS area (seasonal changes in level of pollution)
	Ports and Marinas: High level of pollution by mercury in Haifa Port and Akko Marina; medium level of pollution by several metals in the ports of Haifa, Qishon and Ashdod and in the marinas of Akko, Hertzelia, Ashdod and Ashquelon.	Similar and even higher levels of pollution found previously in Haifa and Qishon ports.
Heavy metals in suspended particulate matter	**Haifa Bay**: Concentrations in southern Haifa Bay, near the Qishon estuary, higher than those recorded outside of the bay.	No change in mercury levels. Cadmium levels in the southern part of the bay decreased as of July 2000.
	Coastal rivers: High concentration of mercury, cadmium and copper in several rivers.	No significant trend.
	Along the coast: Much lower concentrations than in the outlets of the coastal rivers. Cadmium enrichment in the Qishon estuary.	No significant trend.
Heavy metals in fish	Fish fit for consumption with respect to national safety limit. Mercury enrichment in inshore fish from Haifa Bay relative to fish from other areas. Mercury enrichment in some trawl fish from the central part of the coast relative to fish from the south.	Mercury concentrations stabilised at a lower level than in previous decade.
Heavy metals in benthic organisms	**Haifa Bay and Akko**: Mercury enrichment in bivalves and gastropods relative to other areas. Mercury concentrations lower than in 2004. Cadmium enrichment in gastropods from southern Haifa Bay and Akko relative to other areas.	Mercury concentrations in bivalves decreased during 1980 – 1992 and then increased from 1993 to 2002. The trend of increase has stopped in the last 4 years. Cadmium concentrations in the Qishon estuary decreased.
	Along the coast (selected sites): Cadmium enrichment in gastropods at Palmachim.	
Heavy metals in air (dust)	Concentrations similar to Europe and higher than in open sea areas. Lead concentrations similar to those recorded in 2004.	Lead concentrations decreased. No clear trend of change in cadmium, copper and zinc concentrations.
Organic pollutants in sediments	**Ports and marinas:** Medium level of DDT pollution in Akko marina and the cooling basin of the Ashdod power plant. Levels of PCBs much smaller than those recorded in 2004. PAHs and dioxins not detected. TBT pollution in Haifa, Qishon and Ashdod ports and in the Akko, Michmoret, Hertzelia, Tel-Aviv and Ashquelon marinas; the findings indicate continued TBT input.	Monitoring started in 2000. Levels of DDT PCBs and at some sites also of TBT decreased in 2005.

Environmental Indicator	Status in 2005	Trends in last decade
Organic pollutants in water	**Ports and marinas:** Concentrations of volatile and semi-volatile pollutants below detection limit or much lower than levels harmful to marine organisms. High levels of TBT pollution in Haifa Port and in Akko, Michmoret, Hertzelia, Tel-Aviv and Ashdod marinas. At all ports and marinas, TBT concentrations were higher than the Israeli water quality criteria.	No significant change during 2002-2005
Nutrients in rain water	Nitrogen and phosphorus fluxes into the coastal waters smaller than in Europe but higher than in open sea areas.	Nitrogen and phosphorus fluxes depend on annual precipitation. No significant change in nitrogen flux in the last 8 years.
Nutrients in coastal rivers (outlet areas)	Medium to high levels of pollution in most rivers.	Some decrease in nutrient concentrations (especially in Soreq and Qishon rivers).
Nutrient load from point sources	Coastal rivers (including Qishon) > TAS outfall > others.	Reported decrease in the quantities of nutrients discharged into the rivers.
Nutrients in coastal waters	**Haifa Bay**: Nitrogen and phosphorus enrichment opposite the Qishon estuary and the Naaman river outlet; decreasing concentrations with distance from the shore.	Possibly a trend of decreasing concentrations since 2002. In recent years significant increase in N/P ratios in the Qishon river and the southern part of Haifa Bay.
	Along the coast: Phosphorus enrichment near the outlets of Yarkon and Soreq rivers; nitrate enrichment near the outlet of the Tanium river. Nutrient enrichment near the outfall of the Hertzelia sewage treatment plant.	
Microalgae in coastal waters	**Haifa Bay:** High concentrations relative to other areas. Especially high concentration in the Qishon River estuary. Potentially toxic species found.	Monitoring started in 2000; possibly beginning of a decreasing trend. Potentially toxic species found previously in Haifa Bay.
	Along the coast: Relatively high concentrations near the Tanim, Yarkon, Alexander, Soreq and Lachish rivers. Enrichment in the south (Ashqelon – Ashdad area). Relatively high concentration in shallow waters (<10m) compared to deeper water (30m). Genera that might include toxic species found along entire coastline.	Potentially toxic species found in previous years.
Benthic communities (indicator for organic matter enrichment)	**Haifa Bay**: Indications for organic matter enrichment opposite Akko in the north and the Qishon estuary in the south.	Monitoring began in 2005.
	Along the coast: Indications for organic matter enrichment in the area of the TAS outfall.	
	In shallow water: Indications for organic matter enrichment opposite the outlets of the Alexander, Poleg, Yarkon and Soreq rivers.	
Biological effects monitoring (biomarkers in inshore fish).	Notable effects of metals and organic pollutants in fish from Haifa Bay compared to fish from sites south of the bay. Effects of reproduction disruptors not found in all fish.	Monitoring started in 2004/5.

Source: IOLR 2006 [(1)]

(1) IOLR (2006) Environmental quality of Israel's Mediterranean coastal waters in 2005

6.3.3 ***Marine Habitats and Species***

Planktons

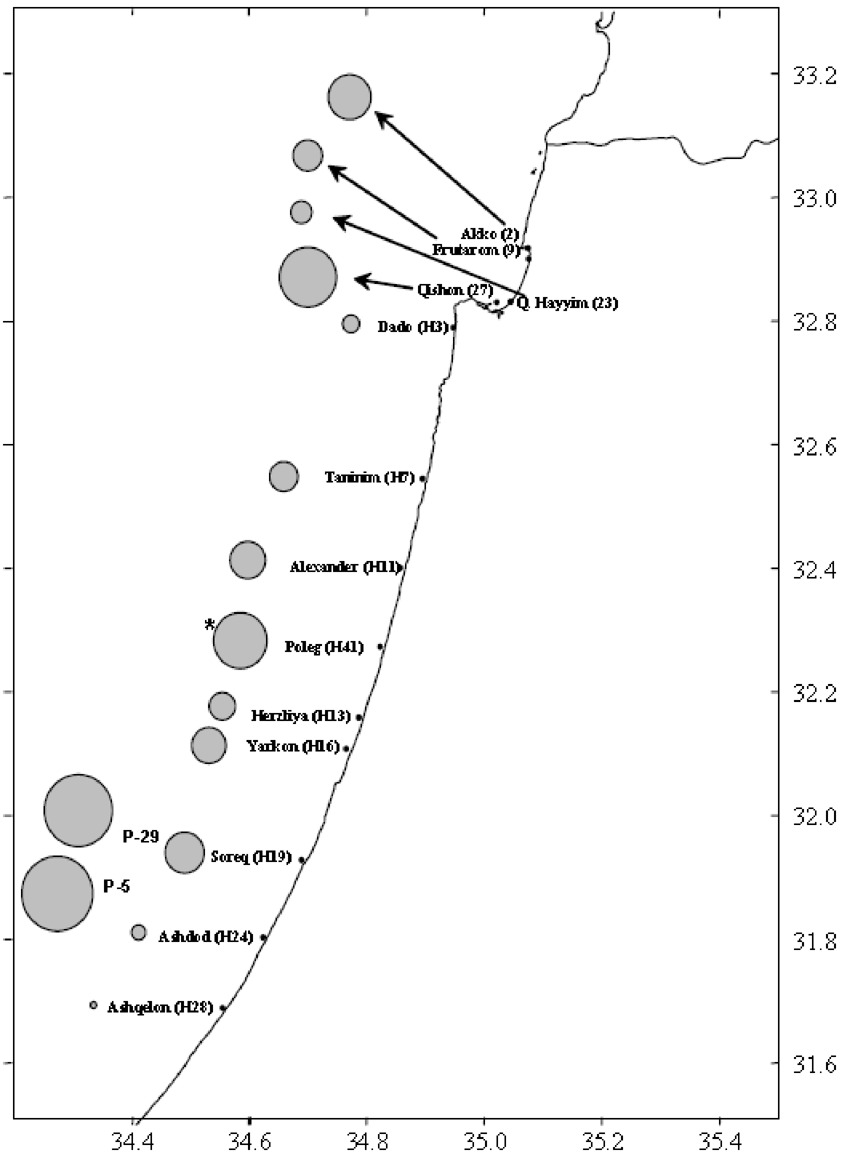
Nearshore plankton in the region can be characterized by the occurrence of jellyfish swarms. Since the mid-1980s each summer has seen large swarms of the jellyfish *Rhopilema nomadica* appear along the Levant coast [(1)]; these vast swarms can stretch to 100 km long.

Benthic Community

The ratio of polychaete specimens (an important component of the benthic community) to the total number of specimens indicates organic matter enrichment as the aggregate of polychaetes increases alongside increasing content of organic matter in the sediments [(2)]. This ratio is represented in *Figure 6.9*.

(1) Galil and Zenetos 2002 cited by Karish-1 Environmental Impact Assessment
(2) IOLR (2006) Environmental quality of Israel's Mediterranean coastal waters in 2005

Figure 6.9 Ratio of Polychaete Specimens to Total Specimens in Shallow Water Area



Source: IOLR 2006 (1)

Mammals

Eighty five percent of all reported sightings of marine mammals in Israel have been identified as the common bottlenose dolphin (2). The majority of these sightings are in shallow coastal waters. The Mediterranean subpopulation is recognized as vulnerable by the IUCN (3).

(1) IOLR (2006) Environmental quality of Israel's Mediterranean coastal waters in 2005

(2) Kerem et al 2012 cited by CSA Ocean Sciences Inc. (2016) Environmental Impact Report for Production Drilling, Production Tests, and Completion – Leviathan Field

(3) 2014 cited by CSA Ocean Sciences Inc. (2016) Environmental Impact Report for Production Drilling, Production Tests, and Completion – Leviathan Field

Fish

Demersal species in inner shelf water depths (15 to 38 m) the soft bottom assemblage is composed of porgies (*Boops boops*, *Pagellus erythrinus*, *Lithognathus mormyrus*), lizardfishes (*Saurida undosquamis*) and goatfishes (*Upeneus pori*) (1).

In water depths greater than 84 m, hake (*Merluccius merluccius*), sparids (*Dentex macrophthalmus*), snipefishes (*Macroramphosus scolopax*) and goatfishes (*Mullus barbatus*, *Mullus* spp.) are prevalent. Some demersal species such as dragonets (*Callionymus filamentosus*), gurnards (*Lepidotrigla cavillone*, *Trigla* spp.) and flatfishes (*Bothus podas* and *Citharichthys lingulata*) live in direct contact with the substrate, whereas others, including conger eels (*Ariosoma baelericum*), cusk-eels (*Ophidion barbatum*), weavers (*Trachinus draco*) and stargazers (*Uranoscopus scaber*) remain buried (or partially buried) in the sediment (2).

The inshore fishery sector is overall evenly distributed along the coast, with substantial concentrations manifesting around complex rocky bathymetry like sandstone ridges or sunken ships (3).

Seabirds

A variety of seabirds, such as species of pelicans, gulls, cormorants and terns are likely to be found abundantly around coastal waters (4).

Annexe II of the Protocol Concerning Specially Protected Areas and Biological Diversity of the Mediterranean lists some shorebirds species from Israel, shown in *Table 6.3.*

Table 6.3 Israel Shorebird Species Listed in Annex II

Common Name	Scientific Name	IUCN Status[1]	Israel Occurrence[2]	Breeding in Israel[3]
Kentish Plover	*Charadrius alexandrinus*	LC	Native	No
Greater Sand Plover	*Charadrius leschenaultii columbinus*	LC	Native	No
Pied Kingfisher	*Ceryle rudis*	LC	Native	Yes
White-throated Kingfisher	*Halcyon smyrnensis*	LC	Native	Yes
Slender-billed Curlew	*Numenius tenuirostris*	CR	Vagrant	No
Osprey	*Pandion haliaetus*	LC	Native	No
Eleonora's Falcon	*Falco eleonorae*	LC	Native	No

Source: Leviathan EIA 2016 (5)

(1) Jones et al 2003 and Galil 2004 cited by CSA Ocean Sciences Inc. (2013) Karish-1 Exploration Program Environmental Impact Assessment.

(2) Jones et al 2003 and Galil 2004 cited by CSA Ocean Sciences Inc. (2013) Karish-1 Exploration Program Environmental Impact Assessment.

(3) CSA Ocean Sciences Inc. (2016) Environmental Impact Report for Production Drilling, Production Tests, and Completion – Leviathan Field

(4) CSA Ocean Sciences Inc. (2016) Environmental Impact Report for Production Drilling, Production Tests, and Completion – Leviathan Field

(5) CSA Ocean Sciences Inc. (2016) Environmental Impact Report for Production Drilling, Production Tests, and Completion – Leviathan Field

Migratory Birds

As one of the two primary migration routes in the Mediterranean region, Israel sees around 500 million migrating birds fly over its airspace (1). The migration period starts in March until the end of May and in August until the end of November (2). The region represents a 'bottleneck' of the migratory journey of various species of birds of prey, a majority of the Palearctic population of white pelicans as well as 85 percent of the world's white stork population. Three hundred fifteen (315) migratory bird species have been found to be occurring in Israel by BirdLife International (3).

Two Important Bird Areas (IBAs) are found in coastal habitats: the Carmel Coast IBA and the Zevulun Valley IBA (4). The pipeline landfall and onshore activities near the CVS and DVS will be located within Carmel Coast IBA.

6.3.4 *Archaeological Sites*

The eastern Mediterranean Sea possesses extremely rich cultural heritage in the form of shipwrecks and cargo from Greek, Phoenician, and Roman trade routes. Offshore Declared Antiquities sites are found less than 50 metres off the coast in shallow waters of depths up to 30 metres. Some of these could include shipwrecks as old as 3,000 years (5).

The planned EBS will include a visual inspection of the seabed along the proposed pipeline route. If any tangible cultural heritage is observed, e.g. shipwrecks, the pipeline will be rerouted to avoid these.

6.3.5 *Protected Areas for Nature Protection*

There a number of marine protected areas (MPAs) in Israel, as well as other marine managed areas. Those located on the coast of the Mediterranean Sea are listed in *Table 6.4*. The Israel Nature and Parks Authority (INPA) is the management authority for all MPAs (6).

Table 6.4 Marine Protected Areas and Other Marine Managed Areas in Israel

Type	Name	Label	IUCN Category
MPA	Nahal Alexander	National Park	V
MPA	Rosh Hanikra	National Park	V
MPA	Rosh Hanikra Sea and Shore	Nature Reserve	Not reported
MPA	Shiqmona	Nature Reserve	Not reported
MPA	Yam Dor Ha Bonim	Marine Nature Reserve	IV
MPA	Yamit Evtah	Nature Reserve	Not reported
MPA	Yam Maa'gan Mikeal	Nature Reserve	Not reported

(1) Leshem and Atrash 1988 cited by CSA Ocean Sciences Inc. (2016) Environmental Impact Report for Production Drilling, Production Tests, and Completion – Leviathan Field
(2) CSA Ocean Sciences Inc. (2013) Karish-1 Exploration Program Environmental Impact Assessment.
(3) 2014 cited by CSA Ocean Sciences Inc. (2016) Environmental Impact Report for Production Drilling, Production Tests, and Completion – Leviathan Field
(4) BirdLife International, 2014c cited by CSA Ocean Sciences Inc. (2016) Environmental Impact Report for Production Drilling, Production Tests, and Completion – Leviathan Field
(5) CSA Ocean Sciences Inc. (2013) Karish-1 Exploration Program Environmental Impact Assessment.
(6) Marine Conservation Institute, 2017

Type	Name	Label	IUCN Category
MPA	Yam Shiqma	Nature Reserve	Not reported
Other Marine Managed Area	Hof Dor HaBonim Beach Nature Reserve	Nature Reserve	IV
Other Marine Managed Area	Shark Sanctuary	Shark Sanctuary	None
Other Marine Managed Area	Iyye Hof Dor U-Ma'agn Mikha'el	Nature Reserve	IV
Other Marine Managed Area	Iyye Hof Rosh Ha-Niqra	Nature Reserve	IV

Source: Based on the information by the Marine Conservation Institute (2017) (1)

6.4 *ONSHORE ENVIRONMENT*

6.4.1 *Climate and Meteorology*

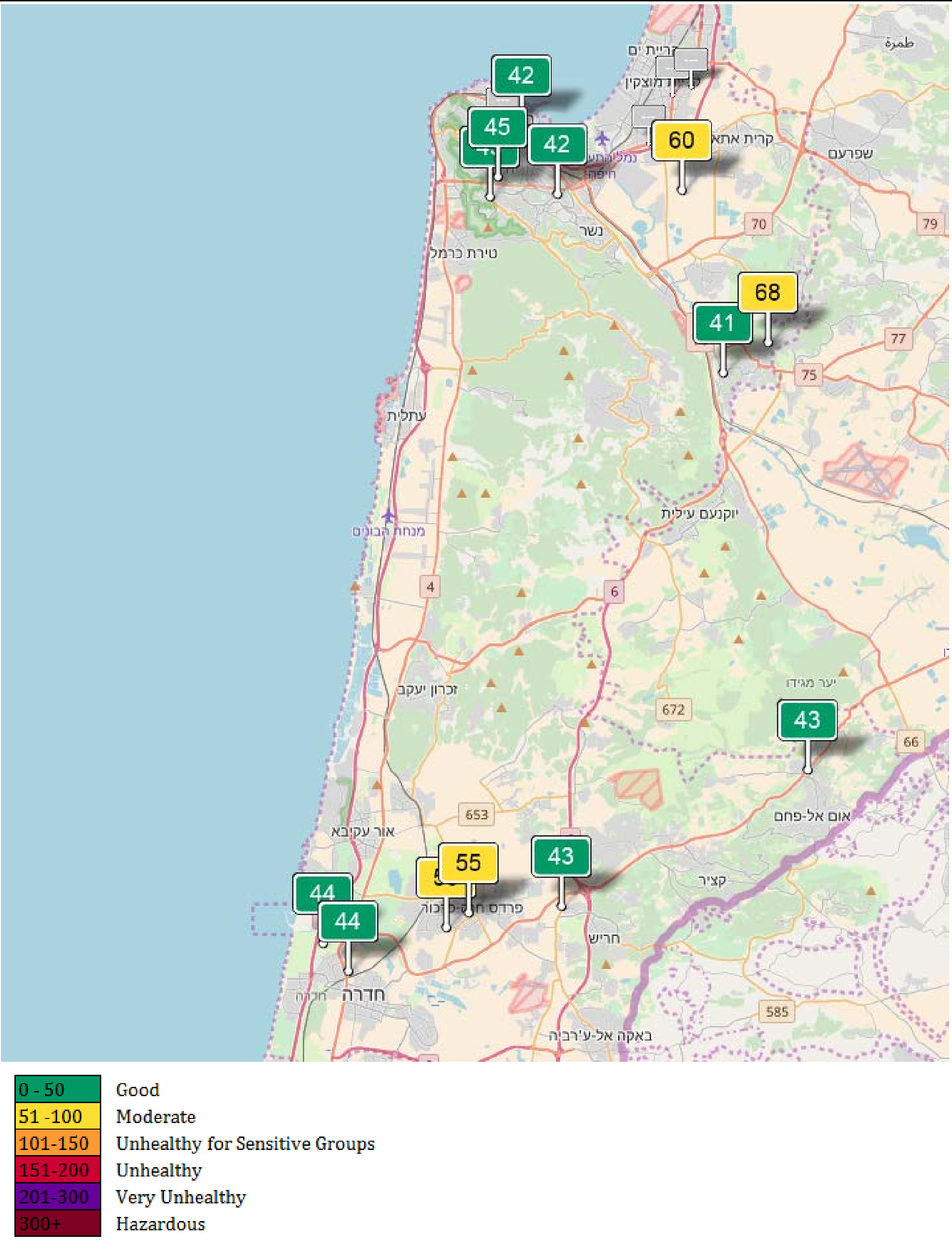
Because the long-term impacts for this project will occur during the production phase at the FPSO, the meteorological data used in both the onshore and offshore air dispersion modelling scenarios was centred on the FPSO's location (See *Figure 6.1*). There are no meteorological monitoring stations located in the immediate vicinity of the onshore sites which measure all of the parameters required by an AERMOD model; however, there is one in Ein Carmel ~8 km north of the Project area. Comparing this data to the offshore data used in the air dispersion modelling, there are significant differences in the predicted predominate wind direction (i.e. from the southeast at Ein Carmel versus from the west near the FPSO). However, as the worst case impacts on human health receptors occur when the wind is blowing from the west, the meteorological data used from the FPSO location is considered to be conservative.

6.4.2 *Air Quality*

Air quality in coastal Israel has been shown to decline consistently over the past century, due to airport and shipping activities (2). There was no quantitative air quality baseline data available for the area at the time of reporting. Within the Project's area of influence, the key sources of air pollution are expected to be the railway line and Kvish HaHof ("Highway 2"). The airshed is considered to be undegraded for all pollutants and averaging periods except within the immediate vicinity of Highway 2 (e.g. within 200 m). This is based on the air quality index values reported for Israel.

(1) Marine Conservation Institute (2017) Israel. [Online] Available at: http://www.mpatlas.org/region/nation/ISR/ [Accessed 30th of October 2017]
(2) Maritime Communication Services, Inc et al. 2008 cited by Karish Environmental Impact Assessment 2013

Figure 6.10 Air Quality Index Values for Region



Source: http://aqicn.org/map/israel/#@g/32.6755/34.8016/11z accessed on 03 November 2017.

6.4.3 *Noise and Vibration*

Receptors that have the potential to be significantly affected by noise emissions from the project are summarised in *Table 6.5* and illustrated in *Figure 6.11.* These were identified by ERM following review of satellite imagery, a site reconnaissance and consultation with Energean. Abandoned properties, such as the fish farm located immediately north and west of the project, are not considered in the assessment.

Operational industries near the project include an avocado grove plantation east of the existing highway and onshore pipeline route; and fish farms south of the CVS station. People working outdoors at these industries will be largely mobile and are therefore unlikely to be stationed within close proximity to the nearest project worksite for more than a few hours at a time. Workers may also be operating industrial equipment, which will be a dominant source of noise. Due to the low sensitivity of these receptors to noise from project construction, these receptors have not been considered in this assessment.

The beach north of the pipeline landing site is currently used for recreation purposes. From information gathered during a site reconnaissance, Michal Hill, located approximately 600 m north of the staging area along the beachfront is used as a recreational camping site. While construction noise may be audible at these locations, it is noted that the duration of exposure of these recreational users will be no more than a few days. These receptors have therefore been scoped out from this assessment.

Table 6.5 Identified Noise Sensitive Receptors within Area of Influence

ID	Receptor	Receptor Type	Nearest Onshore Worksite	Distance from Worksite, m
1	Village of Dor	Residential	DVS	665
2	Properties at Highway 2 Junction	Industrial	DVS	1,000

Figure 6.11 Location of Identified Noise Sensitive Receptors Near Project Worksites

There was no quantitative noise baseline data available for the area at the time of reporting. Within the Project's area of influence, the key noise sources are expected to be the railway line and Kvish HaHof ("Highway 2"). Site observations confirmed that vehicular traffic along Highway 2 was heavy, and that vehicular traffic along the highway was audible from the proposed staging area worksite.

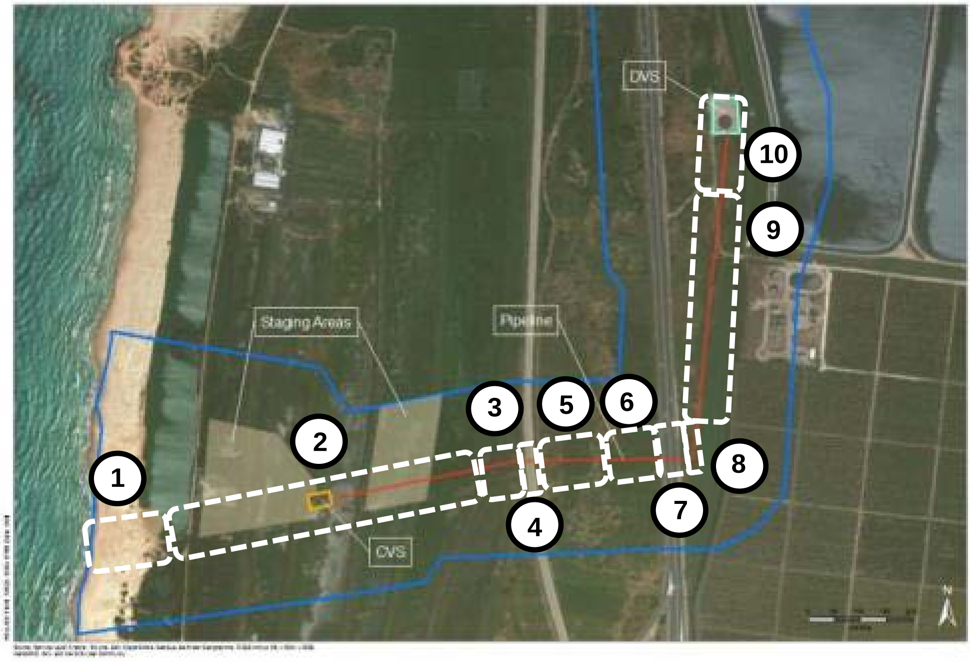
6.4.4 *Terrestrial Ecology*

Habitats

The primary objective of the onshore site reconnaissance survey was to determine the land use along the onshore pipeline corridor between the landfall and DVS, as shown in *Figure 6.11*. Although it was not an ecology survey itself, the assessment of land use provides sufficient information about the existing habitats, taking into account the link between habitats and land use.

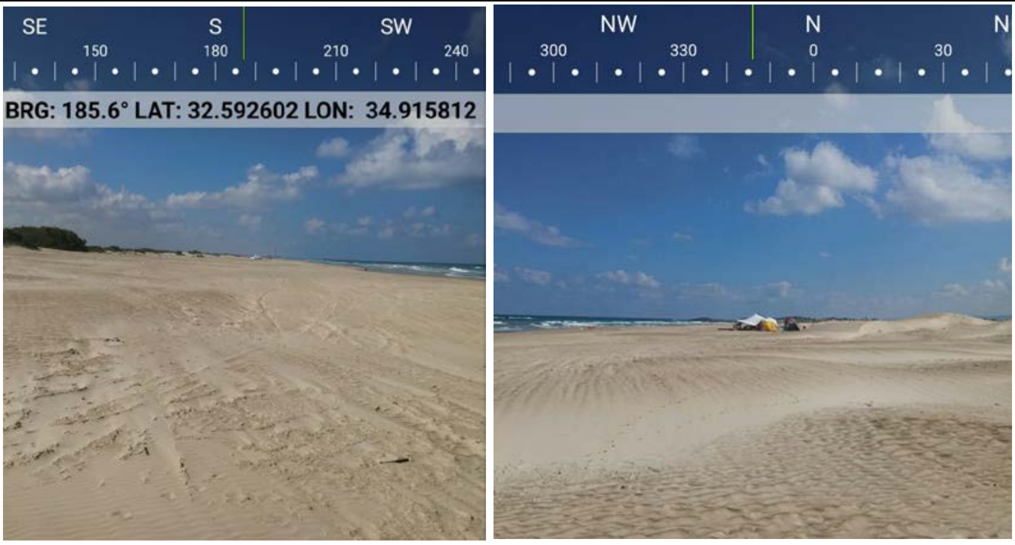
Based on the onshore site reconnaissance survey, ten discrete sections of the pipeline route with different land use were identified within the survey area. These sections are shown in *Figure 6.12* and details of each section, including representative photographs taken during the survey, are provided herein.

Figure 6.12 Onshore Site Reconnaissance Survey Area



Section 1 is about 150 m length and it covers a sandy beach (*Figure 6.13*). The beach is backed by a low dune system.

Figure 6.13 View of Section 1



Source: P3EHS Ltd, 2017

Section 2 is about 575 m length and consists of a group of abandoned fish ponds or lagoons. The pond closest to the beach still holds open water, however due to their abandonment, the other former fish ponds have largely dried out and support marshy vegetation (*Figure 6.14*). The CVS will be located in this section, in an area already filled in and compacted by Noble Energy for the planned Leviathan Project pipeline activities (*Figure 6.15*).

Figure 6.14 View of Section 2

Source: P3EHS Ltd, 2017

Figure 6.15 CVS Location in Section 2

Source: P3EHS Ltd, 2017

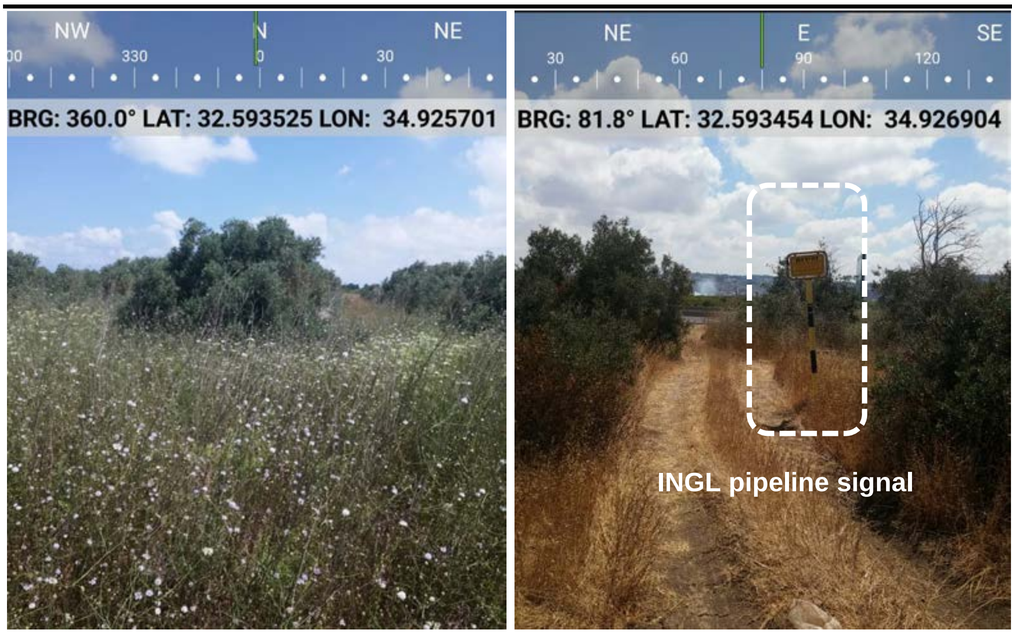
Section 3 is about 75 m length. It is the area between the abandoned fish ponds and a railway line connecting the main cities and towns along the coast. Similar to the **Section 2** it presents some marsh as well as shrubby vegetation. **Section 4** is about 25 m length and it corresponds to the railway line itself. Both **Section 3** and **Section 4** are shown in the *Figure 6.16*.

Figure 6.16 View of Section 3 (left) and Section 4 (right)

Source: P3EHS Ltd, 2017

Sections 5 and **Section 6** together are about 230 m length and comprise the area between the railway and the coastal highway (Kvish Hahof, also referred to as Highway 2) connecting Tel Aviv with Haifa. They support an abandoned plantation of olive trees. Because of their abandonment, dense herbal vegetation has grown up among the olive trees. Both **Section 5** and **Section 6** are shown in the *Figure 6.17*.

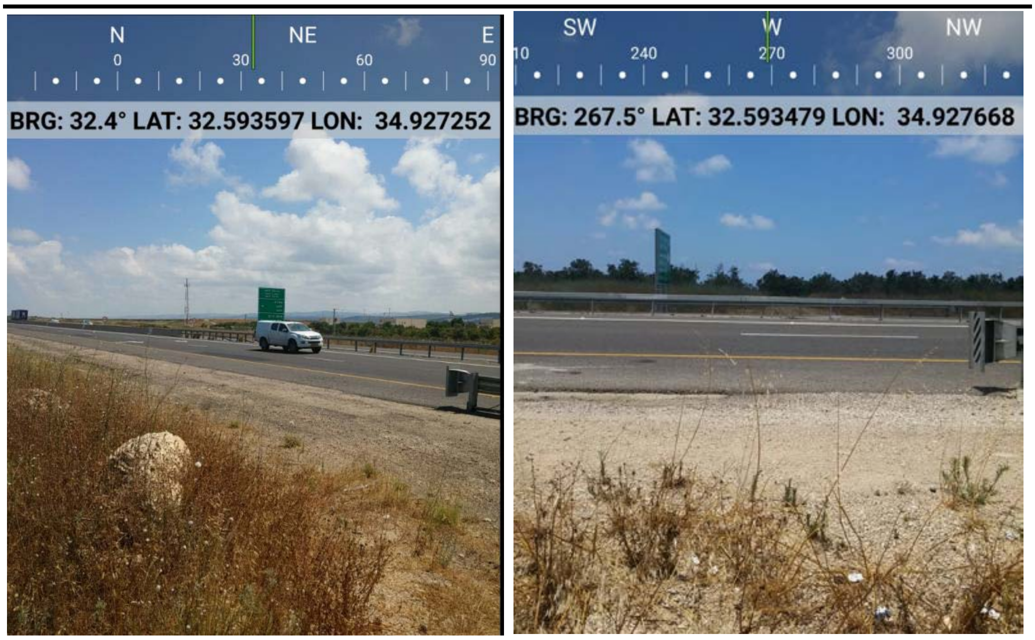
Figure 6.17 View of Sections 5 and 6



Source: P3EHS Ltd, 2017

Section 7 is about 40 m length and corresponds to the highway itself, shown in the *Figure 6.18*.

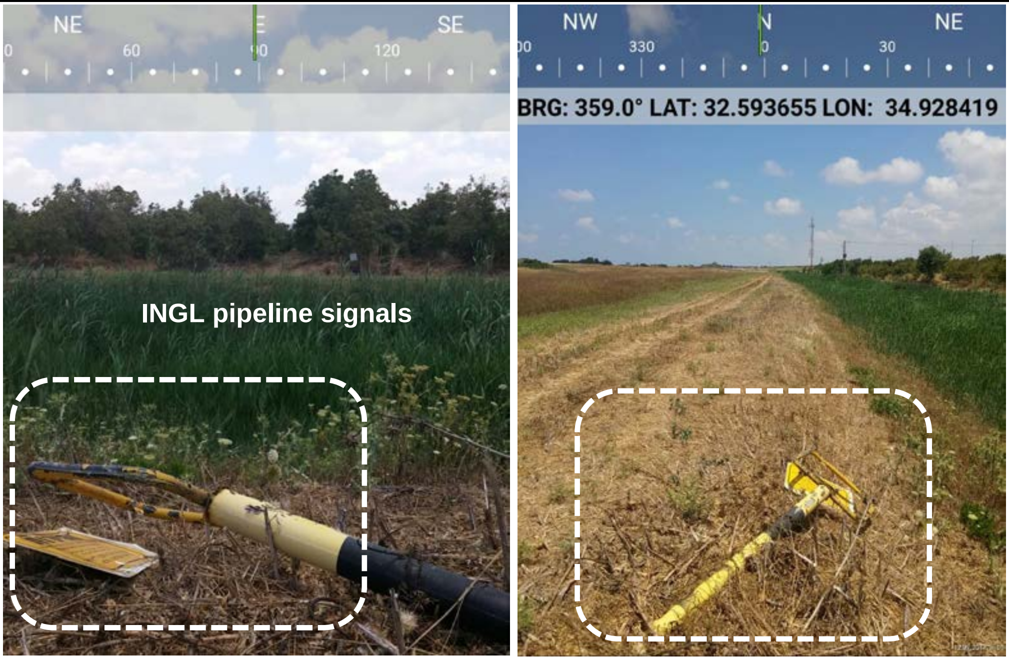
Figure 6.18 View of Section 7



Source: P3EHS Ltd, 2017

Sections 8 and **Section 9** together are about 440 m length. They are characterised by an avocado plantation that is actively managed and maintained. There is a fence and a deep wet trench (irrigation evidence) between the plantation and the proposed project area. Both **Section 8** and **Section 9** are shown in the *Figure 6.19*.

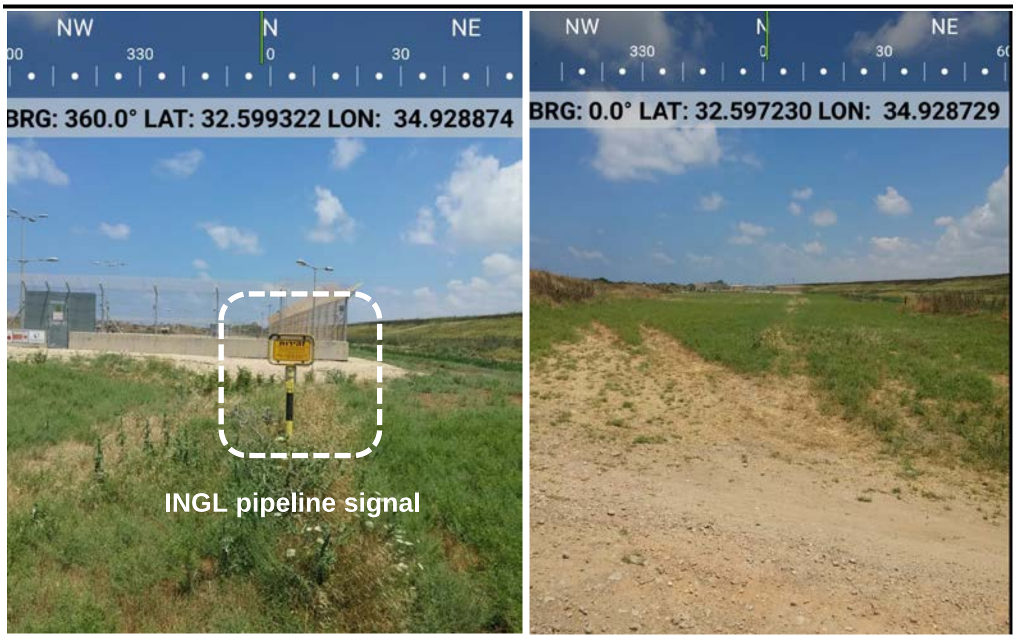
Figure 6.19 View of Sections 8 and 9



Source: P3EHS Ltd, 2017

Section 10 is about 300 m in length and corresponds to the location of the existing DVS. The DVS is surrounded by agricultural land. It is shown in the *Figure 6.20*.

Figure 6.20 View of Section 10



Source: P3EHS Ltd, 2017

The wider AoI has been subject to a range of anthropogenic activities including:

- settlements (e.g. the village of Dor);
- transportation infrastructure (e.g. railway, Highway 2 and other roads);
- active and historic agricultural areas (e.g. cultivated avocado fields, abandoned olive trees, and filled in fish ponds); and
- the existing INGL (Israeli Gas Distribution Grid) pipeline and DVS.

Flora

Because the onshore site reconnaissance survey did not include detailed identification of plant species, secondary data has been used to inform the baseline with regards to flora. The following sources of information have been reviewed:

- BioGIS webpage [(1)]: provides a list of flora in any area selected in Israel together with the main conservation conditions of the flora. It is a web site hosted by the Hebrew University of Jerusalem in collaboration with the Israel Nature and Parks Authority.
- BirdLife International webpage [(2)]: provides information about Important Bird and Biodiversity Areas (IBA), including vegetation and flora descriptions.
- Previous EIAs reports: Tamar EIA (2012) [(3)] and Leviathan project EIA (2016) [(4)].
- Scoping Report. Karish Field Development (2017) [(5)].

According to the database available in the BioGIS webpage, up to a total of 451 different species of plants would be present in the AoI. Most of them correspond to common species with a widespread and global distribution.

A screen on the identified plant species was done based in the following criteria available in the BioGIS webpage: protected species, endangered species, endemic species and invasive species. The resulting screening is a limited list of 59 species of plants that have some significant characteristic, linked with the criteria defined above. *Table 6.6* shows the list of significate flora in the AoI.

Table 6.6 List of Threatened and Protected Flora in the AoI

Species (scientific name)	Protected Species	Endemic	Invasive	National Conservation Status [(1)]	IUCN Red List Category [(2)]
Aeluropus littoralis	No	No	No	Vulnerable	-
Amygdalus communis	Yes	No	No	-	-
Anemone coronaria	Yes	No	No	-	-

1) http://www.biogis.huji.ac.il/eng/searchlocation.html
2) http://datazone.birdlife.org/site/mapsearch
3) Environmental Impact Assessment. Tamar Field Development Project. Offshore Israel. For: Noble Energy. By: CSA International, Inc. 2012.
4) Leviathan Project: Supplemental Lender Information Package – Overarching Environmental and Social Assessment Document. For: Noble Energy. By: ERM, 2016.
(5) Scoping Report. Karish Field Development. For: Energean Oil and Gas. By: ERM, 2017.

Species (scientific name)	Protected Species	Endemic	Invasive	National Conservation Status [(1)]	IUCN Red List Category [(2)]
Aster subulatus	No	No	Yes	-	Least Concern
Cardopatium corymbosum	No	No	No	Vulnerable	-
Catapodium marinum	No	No	No	Vulnerable	-
Ceratonia siliqua	Yes	No	No	-	-
Cladium mariscus	No	No	No	Vulnerable	Least Concern
Conyza bonariensis	No	No	Yes	-	-
Conyza canadensis	No	No	Yes	-	-
Coridothymus capitatus	Yes	No	No	-	-
Crocus aleppicus	Yes	No	No	Endangered	-
Crocus hyemalis	Yes	No	No	-	-
Cutandia maritima	No	No	No	Vulnerable	-
Cyclamen persicum	Yes	No	No	-	-
Cyperus sharonensis	No	No	No	Vulnerable	-
Enarthrocarpus arcuatus	No	No	No	Vulnerable	-
Erodium subintegrifolium	No	No	No	Endangered	-
Eryngium maritimum	No	No	No	Vulnerable	-
Gundelia tournefortii	Yes	No	No	-	-
Heterotheca subaxillaris	No	No	Yes	-	-
Ipomoea sagittata	No	No	No	Endangered	-
Iris palaestina	Yes	No	No	-	Least Concern
Lathyrus gorgonei	No	No	No	Vulnerable	-
Limonium narbonense	Yes	No	No	-	-
Limonium sinuatum	Yes	No	No	-	-
Linum maritimum	No	No	No	Critically Endangered	Vulnerable
Narcissus serotinus	Yes	No	No	Endangered	-
Narcissus tazetta	Yes	No	No	-	-
Nicotiana glauca	No	No	Yes	-	-
Oenothera drummondii	No	No	Yes	-	-
Onopordum carduiforme	No	No	No	Vulnerable	-
Ophrys umbelicta	Yes	No	No	-	-
Oxalis pes-caprae	No	No	Yes	-	-
Pancratium maritimum	Yes	No	No	-	-
Parapholis filiformis	No	No	No	Endangered	-
Paspalum distichum	No	No	Yes	-	Least Concern
Pennisetum clandestinum	No	No	Yes	-	-
Phillyrea latifolia	Yes	No	No	-	-
Pinus halepensis	Yes	No	No	-	Least Concern
Pistacia palaestina	Yes	No	No	-	-
Populus euphratica	Yes	No	No	-	-
Ranunculus asiaticus	Yes	No	No	-	-
Retama raetam	Yes	No	No	-	-
Ricinus communis	No	No	Yes	-	-
Romulea columnae	No	No	No	Endangered	-

Species (scientific name)	Protected Species	Endemic	Invasive	National Conservation Status (1)	IUCN Red List Category (2)
Salix acmophylla	Yes	No	No	-	Least Concern
Sarcocornia perennis	No	No	No	Endangered	-
Satureja thymbra	Yes	No	No	-	-
Serapias vomeracea	Yes	No	No	-	-
Silene sedoides	No	No	No	Vulnerable	-
Styrax officinalis	Yes	No	No	-	-
Suaeda splendens	No	No	No	Vulnerable	-
Tamarix nilotica	Yes	No	No	-	Least Concern
Teucrium scordium	No	No	No	Vulnerable	-
Trachomitum venetum	No	No	No	Vulnerable	-
Valantia muralis	No	No	No	Critically Endangered	-
Ziziphus lotus	Yes	No	No	-	-
Ziziphus spina-christi	Yes	No	No	-	-

Notes:
(1) BioGIS
(2) http://www.iucnredlist.org/search

Source: BioGIS, search done in 31st October 2017 & IUCN webpage

Previous assessments for Noble Energy's Leviathan project note that two endangered plant species can be found in the former fishing ponds (corresponding to the habitat "Former aquiculture areas") where marshy vegetation is found. These two plant species are:

- Perennial glasswort (*Sarcocornia perennis*). Widespread species globally, not considered Threatened by the IUCN Red List, but described as Endangered by the "Red Data Book: Endangered Plants of Israel" [(1)]. It is a species believed to be extinct in Israel except in acre salt marshes.
- Saltmarsh morning-glory (*Ipomoea sagittata*). Widespread species globally, not considered Threatened by the IUCN Red List, but described as Endangered by the "Red Data Book: Endangered Plants of Israel" [(2)]. Its distribution would be limited to 12-13 sites across Israel.

The site datasheet for the Carmel Coast IBA lists two additional plant species as key biodiversity elements of the Carmel Coast IBA): *Aegialophila pumilio* and *Salsola soda*, both of them described as Endangered by the "Red Data Book: Endangered Plants of Israel"[(3)].

No further information about flora was found in the additional sources of information reviewed during the review of secondary data.

It should be noted that among the fifty-nine significate plant species identified in the AoI, not all of them will be present in the project footprint areas and

1) "Red Data Book: Endangered Plants of Israel"; Shmida et al., 2011.
2) "Red Data Book: Endangered Plants of Israel"; Shmida et al., 2011.
3) "Red Data Book: Endangered Plants of Israel"; Shmida et al., 2011.

therefore will be excluded from the main impact resulting from the project activities: clearance of vegetation.

Taking into account that within these fifty-nine plant species in the AoI, up to nine species are described as Endangered or Critically Endangered, an additional assessment (*Table 6.7*) has been done in their cases, in order to assess the likelihood of being present in the project footprint area, what would result in a potential loss of such Endangered and / or Critically Endangered species.

Table 6.7 Habitat Description of Endangered or Critically Endangered Flora in the AoI

Species (scientific name)	National Conservation Status	Land Uses Where Recorded (representative of habitat)	Distance Between Project Footprint and Nearest Recorded Location
Crocus aleppicus	Endangered	Open area Cultivated fields Built-infrastructure / industry Orchards Forest Built-residence No data	150 m in S direction
Erodium subintegrifolium	Endangered	Open area Cultivated fields Forest Built-infrastructure / industry Orchards Built-residence	150 m in S direction
Ipomoea sagittata	Endangered	No data Cultivated fields Open area Built-infrastructure / industry Forest Orchards	150 m in S direction
Linum maritimum	Critically Endangered	Open area Cultivated fields No data	600 m in W direction
Narcissus serotinus	Endangered	Cultivated fields Orchards Open area Built-residence Forest	550 m in E direction
Parapholis filiformis	Endangered	Open area Cultivated fields No data Built-residence	550 m in E direction
Romulea columnae	Endangered	Forest Orchards Built-residence No data Cultivated fields Open area	1 km in N direction
Sarcocornia perennis	Endangered	Cultivated fields	550 m in E direction
Valantia muralis	Critically Endangered	Cultivated fields	550 m in E direction

Source: BioGIS, search done in 2nd November 2017

Fauna

Because the onshore site reconnaissance survey did not include detailed identification of animal species, secondary data has been used to inform the baseline with regards to fauna. The same sources of information used to inform the flora baseline have been reviewed for fauna.

The following groups of fauna are described in the following subsections:

- fish;
- amphibians;
- reptiles;
- birds;
- mammals;
- marine mammals (related to potential beach presence only); and
- marine turtles (related to potential beach presence only); and

Because the AoI includes coastal areas, marine mammals and marine turtles are evaluated in relation to their nesting / refuge activity, which occurs in the shore. Further information about the baseline conditions of these groups of fauna can be found in *Sections 6.2.8* and *6.3.3*.

Fish - Freshwater

According to the database available in the BioGIS webpage, up to a total of five different species of fish (freshwater) would be present in the AoI, in the Dalia River and tributaries (see *Table 6.8*).

Table 6.8 List of Fish Species (Freshwater) in the AoI

Species (scientific name)	Family	Protected / Endemic / Invasive Species	National Conservation Status [1]	IUCN Red List Category [2]
Capoeta damascina	Cyprinidae	No	-	Least Concern
Cyprinus carpio	Cyprinidae	No	-	Vulnerable
Gambusia affinis	Poeciliidae	No	-	Least Concern
Salaria fluviatilis	Blenniidae	No	-	Least Concern
Tilapia zillii	Cichlidae	No	-	Least Concern
Notes: (1) Red Book Vertebrates in Israel (2010) (2) http://www.iucnredlist.org/search				

Source: BioGIS, search done in 31st October 2017 & IUCN webpage

None of the fish species identified are of conservation concern.

As described previously, former aquiculture areas were identified during the onshore site reconnaissance survey. In addition to this, operating aquiculture areas are present within the AoI, although these are not within the footprint of the onshore activities. According to the Scoping Report (ERM, 2017)[1], commercial species found in these aquiculture areas include: white grouper (*Epinephelus aeneus*), barramundi (*Lates calcarifer*), sea bass (*Dicentrarchus labrax*), sea bream (*Sparus aurata*), red drum (*Sciaenops acellatus*), hybrid striped bass (*Moron saxatilis*), goldfish (*Carassius auratus*) and koi, carp (*Cyprinus carpio*).

No further information about freshwater fish was identified as part of the secondary data review.

1) Scoping Report. Karish Field Development. For: Energean Oil and Gas. By: ERM, 2017

Amphibians and Reptiles

According to the database available in the BioGIS webpage, no species of amphibians are present in the AoI. Up to two species of reptiles may be present in the AoI (see *Table 6.9*).

Table 6.9 List of Reptiles Species in the AoI

Species (scientific name)	Species (common name)	Protected Endemic / Invasive species	National Conservation status (1)	IUCN Red List Category (2)
Chamaeleo chamaeleon	Common chameleon	No	Vulnerable	Least Concern
Mauremys caspica rivulata	Western Caspian turtle	No	Least Concern	-

Notes:
(1) Red Book Vertebrates in Israel (2010)
(2) http://www.iucnredlist.org/search

Source: BioGIS, search done in 31st October 2017 & IUCN webpage

It should be noted that there is one additional reference to reptile species in the previous Noble Energy assessments for the Leviathan project. Schreiber's Fringe-fingered Lizard (*Acanthodactylus schreiberi*) is described as being present in fragmented sandy habitats (i.e. sand and hamra soils) in the eastern Mediterranean, occupying an area of less than 500 km^2, including portions of the Israeli Coastal Plain where the AoI is located. *Acanthodactylus schreiberi* is listed as Endangered by the IUCN and as Critically Endangered by the Israel Red Book.

The site datasheet for the Carmel Coast IBA includes one additional reptile species as key biodiversity element: Günther's cylindrical skink (*Chalcides guentheri*). This species is listed as Vulnerable by both the IUCN and by the Israel Red Book. It is however restricted to un-modified natural woodlands, shrubland glades and surrounding grasslands(1) and it is unlikely to occur in the Project AoI.

No further information about amphibians or reptiles was identified during the secondary data review.

Birds

According to the database available in the BioGIS webpage, up to 215 different species of birds may be present in the AoI. Most of them correspond to common species with a widespread and global distribution. Typical species of the anthropogenic, agricultural and wetland habitat present within the AoI include chukar partridge (*Alectoris chukar*), common swift (*Apus apus*), white stork (*Ciconia ciconia*), feral pigeon (*Columba livia domestica*), carrion crow (*Corvus corone*), great tit (*Parus major*), house sparrow (*Passer domesticus*), mallard (*Anas platyrhynchos*), grey heron (*Ardea cinérea*), little egret (*Egretta garzetta*), slender-billed gull (*Larus genei*), black-headed gull (*Larus ridibundus*), great white pelican (*Pelecanus onocrotalus*) and common tern (*Sterna hirundo*).

1) IUCN Red List - Chalcides guentheri http://www.iucnredlist.org/details/61476/0

Eleven species of birds of conservation concern that may occur within the AoI have been identified from the BioGIS webpage. *Table 6.10* shows the list of species of birds of conservation concern in the AoI.

Table 6.10 List of Bird Species of Conservation Concern within the AoI

Species (scientific name)	Species (common name)	Protected Species	Invasive / Endemic	National Conservation Status (1)	IUCN Red List Category (2)
Acrocephalus melanopogon	Moustached warbler	No	No	Critically Endangered	Least Concern
Anthus campestris	Tawny pipit	No	No	Endangered	Least Concern
Apus affinis	Little swift	No	No	Vulnerable	Least Concern
Aythya nyroca	Ferruginous duck	No	No	Critically Endangered	Near Threatened
Charadrius alexandrinus	Kentish plover	No	No	Critically Endangered	Least Concern
Charadrius dubius	Little ringed plover	No	No	Critically Endangered	Least Concern
Glareola pratincola	Collared pratincole	No	No	Critically Endangered	Least Concern
Gyps fulvus	Griffon vulture	No	No	Vulnerable	Least Concern
Merops apiaster	European bee-eater	No	No	Vulnerable	Least Concern
Motacilla flava	Western yellow wagtail	No	No	Critically Endangered	Least Concern
Phalacrocorax pygmaeus	Pygmy cormorant	No	No	Vulnerable	Least Concern

Notes:
(1) Red Book Vertebrates in Israel (2010)
(2) http://www.iucnredlist.org/search

Source: BioGIS, search done in 31st October 2017 & IUCN webpage

In addition, the Project site is located within the Carmel Coast IBA, which was designated because it supports regionally and globally important congregations of waders, waterfowl and seabirds, and species with an unfavourable regional conservation status. See the subsection on National Protected Areas and International Designated Areas within this baseline for further information.

Mammals

According to the database available in the BioGIS webpage, up to a total of 6 different species of mammals may be present in the AoI (see *Table 6.11*).

Table 6.11 List of Mammal Species in the AoI

Species (scientific name)	Species (common name)	Protected Species	Invasive / Endemic	National Conservation Status (1)	IUCN Red List Category (2)
Canis aureus	European jackal	Yes	No	-	Least Concern
Felis chaus	Jungle cat	Yes	No	Vulnerable	Least Concern
Herpestes ichneumon	Egyptian mongoose	Yes	No	-	Least Concern
Mellivora capensis	Honey badger	Yes	No	Endangered	Least Concern
Sus scrofa	Wild boar	Yes	No	-	Least Concern

Species (scientific name)	Species (common name)	Protected Species	Invasive / Endemic	National Conservation Status [1]	IUCN Red List Category [2]
Vulpes vulpes	Red fox	Yes	No	-	Least Concern
Notes: (1) Red Book Vertebrates in Israel (2010) (2) http://www.iucnredlist.org/search					

Source: BioGIS, search done in 31st October 2017 & IUCN webpage

All the mammal species listed in the *Table 6.11* are common species with a widespread and global distribution, with the following exceptions: jungle cat (Vulnerable conservation status) and honey badger (Endangered conservation status).

According to the Carmel Coast IBA datasheet, the Buxton´s jird (*Meriones sacramenti*), an endemic rodent that is listed as Vulnerable by the IUCN and as Endangered in the 2010 Red Book Vertebrates in Israel is present in the IBA. However, latest distribution maps for the species show that it is now restricted to areas south of Tel Aviv, approximately 50 km south of the onshore Project activities[1].

No further information about mammals was identified during the secondary data review.

Marine Turtles

The review of the secondary data identified two species of marine turtles that nest along the coast in the region of the Project: the loggerhead turtle (*Caretta caretta*) and green turtle (*Chelonia mydas*).

The loggerhead turtle nesting period is between May and July. Its conservation status, as per the IUCN criteria, is Vulnerable. The Mediterranean subpopulation of loggerhead turtles was downlisted by the IUCN to Least Concern in August 2015 [2]; however, loggerhead turtles are categorised as Critically Endangered by the Israel Red Book of Vertebrates.[3]

The green turtle nesting period is between mid-June and mid-August (*Chelonia mydas*). They are listed as Endangered by the IUCN and it is known to at least sporadically nest on beaches in Israel [4]. While Israel is not considered an important nesting country at either the scale of the Mediterranean or globally, the Israel Red Book of Vertebrates [5] categorises green turtles as Critically Endangered at the national level.

The onshore site reconnaissance survey reported that a medium number of marine turtle nests (between 40-80) have been documented in the shore area south of the village of Dor, within the AoI. This area is also reported not

1) IUCN Red List Meriones sacramenti http://maps.iucnredlist.org/map.html?id=13168
2) Casale, P. & Tucker, A.D. 2017. Caretta caretta (amended version published in 2015). The IUCN Red List of Threatened Species.
3) Israel Red Book of Vertebrates; Dolev & Perevolotsy, 2002.
4) Seminoff, J.A. (Southwest Fisheries Science Center, U.S.). 2004. Chelonica mydas. The IUCN Red List of Threatened Species.
5) Israel Red Book of Vertebrates; Dolev & Perevolotsy, 2002.

to be a protected hatchery for marine turtles. In addition to this, a marine turtle egg incubation farm has been established near the mouth of the Dalia River, also within the AoI. It should also be noted that the statutory designation of the Dalia River Natural Reserve do not include any specific reference to the marine turtles.

Although, Israel is not considered an important nesting country for marine turtles, their national level of conservation results in existing legislation banning construction activities within 100 m of beaches and driving vehicles on beaches. Light and noise restrictions during the night can also apply during the nesting season of the marine turtles.

Marine Mammals

The Aegean Sea supports the largest remaining European population of globally Endangered Mediterranean monk seal (*Monachus monachus*). The Mediterranean monk seal is classified as Endangered on IUCN's Red List of Threatened Species and as Regionally Extinct by the 2010 Israel Red Book of Vertebrates.

In 2010 there was one sighting of a single Mediterranean monk seal reported in the coast of Herzliya, Israel, located at about 50 km south the AoI. Prior to this time, no sightings had been reported for over 50 years.

Taking into account the distance to Herlizya and the general trend of absence of sightings in Israeli waters, there is no evidence that coastline within the AoI that would be used by the Mediterranean monk seal.

National Protected Areas and International Designated Areas

Nationally protected and internationally recognised areas within the AoI were identified through a desk based study.

National Protected Areas

The following national protected areas have been identified within the limits of the AoI:

- Carmel Coast Kurkar Reserve; and
- Dalia River Natural Reserve.

These are discussed in detail below.

Carmel Coast Kurkar Reserve

The Carmel Coast Kurkar Reserve consists of sixteen small individual areas along the Carmel Coast, between Atilt and Maagan Michael, on both sides of the Highway 2, including sections of the eastern Kurkar Ridge. The Kurkar Ridge is characterised by old and new abandoned quarries, caves used as graves and natural vegetation characterised by geophyte flora.

According to its nature reserve datasheet [1] the nature reserve was designated for its:

- large expanse of well-developed Mediterranean woodland;
- large variety of geological elements; and
- globally important prehistoric sites.

Two of the habitat sections visited during the on-shore reconnaissance survey (**Sections 8** and **Section 10**) are within the limits of the Carmel Coast Kurkar Reserve. Both sections are characterised by modified habitats: agricultural lands (e.g. avocado fields in the **Section 8**) and areas with human structures (e.g. the DVS in **Section 10**). However, due to their protection status as nature reserve, any construction activity within the limits of the nature reserve will require a specific permitting process.

Dalia River Natural Reserve

The Dalia River is located south the CVS, at a distance of about 500 m.

The Dalia River, as with other rivers in Israel, suffers from chronic water shortages. Increased groundwater consumption to supply freshwater to the population has resulted in a reduction of the water flow in the rivers, which, as in the case of the Dalia River, have been partially converted into concrete channels designed to protect the cities against flood events. [2]

Because of this, no relevant ecological features have been identified in the Dalia River, other than a potential for natural nesting of sea turtles. However, during the on-site reconnaissance survey, no protected sea turtles hatcheries were identified. In addition to this, it should be noted that the statutory designation of the Dalia River as Natural Reserve does not include any reference to sea turtles.

International Designated Areas

The only international designated area identified within the limits of the AoI is the Carmel Coast IBA.

The Carmel Coast was designated as Important Bird Area (IBA) in 1994, meeting the following criteria: A4i, A4iv, B1iv and B2. Per the BirdLife International webpage [3], it is a 20-km-strip along the Mediterranean coast, from Atlit south to the Taninim River Nature Reserve. The site includes the Atlit saltpans (8 km south of Haifa) and a large complex of fish-ponds at Ma'agan Mikhael and Ma'ayan Zvi, approximately 25 km north of Netanya, as well as some small islands off Ma'agan Mikhael.

A complete list of IBA trigger species is included in the *Table 6.12.*

1) http://www.parks.org.il/sites/English/parksandreserves/mountcarmel/Pages/default.aspx
2) Restoration of the rivers in Israel´s Coastal Plain. Y. Bar-or. Department of Water and Rivers, Ministry of the Environment, Israel. 2000.
(3) http://datazone.birdlife.org/home

Table 6.12 Populations of IBA Trigger Species

Species (scientific name)	Species (common name)	Season	Population Data (1)	National Conservation Status (3)	IUCN Red List Category (4)
Marmaronetta angustirostris	Marbled teal	winter	10	Critically Endangered	Vulnerable
Ciconia ciconia	White stork	passage	500-50,000	-	Least Concern
Platalea leucorodia	Eurasian spoonbill	passage	155-200	-	Least Concern
Botaurus stellaris	Eurasian bittern	winter	10	-	Least Concern
Nycticorax nycticorax	Black-crowned night-heron	resident / winter	100-250 bp (2)	-	Least Concern
Ardeola ralloides	Squacco heron	passage	100-150	-	Least Concern
Bubulcus ibis	Cattle egret	resident	500-700 bp (2)	-	Least Concern
Ardea cinerea	Grey heron	passage / winter	200-1,000	Regionally Extinct (as breeder)	Least Concern
Ardea alba	Great White egret	winter	100-300	-	Least Concern
Pelecanus onocrotalus	Great White pelican	passage	25,000-30,000	-	Least Concern
Recurvirostra avosetta	Pied avocet	passage / winter	300-400	-	Least Concern
Limosa limosa	Black-tailed godwit	winter	200-300	-	Near Threatened
Glareola nordmanni	Black-winged pratincole	passage	20	-	Near Threatened
Larus cachinnans	Caspian gull	passage / winter	8,000-10,000	-	Near Threatened
Larus ridibundus	Black-headed gull	passage /winter	10,000	-	Least Concern
Sternula albifrons	Little tern	breeding	240-250 bp (2)	-	Least Concern
Chlidonias hybrida	Whiskered tern	passage	1,000-2,500	-	Least Concern
Chlidonias leucopterus	White-winged tern	passage	1,000-3,500	-	Least Concern
A4iv Species group - soaring birds/cranes		passage	25,500 – 80,000	N/A	N/A

Notes:
(1) number of individuals according to estimation done in 1991
(2) bp: breeding pairs
(3) Red Book Vertebrates in Israel (2010)
(4) Birdlife webpage: http://datazone.birdlife.org/site/mapsearch

Source: BioGIS, search done in 31st October 2017

Other bird species present in the Carmel Coast IBA, although not IBA trigger species include:

- Breeding birds: glossy ibis (*Plegadis falcinellus*), listed as Least Concern by the IUCN.
- Wintering birds: good numbers of many wintering birds (i.e. observations of up to 55 individuals of Western marsh harrier, (*Circus aeruginosus)* – listed as Least Concern by the IUCN).

In addition to bird species, other key biodiversity elements present in this IBA include:

- Mammals: presence of Buxton´s Jird (*Meriones sacramenti*), endemic species in Israel and Egypt.

Reptiles: presence of the Günther's Cylindrical Skink (*Chalcides guentheri*).
- Flora: presence of *Aegialophila pumilio* and *Salsola soda*.

Further information about this flora and fauna is included in the preceding sections of this baseline chapter.

Modified, Natural and Critical Habitat

Modified and Natural Habitat Determination

In relation to IFC PS6 (1) , modified habitat is defined as "*areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition*" (IFS PS6 paragraph 12). Natural habitat is defined as *"areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition" (*IFC PS6 paragraph 13*).*

Most of the habitats where the project footprint is located correspond to modified habitat. This would include: former aquaculture areas, human infrastructures, agriculture land and ruderal areas.

Only the sandy coastal beach and dune system represent natural habitat.

Critical Habitat Determination

Critical Habitat identification is required by PS6 to manage risks and avoid, mitigate, and offset impacts to areas with high biodiversity value including:

1) habitat of significant importance to Critically Endangered (CR) and/or Endangered (EN) species;

2) habitat of significant importance to endemic and/or restricted-range species;

3) habitat supporting significant global concentrations of migratory species and/or congregatory species;

4) highly threatened and/or unique ecosystems; and/or

5) areas associated with key evolutionary processes.

A critical habitat determination has been undertaken. The criteria and thresholds used in the determination are set out in IFC Guidance Note 6(2).

(1) IFC 2012. Performance Standards on Environmental and Social Sustainability, published January 2012. Available in English at: http://www.ifc.org/wps/wcm/connect/115482804a0255db96fbffd1a5d13d27/PS_English_2012_Full-Document.pdf?MOD=AJPERES.
2) https://www.ifc.org/wps/wcm/connect/a359a380498007e9a1b7f3336b93d75f/Updated_GN6-2012.pdf?MOD=AJPERES

The AoI sits within the Israeli Coastal Plain biotope, which is part of the wider ecoregion known as "Southwestern Asia: Along the coast of the Mediterranean Sea in Turkey, Jordan, Israel, and Syria" [(1)].

For Critical Habitat Criterion 1-3, using an iterative process, a 'Discrete Management Unit' (DMU) was developed incorporating similar habitat to those found on the AoI under similar management regimes, following the definition presented in IFC GN6:

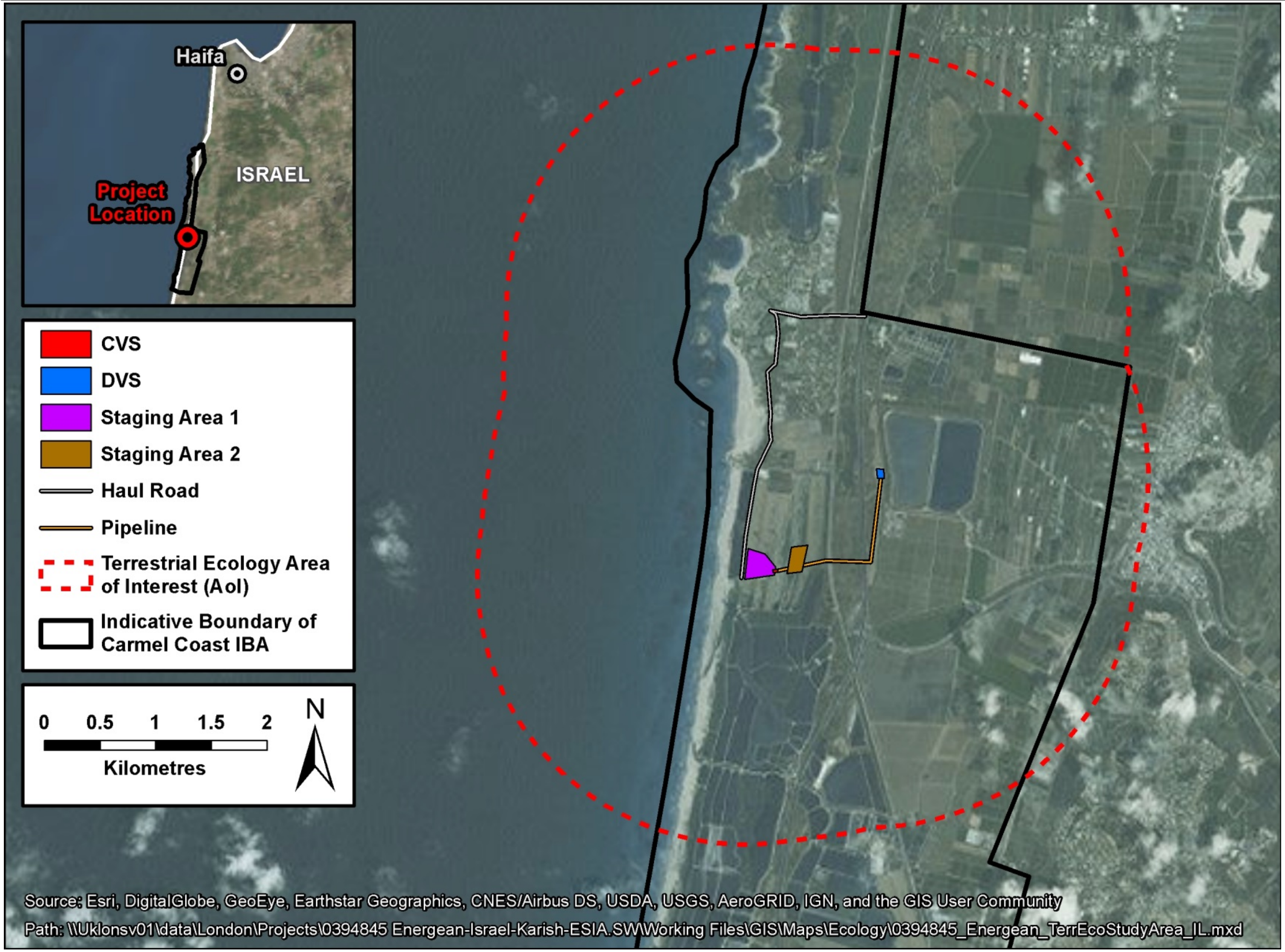
'A discrete management unit may or may not have an actual management boundary (e.g. legally protected areas, World Heritage sites, Key Biodiversity Areas, IBAs, community reserves) but could also be defined by some other sensitive ecologically definable boundary (eg, watershed, interfluvial zone, intact forest patch within patchy modified habitat, seagrass habitat, coral reef, concentrated upwelling area, etc). The delineation of the management unit will depend on the species (and, at times, subspecies) of concern'.

It is considered that the Carmel Coast IBA, where the AoI is located (representing about 49% of the total surface of the IBA) is an appropriate DMU. As described in the BirdLife International datasheet for the site, the Carmel Coast IBA is a 20 km-strip along the Mediterranean coast, from Atlit south to the Taninim River Nature Reserve. The site includes the Atlit saltpans (8 km south of Haifa) and a large complex of fish-ponds at Ma'agan Mikhael and Ma'ayan Zvi, c.25 km north of Netanya, as well as some small islands off Ma'agan Mikhael.

Figure 6.21 shows the scheme of the different areas described above: project footprint, AoI and DMU.

1) Olson et al 2001. Terrestrial Ecoregions of the Word: A New Map of Life on Earth.

Figure 6.21 Scheme of Project Footprint and AoI within the Israeli Coastal Plain



For Critical Habitat Criterions 1 and 2 a review of the conservation status defined for the different groups of flora and fauna has been undertaken in order to identify species defined as Critically Endangered (CR) or Endangered (EN), based on Israeli red lists or in the global IUCN Red List of Threatened Species. Endemic and restricted range species were also reviewed for Criterion 2.

For Criterion 3, literature was reviewed to identify the presence of any designated site or habitat which supported internationally important concentrations of migratory or congregatory species (as defined by IFC GN6), or for the presence of internationally or regionally important congregations of species not identified as a qualifying interest feature of a designated site.

For Criterion 4 and 5, literature was reviewed to identify whether the habitats present within the DMU were considered to be a highly threatened or unique ecosystem or a likely hotspot of evolutionary processes.

The results of the Critical Habitat Determination are presented in the *Table 6.13 - Table 6.17*.

Table 6.13 Critical Habitat Determination – Criterion 1: Critically Endangered and Endangered Species

Species/Feature	Description/Distribution	Qualifies as Critical Habitat (Y/N)	Tier 1 or Tier 2
Flora	The following flora identified in the AoI with a conservation status of Endangered or Critically Endangered (by the Israel Red Book) are recorded to be present at a distance of 150 m from the project footprint (see *Table 6.7*): *Crocus aleppicus, Erodium subintegrifolium* and *Ipomoea sagittata.* Because of this they may be present in the project footprint area. In addition to these plant species, previous Noble Energy assessments defined *Sarcocornia perennis* as potentially present in the former aquiculture areas (present in the project footprint area too). According to the species distribution maps shown in the BioGIS webpage, these species do not have a spread distribution across Israel. They have limited areas of distribution, being the Carmel Coast IBA one of the few areas where they can be found in Israel.	Y	Tier 2
Reptiles: Schreiber's fringe-fingered lizard – SFFL - (*Acanthodactylus schreiberi*)	SFFL is listed as Endangered by the IUCN and as Critically Endangered by the Israel Red Book. It is restricted to fragmented sandy habitats (i.e. sand and hamra soils) in the eastern Mediterranean, including portions of the Israeli Coastal Plain. The majority of the population is restricted to Cyprus. It is important to note, that while the Carmel Coast landscape is considered critical habitat, much of the habitat within the AoI is no longer suitable for the SFFL due to past land conversion.	Y	Tier 2
Birds	The following species of birds have been identified in the AoI with a conservation status by the Israel Red Book of Endangered or Critically Endangered (see *Table 6.10*): *Acrocephalus melanopogon, Anthus campestris, Aythya nyroca, Charadrius alexandrines, Charadrius dubius, Glareola pratincola* and *Motacilla flava.* However, they are not listed as Carmel Coast IBA trigger species (see *Table 6.12*). This excludes the IBA as an area regionally important for the above species.	N	N/A
Mammals	The honey badger (*Mellivora capensis*) has been identified in the AoI with a conservation status of Endangered by the Israel Red Book (see *Table 6.11*). However, it is not considered a key biodiversity element of the Carmel Coast IBA[(.)] This excludes the IBA as an area regionally important for the honey badger. In addition to this, it should be noted that the honey badger is listed as a Least Concern species by the IUCN and described to have a widespread distribution, living in wide variety of habitats.	N	N/A

Species/Feature	Description/Distribution	Qualifies as Critical Habitat (Y/N)	Tier 1 or Tier 2
Marine turtles	The Loggerhead turtle (*Caretta caretta*) and the Green turtle (*Chelonia mydas*) are listed as Critically Endangered by the by the Israel Red Book. In addition to this, they are listed as Vulnerable (*Caretta caretta*) and Endangered (*Chelonia mydas*) by the IUCN. Although there are not protected hatcheries within the AoI, it has been reported about 40-80 marine turtle nests in the shore area within the AoI. However, these populations are not considered regionally important: x Green turtle: Israel is not considered an important nesting country at either the scale of the Mediterranean or globally, being their nests in Israel sporadic. x Loggerhead turtle: it is the most common nesting species along Israeli shores, however the main nesting grounds in the Mediterranean Sea are in Greece, Turkey and Cyprus.	N	N/A

Table 6.14 Critical Habitat Determination – Criterion 2: Endemic / Restricted Range Species

Species/Feature	Description/Distribution	Qualifies as Critical Habitat (Y/N)	Tier 1 or Tier 2
Flora	The Flora of Israel includes many endemic plant species. For example, a 1985 paper reported that there were 43 endemic plant species in the littoral belt of the Israeli Coastal Plain. However, none of the flora listed to be present in the AoI and / or Carmel Coast IBA is defined as endemic.	N	N/A
Reptiles: Schreiber's fringe-fingered lizard – SFFL - (*Acanthodactylus schreiberi*)	Described to be present in fragmented sandy habitats (i.e. sand and hamra soils) in the eastern Mediterranean, occupying an area of less than 500 km^2 (Hraoui-Bloquet et al., 2009).	Y	Tier 2

Table 6.15 Critical Habitat Determination – Criterion 3: Migratory / Congregatory Species

Species/Feature	Description/Distribution	Qualifies as Critical Habitat (Y/N)	Tier 1 or Tier 2

Species/Feature	Description/Distribution	Qualifies as Critical Habitat (Y/N)	Tier 1 or Tier 2
Marine turtles Loggerhead turtle (*Caretta caretta*) Green turtle (*Chelonia mydas*)	Marine turtles qualify as congregatory species because they nest in large numbers at a small number of geographically-restricted beaches worldwide. While of national interest due to its potential for natural nesting, the AoI does not qualify as critical habitat since the beaches are not considered of significant importance for the global populations of the marine turtles.	N	N/A
Internationally Important Assemblage of congregatory or Migratory Birds	The AoI is located within the Carmel Coast IBA, which was designated as meeting the following criteria: A4i, A4iv, B1iv and B2. The A4i criterion was triggered as the site supports over 25,500 migratory soaring birds. See *Table 6.12* for further details.	Y	Tier 2

Table 6.16 Critical Habitat Determination – Criterion 4: Highly Threatened or Unique Ecosystem

Species/Feature	Description/Distribution	Qualifies as Critical Habitat (Y/N)
Israeli Coastal Plain	Considered a high conservation priority within the ecoregion “Southwestern Asia: Along the coast of the Mediterranean Sea in Turkey, Jordan, Israel, and Syria” with a “Critical/Endangered” conservation status by the WWF or containing highly threatened ecosystems due to land use changes and their high levels of endemism.	Y

Table 6.17 Critical Habitat Determination – Criterion 5: Key Evolutionary Processes

Species/Feature	Description/Distribution	Qualifies as Critical Habitat (Y/N)
None Present	N/A	N

Conclusions Regarding Onshore Critical Habitats

The potential critical habitat triggers identified are:

- Criterion 1 (Tier 2): resulting from (1) the potential presence in the project footprint area of up to 4 different plant species listed as Endangered or Critically Endangered by the Israel Red Book; and (2) potential presence of the Schreiber's fringe-fingered lizard (*Acanthodactylus schreiberi*), listed as Endangered by the IUCN and as Critically Endangered by the Israel Red Book, in the AoI (sandy habitats).

- Criterion 2 (Tier 2): resulting from the restricted range of distribution described for the Schreiber's fringe-fingered lizard (*Acanthodactylus schreiberi*): less than 500 km^2.

- Criterion 3 (Tier 2): resulting from the internationally important assesmblage of migratory birds defined for Carmel Coast IBA, which supports over 25,500 migratory soaring birds.

- Criterion 4: resulting from the high conservation priority within the ecoregion "Southwestern Asia: Along the coast of the Mediterranean Sea in Turkey, Jordan, Israel, and Syria", where the Israeli Coastal Plain is located.

These criteria are discussed in further detail as part of the assessment of potential impacts to critical habitat provided in *Section 8.6*.

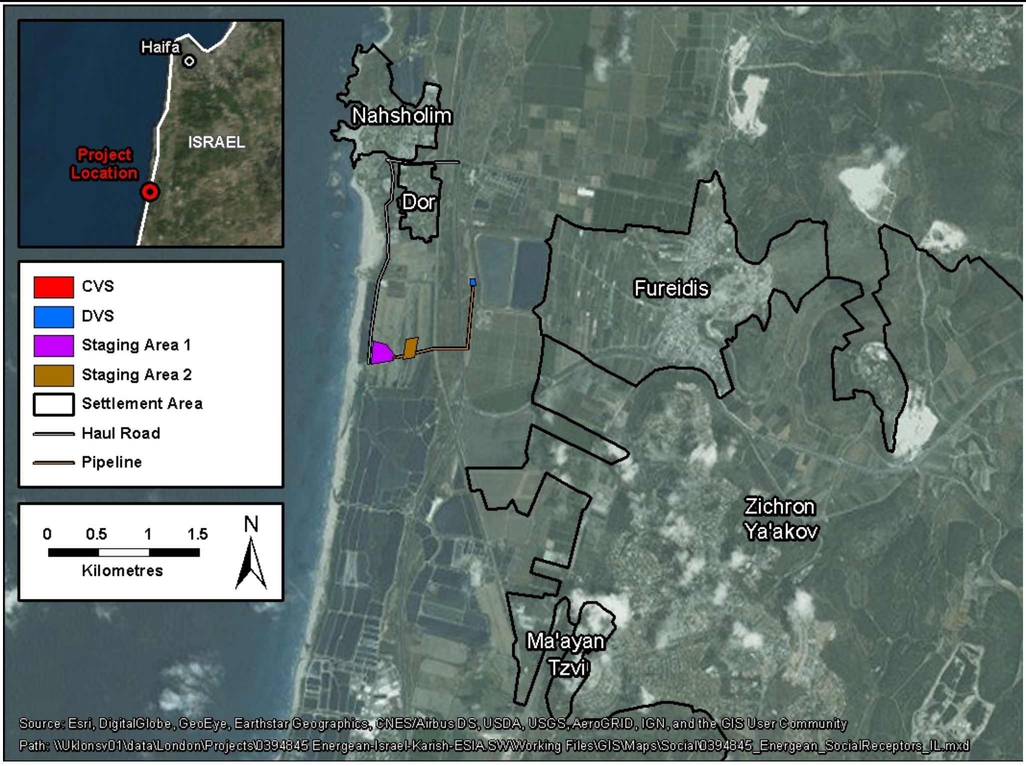
6.4.5 *Social Conditions*

Introduction

This section focuses on presenting relevant aspects of the socio-economic conditions in the Project area to support the assessment of impacts (see *Sections 8.7* to *8.9)* and provide necessary general background information. As such, the level of detail provided is commensurate to the anticipated impacts.

The social study area under consideration is comprised of the project footprint area both offshore and onshore, as well as the three surrounding villages of Dor, Nahsholim, Fureidis, and Ma'ayan Tzvi. Dor is the closest settlement located 500 m northwest of the Dor Valve Station, while Nahsholim is located immediately north of Dor. Fureidis is located about 3 km to the east of the landfall. Ma'ayan Tzvi and Zichron Ya'akov are located about 3.3 km southeast of the landfall.

Figure 6.22 Social Area of Influence



The baseline information presented in the following subsections is based on the findings of the reconnaissance survey (conducted on 01 June 2017) combined with desktop research which consisted of the review of publically available secondary data. Note that some of the information and assumptions presented here are pending confirmation through ongoing stakeholder engagement with local communities and authorities. Any changes to the assumptions presented thereafter will be incorporated accordingly in an updated report as needed.

Administrative Structure

The State of Israel is organised into six administrative districts or "*mehozot*" and fifteen sub-districts or "*nafot*". Each sub-district is further divided into fifty natural regions. These are non-administrative units that the government uses for statistical purposes and to develop the census of the population.

There are three types of municipalities in Israel:

- *Cities*: These include the 71 settlements that have on average over 20.000 inhabitants.
- *Local councils:* these administer the 141 settlements between 2,000 y 20,000 inhabitants.
- *Regional councils:* These administer the 54 groups of settlements that have less than 2,000 inhabitants.

The Project is located close to the settlement or *"moshav"* of Dor, the *"kibbutzim"* of Nahsholim and Ma'ayan Tzvi, as well as the town of Fureidis in the district of Haifa, in northern Israel. Both the *"kibbutzim"* of Nahsholim and

Ma'ayan Tzvi and the *"moshav"* of Dor fall under the jurisdiction of the Hof HaCarmel Regional Council. The town of Fureidis due its size is however administered by a Local Council.

"*Kibbutzim*" and "*moshavim*" were traditionally based on agriculture. Today however, farming has been partly replaced by other economic sectors including industry and services.

Demographics

Population

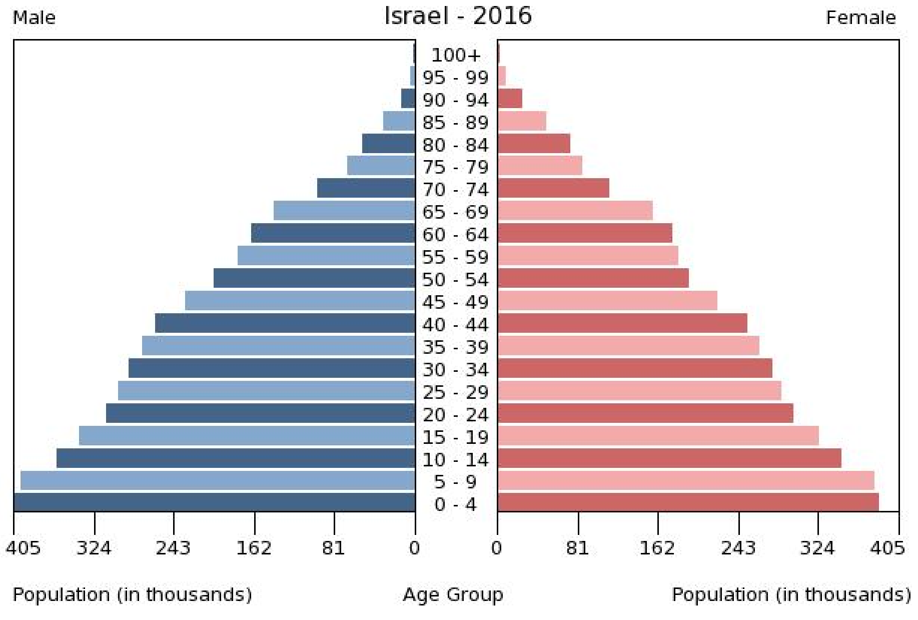
The total population of Israel was of 8,299,706 in 2016, with a population of 996,300 in the District of Haifa. The population of Hof HaCarmel Regional Council was of 28,500 in 2014. Specifically, Dor has a population of 410 inhabitants and Nahsholim of 656 as of 2016, while Fureidis is a larger town with a population of 12,608 inhabitants.(1)

Age and Gender Distribution

The population of Israel is mostly of working age with a majority of the population in the 25-54 age group and a homogenous gender distribution across the age spectrum with a median age of 29.1 for men and 30.4 for women.(2)

The age and gender structure in Israel as of 2016 is shown in *Figure 6.23* below.

Figure 6.23 Age and Gender Structure in Israel (2016)



Source: the World Factbook, CIA. 2017

(1) http://www.cbs.gov.il/ishuvim/reshimalefishem.pdf
(2) The World Factbook, CIA. https://www.cia.gov/library/publications/the-world-factbook/geos/is.html

Ethnic Background and Religion

The population in the district of Haifa is composed of Jews (approximately 69%), Arabs (approximately 25%) other ethnic groups (approximately 6%). (1) The primary religion is Judaism, but other religions include Muslim (approximately 20.8%), Druze (approximately 2.6%) and Christians (approximately 2.5%). These numbers are very close to the national averages.

Languages spoken are Hebrew and Arabic. Note that Fureidis is primarily an Arab town.

Literacy and Education

In Israel, the population is largely literate with 97.8% of the total population aged 15 and over who can read and write. (2)

Vulnerable Groups

Vulnerable individuals or groups are understood as those that are less able to cope with change due to a pre-existing condition that limits their ability to access social, economic, technological, institutional and cultural resources. Those who can be considered vulnerable in the Project area include the elderly, women, low income individuals or households or people who are unemployed and/or living below the poverty line.

Land Use and Ownership

Land Use

The study area is characterised by the presence of various types of land use with the predominance of agricultural land (crop production), including areas dedicated to aquaculture production, as shown in *Figure 6.24*.

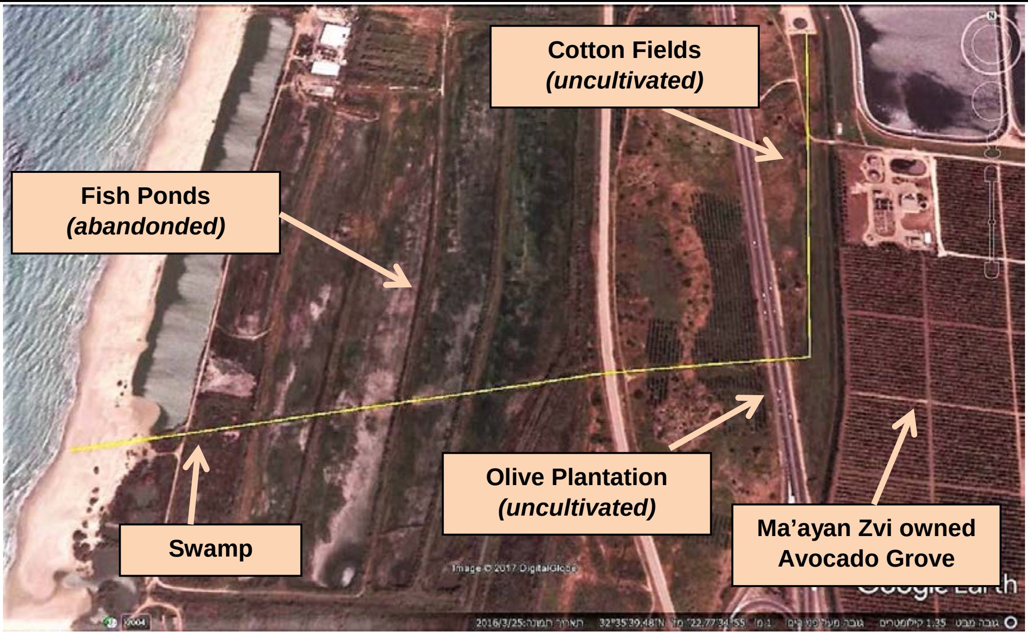
Figure 6.24 Land Use in the Study Area

Source: P3HS Reconnaissance Survey, June 2017

(1) https://en.wikipedia.org/wiki/Haifa_District
(2) The World Factbook, CIA. https://www.cia.gov/library/publications/the-world-factbook/geos/is.html

The social area of influence (AoI) is characterised by the presence of uncultivated historic agricultural land. One patch of land between the railway and the main motorway just south of the DVS was identified as an olive plantation belonging to the settlement of Dor. The plantation is believed to be leased to the village of Dor but is owned by the government. Field observations have shown that the plantation is surrounded with thick vegetation and that olive trees have grown wild and are not currently cultivated. A large avocado plantation is located 80 m to the east of the pipeline laydown area south of the DVS. The reconnaissance survey also identified a wheat field located approximately 30 m east of the landfall area as well as two cotton fields south of the DVS. Satellite imagery suggests that these fields are not currently being cultivated.

Figure 6.25 Main Land Use in the Vicinity of the Project Footprint



Source: P3HS Reconnaissance Survey, June 2017

Land Ownership

The Kibbutz and Moshav types of settlement are both traditionally based on agriculture. The Moshav is a type of cooperative agricultural community of individually owned farms where crops and goods are produced through individual and/or pooled labour and resources and the profit and food products are used for self-consumption and partly for commercialisation. The Kibbutz in contrast is a type of collective community which relied traditionally on a combination of socialism and Zionism in which farms were collectively owned. In recent decades, some kibbutzim have been privatised and have experienced changes in their communal lifestyles. Privatisation has included land but also basic services such as education and health systems in some cases.

The land to be used for the establishment of the onshore Project (project footprint) has been designated by the government to accommodate various gas pipeline projects. All lots and parcels along the proposed onshore Karish

Tanin pipeline route, from the landfall water line up to the DVS, are owned by three bodies: Government of Israel, Development Authority, and the Jewish National Fund [1]. Whilst the local community does not own the land, there is evidence that the community has used the land in the past for agricultural purposes (i.e. the filled in fish ponds and the existing olive trees).

It is important to note that this agricultural use is not current. The fish pond has been filled in, and the olive trees are not being maintained based on visual inspection (i.e. high scrub undergrowth and no pruning).

Figure 6.26 Comparison of Olive Trees in Project Area to Those Being Maintained

	
Olive Trees in Project Area (few olives present, and smaller than maintained trees)	Maintained Olive Trees, approximately 1 km north of DVS (many olives per tree)

Source: ERM site visit, July 2017.

Despite this apparent lack of community use for the land, Noble Energy has signed a contract with Dor village covering the land use during their construction and operation phases for the Leviathan pipeline. The contract sets compensation terms for loss of land use. Noble Energy is also implementing a Livelihood Restoration Plan for the Leviathan project.

Economy and Employment

<u>Overview</u>

Israel has developed from an agrarian state run along collectivist lines into a hi-tech economy in the past 60 years. Israel's progressive, globally competitive, knowledge-based technology sector employs only about 8% of the workforce, with the rest mostly employed in manufacturing and services - sectors which face downward wage pressures from global competition.

In 2010, the 270 *kibbutzim* in Israel accounted for 9% of the country's industrial output, worth US$8 billion, and 40% of its agricultural output, worth over $1.7 billion, while some *kibbutzim* had also developed substantial high-tech and military industries. [2] Some *kibbutzim* have also developed into important tourism destinations. *Kibbutz* Nahsholim, which is located within the AoI, is one of them.

(1) Onshore Site Reconnaissance Survey, P3EHS Ltd., June 2017
(2) Kibbutz reinvents itself after 100 years of history, Taipei Times, November 16, 2010

Agriculture

Agriculture in Israel is a highly developed industry and Israel is a major exporter of fresh produce as well as a world-leader in agricultural technologies. The importance of agriculture in Israel's economy has fallen over time, accounting for decreasing values of GDP (e.g. just under 6% in 1979, 5.1% in 1985, and 2.5% in 2016). The main crops and livestock products produced include citrus, vegetables, cotton, beef, poultry, and dairy products.

Israel has suffered from a chronic water shortage for years. In recent years, however, the situation has developed into a severe crisis; since 1998, the country has suffered from drought, and the annual rainfall was short of the multi-annual average in most of the years. The agricultural sector has suffered most because of the crisis. Due to the shortage, water allocations to the sector had to be reduced drastically causing a reduction in the agricultural productivity. (1)

Agriculture represents an important sector of the economy for the settlements in the study area. The *kibbutz* of Nahsholim and the settlement of Dor grow bananas, avocado and cotton. Olive trees are also found in the area. With regards to the project footprint where the pipeline will be established field observations confirmed that these areas designated in the past for agricultural use are currently uncultivated or neglected.

Figure 6.27 Uncultivated Field (left) and Olive Grove (right) along the Pipeline Corridor

Source: P3HS Reconnaissance Survey, June 2017

Fishing

No fishing areas have been identified near the FPSO; however, fishing does occur in Israeli waters. Fishing is divided into two main geographic areas:

(1) http://www.fao.org/docrep/015/ba0114e/ba0114e05.pdf retrieved 9 November 2017

marine (i.e. the Mediterranean Sea) and freshwater (e.g. Lake Kinneret [Sea of Galilee]). While there is some fishing in the Gulf of Akaba (Elat), it is of minor importance. The marine sector (Mediterranean and Elat) fishery caught 11% of total fish produced, while Lake Kinneret yielded 5%. (1)

Offshore and coastal fisheries in Israel are organised as follows:

- *Trawling:* Based on 2005 data, a total of 32 trawlers were registered and licensed in Israel, but only 28 were actively working. The boats range in size from 14 to 25 m. The trawl fleet is well equipped with electronic gear, hydraulic winches and refrigerated fish holds, but the fleet is quite old. They usually fish at depths ranging up to 400 m. The trawl fleet is prohibited from fishing at depths less than 15 m. The closet port where trawlers are found is Haifa-Kishon located 25 km to the north of the study area.
- *Purse Seine:* Although 28 purse seiners were registered in 2005, many boats fished only sporadically. The boats range in size from 10 to 12 m. This fishery has been affected in the long term by many environmental changes, which have caused pelagic species, such as sardines, to disappear from the Israeli coast. Purse seiners are located in the major ports, but most are concentrated in the north (Kishon and Akko ports near Haifa).
- *Artisanal:* In 2005, 519 small boats (up to 11 m in length) were licensed. These fishers can switch between gillnets and bottom or floating longlines, depending on the availability of fish and the season. These boats land along the entire Israeli coast, either drawn up on the beaches or in small protected inlets, as well as the major ports and or marinas. (2)

It is possible that small scale commercial/ subsistence artisanal nearshore fishing may occur along the coastal strip where the pipeline will be built.

Aquaculture

Similar to other locations in the Israeli coastal plain aquaculture is an important livelihood for communities in the study area. Freshwater polyculture is carried out in intensive fish ponds to produce a variety of marine species. Aquaculture in Israel has been and continues to be based upon the use of cooperative farms (i.e. the kibbutz). Between 1995 and 2003, aquaculture contributed on average to approximately 4.7% of the country's livestock production.

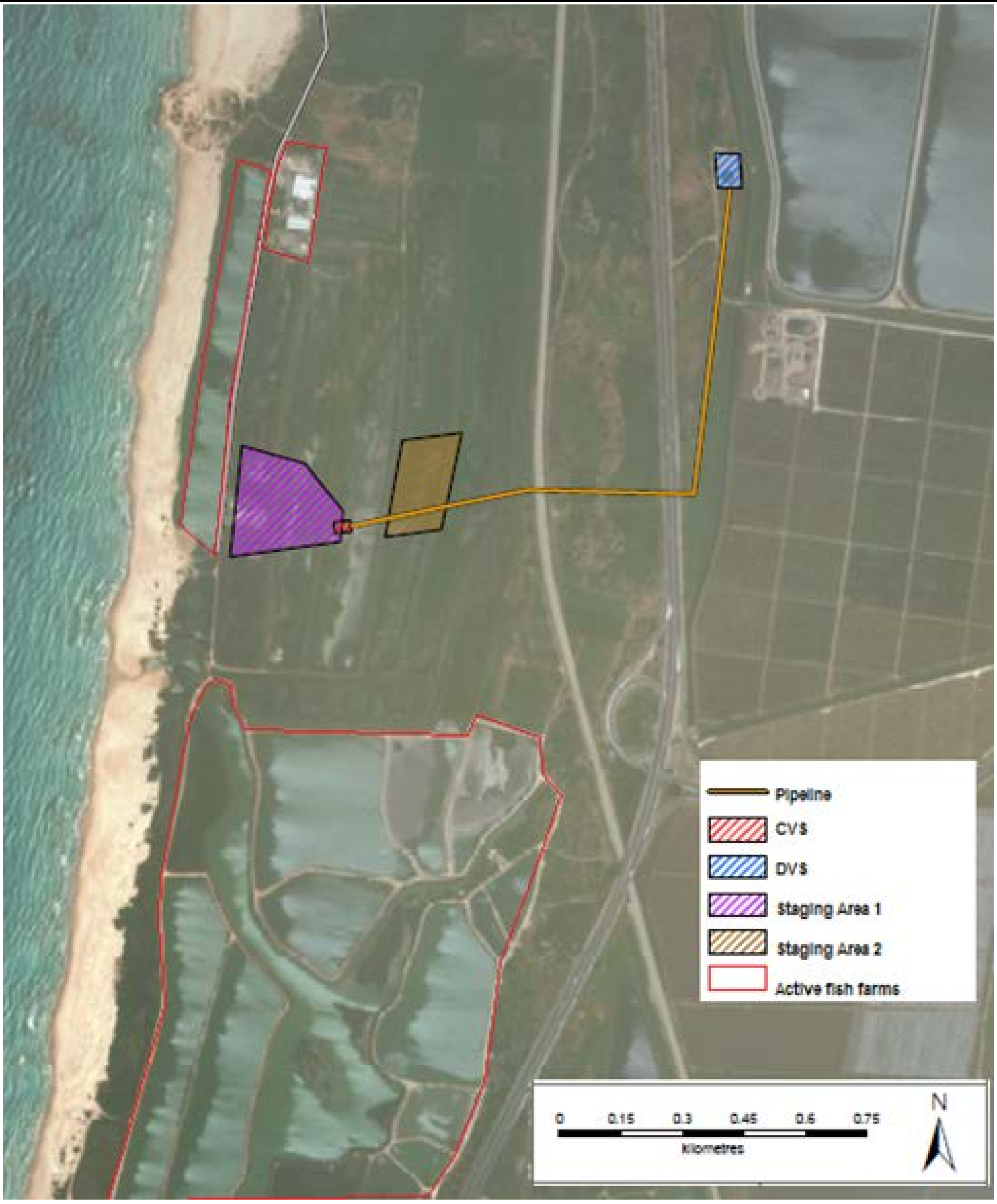
Large scale onshore fish farms exist along the Israeli coast, between Dor and Ma'agan. The industry includes fish breeding centres consisting of numerous large lagoons, offices and laboratories. Fingerlings of edible species produced include white grouper (*Epinephelus aeneus*), barramundi (*Lates calcarifer*), sea bass (*Dicentrarchus labrax*), sea bream (*Sparus aurata*), red drum (*Sciaenops ocellatus*), and hybrid striped bass (*Moron saxatilis*). Ornamental species are also bred, including koi, goldfish and carp (*Cyprinus carpio*). The

(1) http://www.fao.org/fishery/docs/DOCUMENT/fcp/en/FI_CP_IL.pdf retrieved on 9 November 2017
(2) http://www.fao.org/fishery/docs/DOCUMENT/fcp/en/FI_CP_IL.pdf retrieved on 9 November 2017

Dor Fish farm located within the study area at a distance of 600 m north of the pipeline corridor.

Historically part of the onshore pipeline corridor was used for fish farming however now the active fish farms are predominately located 250m south of the pipeline landfall area and one area immediately west/northwest of the pipeline corridor. *Figure 6.28* shows these active fish farms.

Figure 6.28 Active Fish Farms near the Pipeline Corridor



Industry

The primary industries in Israel are the following: high-technology products (including aviation, communications, computer-aided design and manufactures, medical electronics, fiber optics), wood and paper products, potash and phosphates, food, beverages, and tobacco, caustic soda, pharmaceuticals, chemical products, cut diamonds, textiles, and footwear.

Cement, plastics, construction, and metal products are also main industries in Israel, and may potentially constitute a supply source for the Project. In the study area, a plastic factory manufacturing irrigation equipment operates in Nahsholim.

Tourism

The region is known for tourism and with a number of marinas, resorts, recreational beaches and water sport organisations established along the coastline. Recreational activities in the area include sailing, wind surfing, camping, hiking, biking and turtle watching among others.

The Dor beach is less than 500 m north from the landfall and has been identified as an important sea turtle nesting area. The Dor beach is connected by the same trail road which also passes the landfall site and leads to the Dalia River Natural Reserve (see *Section 6.4.4* for further details). This coastal plain area is also a biking and hiking route. In the TAMA 37/H EIS, it was estimated that approximately 300 tourists per day visit Dor for the beaches and approximately 10 hikers per day visit. (1)

During the reconnaissance survey it was confirmed that campers regularly use the beach in Dor. This is most common during the summer period, and has resulted in some adverse effects on the beach from people leaving rubbish behind. *Figure 6.29* shows an example of free beach camping to the south of Mont Michal Hill with the landfall area in the background observed during the reconnaissance survey. (2)

Figure 6.29 Free Camping in Dor Beach

(1) TAMA 37/H EIS, Government of Israel, 2012.
(2) Onshore Site Reconnaissance Survey, P3EHS Ltd., June 2017

Source: P3HS Reconnaissance Survey in June 2017

Employment

At the national level the majority of the Israeli labour force in 2015 was employed in the services sector (81.6%), while 17.3% were employed in industry and the smallest proportion of 1.1% in agriculture. Note that given the land use in the AoI, agriculture and tourism services are expected to represent a much larger percentage of employment in the AoI.

The total unemployment rate in Israel is of 4.1% in 2017, with an unemployment rate for youth between 15 and 24 of 8.6%. The unemployment rate for this age group is higher for women than men (9.1% vs. 8.2%).

Labour and Working Conditions

Israel has ratified all eight fundamental International Labour Organisation (ILO) conventions and all of them are in force as shown in *Figure 6.30* below.

Figure 6.30 ILO Fundamental Conventions Ratified by Israel

Convention	Date	Status	Note
C029 - Forced Labour Convention, 1930 (No. 29)	07 Jun 1955	In Force	
C087 - Freedom of Association and Protection of the Right to Organise Convention, 1948 (No. 87)	28 Jan 1957	In Force	
C098 - Right to Organise and Collective Bargaining Convention, 1949 (No. 98)	28 Jan 1957	In Force	
C100 - Equal Remuneration Convention, 1951 (No. 100)	09 Jun 1965	In Force	
C105 - Abolition of Forced Labour Convention, 1957 (No. 105)	10 Apr 1958	In Force	
C111 - Discrimination (Employment and Occupation) Convention, 1958 (No. 111)	12 Jan 1959	In Force	
C138 - Minimum Age Convention, 1973 (No. 138) *Minimum age specified: 15 years*	21 Jun 1979	In Force	
C182 - Worst Forms of Child Labour Convention, 1999 (No. 182)	15 Mar 2005	In Force	

Source: ILO, 2017.

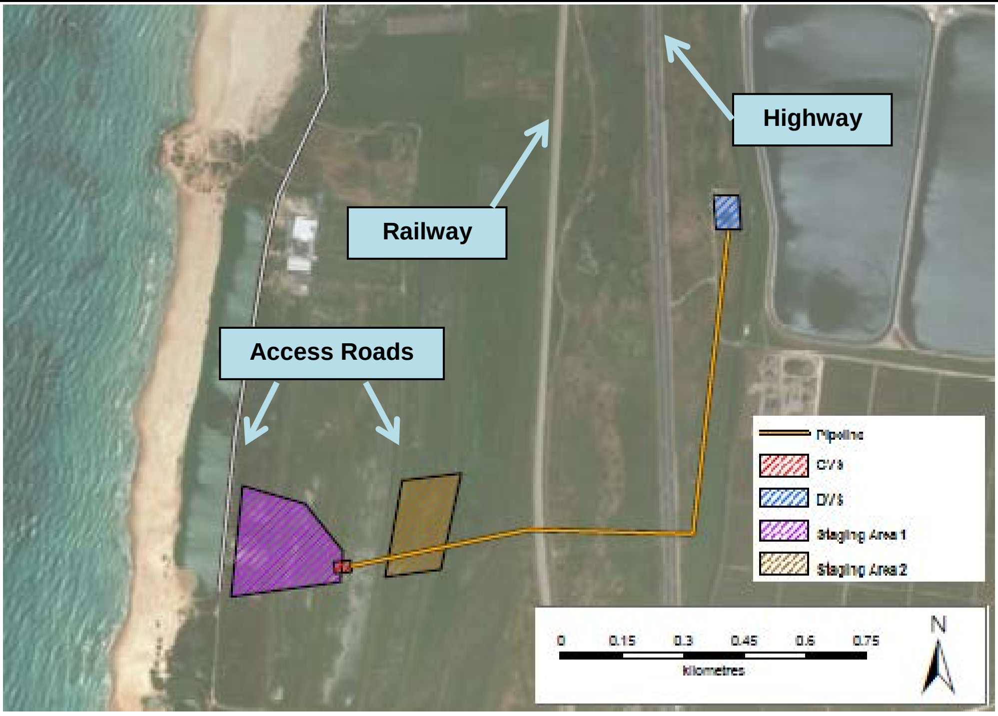
Infrastructure and Public Services

Transport

As presented in *Figure 6.31* below, the Study area is crossed by Highway 2 or (The Coastal Highway or Kvish HaHof) that connects Tel Aviv and Haifa through the coastal plain. The main northern railway also connecting Tel Aviv and Haifa line passes parallel to this highway.

The project will utilise existing roads, and potentially rail networks within Israel during the construction phase. The pipeline corridor crosses rail tracks and Highway 2. The project area is also accessible via two access roads that are not open to the public.

Figure 6.31 ***Road and Railway Infrastructures in the Study Area***



Water Supply and Sanitation

Water supply and sanitation in Israel are intricately linked to the historical development of Israel in the context of scarce water resources. Water distribution and sanitation has historically been the responsibility of municipalities (cities, local councils and regional councils). The promulgation of the Water and Sewerage Corporations Law of 2001 provided for the gradual transfer of water and sewerage services from the municipalities to newly created corporate entities. The main sanitation infrastructure within the study area is the Ma'ayan Zvi wastewater treatment plant owned by water utility company Mayanot Ha-Amakim (see *Figure 6.32*). The wastewater treatment plant was built in 2007 and it has two treatment lines in parallel. These lines have been designed to treat 6,000 m^3 of wastewater per day. An upgrade of the plant is planned for 2017-18 which with an improved technology will increase its capacity between 15 to 20%, or up to 6,900 m^3 – 7,200 m^3 per day. The pipeline corridor runs very close to the plant and treated wastewater reservoir (approximately 90 m away).

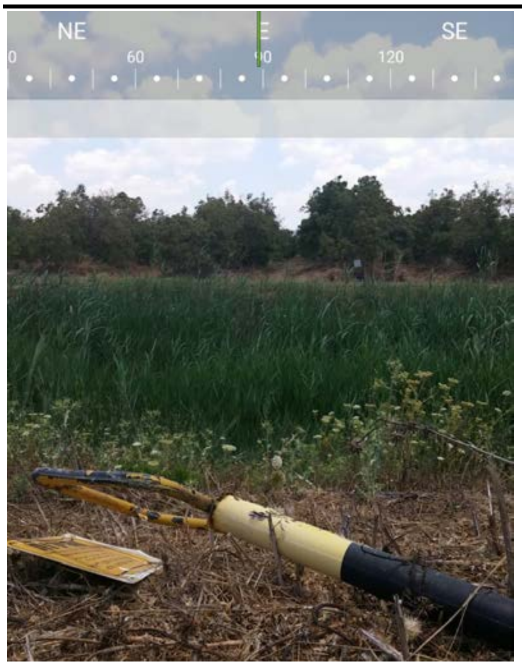
Figure 6.32 Ma'ayan Zvi Wastewater Treatment Plant

Source: P3HS Reconnaissance Survey in June 2017

Irrigation Networks

Evidences of irrigation systems within the study area were identified during the field reconnaissance survey. A deep wet trench (irrigation evidence) between the Ma'ayan Zvi avocado plantation and the pipeline corridor is shown in *Figure 6.33.*

Figure 6.33 Evidence of Irrigation Network

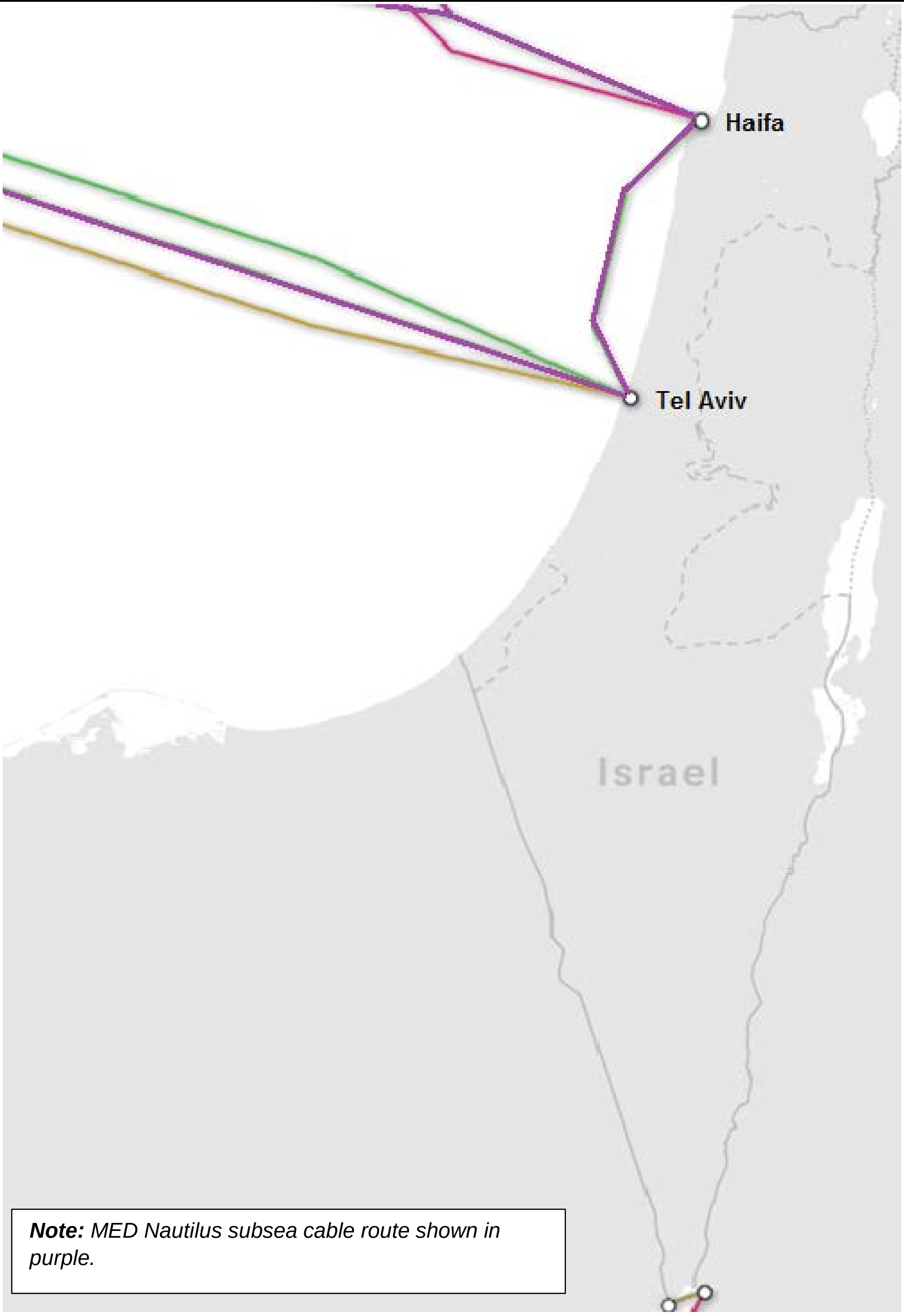


Source: P3HS Reconnaissance Survey in June 2017

Marine Underground Cables

There are a number of subsea cables in Israel (see *Figure 6.34*). The proposed pipeline route does include crossing the MED Nautilus fibre optic cable route; however, Energean will engage with MED Nautilus prior to any subsea construction activities to ensure no damage to the cable occurs.

Figure 6.34 Subsea Telecommunication Cables in Israel



Note: *MED Nautilus subsea cable route shown in purple.*

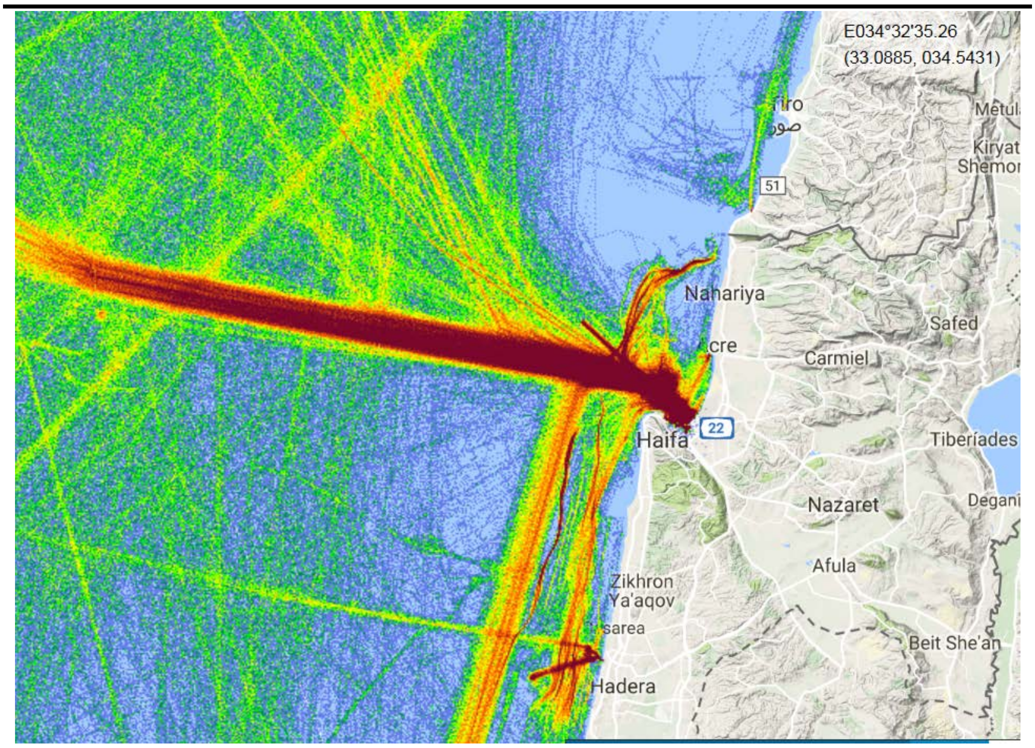
Source: TeleGeography, https://www.submarinecablemap.com/ (accessed 11/12/2017)

Ports and Marine Traffic

The two closest ports are Haifa Port to the North and Submarinean Port in Caesarea to the South. Shipping lanes exist parallel and perpendicular to the coast of Israel. There is some offshore oil and gas exploration and operation offshore and shipping lanes which pass along the coastline leading to the port of Haifa to the north. Haifa is the largest port in Israel and is an industrial scale port with activities including storage, shipping and transportation of all types of cargo as well as docking facilities for large passenger liners. This is the port that will be used for marine vessel support for the Karish field. Submarinean Port in Caesarea is also located along the coast South of Dor, approximately 19 km from the landfall site.

The eastern Mediterranean Sea is a busy navigation area that concentrates high number of routes where merchant ships, takers (oil, gas, chemical), ferries, large cruises, fishing vessels, war ships and other recreational ships coexist. The lower incidence of marine traffic on the area where the FSPO and the marine pipeline will be established has been confirmed by the data provided by Marine Traffic (see *Figure 6.35)*. The figure presents the ship traffic density plot in relation to the FSPO and export pipeline route and in the wider marine area. The colour ranging from yellow to red to black is used to indicate the ship traffic density for the given Automatic Identification System (AIS) data. The area around the port of Haifa, to the northeast of the Karish field, is darkest due to documented intensity of traffic into and out of Haifa port. The marine traffic in the area of the pipeline route and location of the FSPO is less intense compared to the traffic further north.

Figure 6.35 Marine Traffic Density



Source: https://www.marinetraffic.com

7 STAKEHOLDER ENGAGEMENT

7.1 INTRODUCTION

Stakeholder engagement is a key aspect of the ESIA process. The purpose of the engagement is to facilitate participation in the project decision making and to provide a platform for views to inform the identification of impacts and associated mitigation measures. The process involves knowledge sharing, understanding concerns and relationship building. Specifically the objectives of stakeholder engagement include the following.

- **Ensuring Understanding.** An open, inclusive and transparent process and communication so that stakeholders are well informed about the project.

- **Involving Stakeholders in the ESIA Process.** Views and concerns are considered in scoping, the impact assessment process and the implementation of mitigation and management measures.

- **Building Relationships.** Establishes and maintains productive relationships between the project and stakeholders.

- **Engaging Vulnerable Groups.** Pays appropriate attention to stakeholders that are considered more vulnerable.

- **Managing Expectations.** Serves as a mechanism for understanding and managing stakeholder expectations regarding the project.

- **Ensuring Compliance.** A process that ensures compliance with regulatory requirements and international good practice.

Stakeholder engagement is an ongoing two-way process between Energean and those that may influence or be affected by the project. Engaging with stakeholders is essential for the effective management of risk during project delivery.

This chapter provides a summary of the stakeholder engagement activities that have been undertaken to date in support of the project. The Stakeholder Engagement Plan (SEP) provided in *Annex E* provides detail of the overarching engagement framework for the project, which is guided by Israeli requirements and aligned with the International Finance Corporation (IFC) Performance Standards.

7.2 PROGRESS TO DATE

Stakeholder engagement is planned for the following stages of the project:

- Stage 1: National Engagement Programmes;
- Stage 2: Pre-ESIA and Scoping Disclosure;

- Stage 3: ESIA Disclosure;
- Stage 4: Implementation (including construction and production); and
- Stage 5: Decommissioning.

These stages are described in the following sections.

7.2.1 *Stage 1: National Engagement Programmes*

Overview

Two national level engagement programmes have been conducted in Israel that complement the project-specific engagement activities. These were:

- the TAMA 37/H process that was carried out when designating the pipeline corridor route that would be used by multiple projects; and
- engagement around the Strategic Environmental Assessment (SEA) that was carried out for Israeli waters.

These two programmes are directly applicable to the project because they include the entire project footprint. The TAMA 37/H includes the onshore and nearshore project area, and the SEA includes the offshore project area.

See Energean's Stakeholder Engagement Plan (SEP), *Annex E*, for further details about the TAMA 37/H engagement process.

TAMA 37/H Process

Public meetings in support of the EIS for the TAMA 37/H were held at the regional and local level to review the findings of the environmental studies as they progressed. The outcome of the public consultation and disclosure process was the eventual selection of offshore sites for gas production and the least obtrusive design for the onshore landing, including a Coastal Valve Station and connection of the offshore pipelines with the existing domestic export pipeline at an existing INGL facility near Dor Beach.

The process of developing TAMA 37/H from its initiation in 2009 until its final approval by Government of Israel in October 2014 included 18 publicised and documented public consultation meetings with local councils and interest groups. In addition there were 65 planning meetings involving the NPC and other planning committees related to TAMA 37/H. All protocols were publicised and most planning meetings included the public and other stakeholders. These meetings included 15 hearing sessions in which members of the public voiced their remarks and objections to various aspects of the plan. All content and outcome of these meetings were made public on the planning administration website.

A summary of the meetings that were held as part of this process is provided in *Table 7.1*.

Table 7.1 TAMA 37/H Engagement Meetings

Date	Stakeholders	Objective

Date	Stakeholders	Objective
Early 2010	Public hearing with the steering committees for 50 district councils	To discuss potential onshore gas processing terminal sites
October 2011	Public hearing with heads of municipalities (including Fureidis)	Further discussion on potential onshore gas processing terminal sites
November 2011	Twenty-five public forums, representing all districts within which a potential terminal site was located; district councils; government officials (including Furedis)	Further discussion on potential onshore gas processing terminal sites
July 2012	Meetings with local officials	Discuss the status of design and the determination to select five locations as final potential sites
October 2012	30-day public consultation period for EIA Chapters A and B	Garner public feedback on five potential sites
May – June 2013	30-day public consultation period for EIA Chapters C, D and E	Garner public feedback on two potential sites
February to April 2014	15-day period of public hearings involving 100 project opponents, including regional planning and building boards and representatives of the district planners from the North, Haifa, Central and Tel Aviv districts	To hear the views of opponents and allow project proponents to discuss the objections

Strategic Environmental Assessment

The Ministry of National Infrastructure, Energy, and Water Resources commissioned a Strategic Environmental Assessment (SEA) for the Israeli waters of the Mediterranean Sea. The purpose of the SEA was to create a knowledge base to aid decision making for the Petroleum Commissioner in granting petroleum exploration and production rights.

Public involvement was an integral part of the overall SEA process. This included providing data and relevant material regarding the progress of the SEA to relevant stakeholders and the public, and incorporation of their comments within the SEA. The programme for public involvement approved by the steering committee included the following stakeholders:

- 12 Government agencies;
- 78 companies and organisations operating within the affected marine area;
- 15 environmental and social NGOs;
- 12 academic and research organisations; nine planning institutions;
- 23 local councils; and
- the public.

Three meetings were held during the SEA process addressing specific issues. These were in February 2015, December 2015 and February 2016. In June 2016, the SEA was published for public comment for 32 days. During this period the findings of the SEA were presented to the public during a disclosure meeting. The resulting feedback, which included 51 public comments on various topics, was collected and addressed by the SEA team in the final SEA report.

7.2.2 *Pre-ESIA and Scoping Disclosure*

Engagement activities in this stage are all project-specific and led by Energean. *Table 7.2* sets out the completed pre-ESIA engagements conducted by Energean.

Table 7.2 Planned Stages of Engagement, Timing and Proposed Communication Methods and Format

Date	Type	Purpose	Stakeholders	Location	Participants
17-19 July 2017	Formal meeting	Scoping Report Consultation including discussions around: x Discussion around project design x Environmental baseline survey planning x Discussion of how the project plans to align the Israeli EIS requirements with international finance standards x Discussion around scoping process and flagging of any topics of specific environmental or social concern x General ground-truthing of issues and collecting feedback	x Ministry of Environmental Protection x Ministry of National Infrastructures, Energy and Water Resources (Petroleum Unit)	Energean offices in Tel Aviv (Ministry of National Infrastructures, Energy and Water Resources), Ministry of National Infrastructures, Energy and Water Resources offices in Jerusalem, Ministry of Environmental Protection offices in Haifa	x 12 representatives from Energean and their contractors x ~25 representatives from the ministries
17 September 2017	Formal meeting	Development of Karish/Tanin – Initial coordination meeting	Minister of Defence	Minister of Defence Offices	x representatives from Energean x representatives from IDF General Staff Planning Division/Planning and x Development Head of South area, Navy – Gas Infrastructure Branch, IAF.
18 October 2017	Formal meeting	Karish & Tanin Development – Permitting Execution Plan and general project update	Haifa Shipping Authority Offices	Haifa Shipping Authority Offices	x 2 representatives from Energean x 2 representatives from the shipping authority
19 October 2017	Formal meeting	Karish & Tanin Development – Regulatory Execution Plan (REP) and general project update	Village of Ma'ayan Zvi	Village of Ma'ayan Zvi	x 1 representatives from Energean x 2 representatives from Ma'ayan Zvi local government
22 October 2017	Formal meeting	Karish & Tanin Development – Regulatory Execution Plan (REP) and general project update	Haifa District Authority	Haifa District Authority (DA) Offices	x 2 representatives from Energean and their contractors x 3 representatives from the DA
26 October 2017	Formal meeting	Karish & Tanin Development – Regulatory Execution Plan (REP) and general project update	Village of Dor	Village of Dor	x 1 representative for Energean x Dor Chairman
30 October 2017	Formal meeting	Karish & Tanin Development – Permitting Execution Plan and general project update	Nature & Natural Reserves Authority	Michmoret NNRA Offices	x 2 representatives from Energean and their contractors x 1 representative from the NPA
31 October 2017	Formal meeting	presenting the Karish-Tanin project Conceptual Plan	Ministry of Agriculture – The Fishery and Water Agriculture Division	Beit Dagan	x 1 representative for Energean x 1 representative from the Maritime Agriculture Department x 1 representative from the Planning and Development Rural Area
1 November 2017	Formal meeting	Karish & Tanin Development –Environmental Design Basis and Environmental Baseline Study	Ministry of Environmental Protection (MOEP)	MOEP Offices in Haifa	x 2 representatives from Energean and their contractors x 4 representatives from the MOEP x 1 representative from MOE
6 November 2017	Formal meeting	Karish & Tanin Development – Regulatory Execution Plan (REP) and general project update	Hof Carmel Regional Authority	Regional Authority (RA) Offices – Ein Carmel	x 3 representatives from Energean and their contractors x 5 representatives from the RA
8 November 2017	Formal meeting	Karish & Tanin Development – Regulatory Execution Plan (REP) and general project update	Town of Zichron Ya'akov	Zichron Ya'akov	x 2 representatives from Energean x 4 Zichron Ya'akov community members
12 November 2017	Formal meeting	Karish & Tanin Development – Regulatory Execution Plan (REP) and general project update	Village of Dor	Village of Dor	x 1 representatives from Energean x 3 representatives from Dor local government

7.2.3 *Stage 3: ESIA Engagement*

The purpose of the ESIA engagement is to update stakeholders on the following information:

- updates regarding the nature, scale and purpose of the project;
- disclosure of ESIA findings, including identification of impacts; and
- grievance mechanism and company contact details.

The ESIA will be formally submitted as part of the FDP to the Ministry of Energy (MOE) for review and approval. MOE will have the Ministry of Environmental Protection (MOEP) advising on all environmental aspects and proposed mitigations. The reviewing and approving process by both MOE and MOEP will include the following main steps post submission:

- First meeting - Initial presentation and open discussion
- Second meeting - Comments discussion and clarifications
- Third meeting – Discussion on proposed response to comments and draft revised documentation
- Forth meeting – Presentation of the proposed final documentation and formal submission.

After those steps Energean would expect a formal approval by the MOE.

The approved mitigation and measures under the ESIA will be carried on to the detailed permitting processes and be applied in the Building Permits and EMMP documentation. Approved Building Permits and EMMPs are by the law public documentation and be posted on the media and sent to every relevant stakeholder and entities.

The implication of permitting documentation provisions are in practice being put under each executor contractor contract and supervision entities to ensure compliance.

7.2.4 *Stage 4: Implementation*

The purpose of engagement during implementation is for the project to inform stakeholders of project activities, gather and respond to feedback from community members who may be impacted by the project's activities and maintain relationships throughout construction and production.

The primary mechanisms for engagement during this stage will be the project's grievance mechanism (see *Section 6*) and a community forum that will be led by Energean during the construction phase (i.e. when impacts are predicted to be most significant). Representatives of all affected villages will be present at this forum, including the villages of Dor, Nahsholim, Fureidis and Ma'ayan Tzvi.

7.2.5 *Stage 5: Decommissioning*

The purpose of engagement during decommissioning is to consult with stakeholder groups to ensure that feedback regarding the impacts of decommissioning is taken into account.

This section will be updated once the engagement is planned.

7.3 GRIEVANCE MECHANISM

The grievance mechanism allows stakeholders to submit complaints and comments at no cost, without retribution and with the assurance of a timely response. The primary objectives of a grievance mechanism are to:

- enhance trust and positive relationships with stakeholders;
- prevent the negative consequences of failure to adequately address grievances; and
- proactively identify and manage stakeholder concerns and thus support effective risk management.

A detailed description of the grievance mechanism required for the Project is provided in the SEP.

7.4 MONITORING AND REPORTING

In order to assess the effectiveness of the SEP and associated engagement activities, EMP will implement a data management and monitoring process as part of the overall monitoring of ESIA commitments and performance.

All engagement activities, throughout the ESIA process and the life of the project, will be documented and filed in order to track and refer to records when required and ensure delivery of commitments made to stakeholders. The strategies for documenting and recording ongoing stakeholder engagement are detailed in the SEP.

8 ASSESSMENT OF POTENTIAL IMPACTS

8.1 INTRODUCTION

8.2 MARINE BIODIVERSITY

8.2.1 *Overview*

This section assesses the impacts on marine biodiversity. The key project activities considered include:

- underwater noise generated by the FPSO, drillship, installation and support vessels during all project phases.
- the operational discharges from the FPSO, drillship, installation and support vessels during all project phases.
- discharges of muds and cuttings associated with the drilling and completion of three wells.
- the subsea footprint associated with the installation of the subsea production system including the FPSO mooring lines; and
- the footprint associated with the installation of the gas export system.

A number of potential marine biodiversity impacts have been scoped out of the detailed assessment, as presented in the Scoping Report (which is included in the Project's FDP). This includes a number of potential impacts that were included in the State of Israel's *Guidelines for the Preparation of the Environmental Impact Document in the Economic Waters for Development of Karish and Tanin fields (Leases I/17 and I/16)*. These potential impacts are presented below.

Potential Impacts from the Presence of the FPSO, Drillship and Vessels

Collisions between vessels and marine species (particularly marine mammals and turtles) have been known to occur worldwide and increased marine vessel traffic within the Karish Main field and between the field and Haifa will increase the risk of collisions. However, the increased risk of collision is considered to be low given the relatively low volume of project related traffic and the speed that they move, which will typically be less than 12 knots. Marine species are most sensitive in areas with fast moving vessels which frequently change direction and are more able to avoid the large, relatively slow moving vessels that will be associated with the project.

In addition, pelagic species that inhabit the surface layers are also likely to be impact by the presence of the FPSO, drillship and project vessels as species are known to readily associate with floating objects (known as fish aggregate devices (FAD) [1]. However, generally FADs work for only a relatively short period of time as large fish shoals tend to only present for a number of days or weeks in one area and the numbers of fish found beneath floating objects is not necessarily determined by its size [2]. Although commercially exploited species associated with the FPSO, drillship and their safety exclusion zones will be afforded some protection from fishing activity, the benefit to fish is considered not significant due to the temporary nature of the residency of fish near these structures.

Deep water fish are also known to aggregate around seabed structures, such as wrecks, as they provide a variety of habitats and areas of shelter for fish. The addition of the project seabed infrastructure is likely to attract deep water fish, however, the impact of this is not considered to be significant in terms of population ecology due to the size of the area occupied by the infrastructure in relation to the large area of seabed over which deepwater species range.

Potential Impacts from FPSO, Drillship Lighting and Flaring

Artificial lighting may disturb and disorientate seabirds feeding or passing through the area resulting in collisions with the drillship or FPSO. However, experience from other offshore installations around the world has indicated that this is not a significant issue and although some collisions may occur, birds generally become accustomed to the presence of the FPSO and associated vessels.

Light is also an important stimulus for many fish species and they are attracted to the surface waters when the moon is full (due to the vertical migration of zooplankton and other prey species). Fish aggregations around the FPSO and drillship may also be influenced by the artificial light at night as zooplankton and their fish predators are drawn towards the light. The increased availability of prey species to pelagic fish may result in a benefit to a proportion of these pelagic fish populations, however, the scale of this impact will be very small in the context of the area over which these species range and the positive impact will be not significant. In addition, most species are only associated with FADs during daylight hours [3] and will disperse during the night to forage in open waters.

8.2.2 *Potential Impacts from Underwater Noise*

Impact Description

The main sources of underwater sound associated with the project can be categorised as follows.

- Continuous low frequency sound is produced by drilling activities.

(1) Røstad A, Kaartvedt S, Klevjer T A and Melle W (2006). Fish are attracted to vessels. ICES Journal of Marine Science 63: 1431 - 1437.
(2) Nelson P A (2009). Marine fish assemblages associated with fish aggregating devices: effects of fish removal, FAD size, fouling communities, and prior recruits - FADs Fishery Bulletin accessed on 4 June 2009 at http://findarticles.com/p/articles/mi_m0FDG/
(3) Castro J J, Santiago J A and Santana-Ortega AT (2002). A general theory on fish aggregation to floating objects: an alternative to the meeting point hypothesis. Reviews in Fish Biology and Fisheries 11: 255–277.

Noise from propellers and thrusters is predominantly caused by cavitation around the blades whilst moving at speed or operating thrusters under load in order to maintain a vessel's position. The noise produced is typically broadband noise, with some low tonal peaks.

- Machinery sound is produced that is often of low frequency, and often becomes dominant for vessels when stationary or moving at low speeds. The source of this type of sound is from large machinery, such as large power generation units, compressors and fluid pumps. Sound is transmitted through different paths: structural (e.g. machine to hull to water), airborne (machine to air to hull to water), or a mixture of both. Machine sound is typically tonal in nature.

- Sound is produced from subsea equipment such as flowlines and valves. Noise produced will tend to be relatively low for drill casing, but possibly more significant for sub-sea valves.

The propagation of sound through water is affected by spreading (distance) losses and attenuation (absorption) losses with sound energy decreasing with increasing distance from the source. The losses are also influenced by factors such as water depth, temperature and pressure [(1)]. The potential for sound produced by the project to impact marine species will therefore be influenced to a large extent by the distance between the sound source and the marine species, and the sensitivity of these species to sound.

Sound Power Level (SPL) which measures the sound energy is the metric that is most often measured or estimated during disturbance studies; however, it is recognised that the Sound Exposure Level (SEL), which takes into account the duration of exposure, also influences marine fauna behavioural changes. Sound frequency is the property of sound that most determines pitch and is measured in Hertz (Hz) [(2)].

Table 8.1 lists indicative underwater noise levels and frequency ranges for a number of vessels / activities reported. Note that as noise propagates differently in water than air, these should not be compared to airborne noise standards.

Table 8.1 Indication of Underwater Noise that May be Produced by Project Activities

Project Activity	**Approximate Highest Sound Levels (dB re 1 µPa @ 1m)[(a)]**	**Peak Frequency Band – Indicative Ranges (Hz)[(b)]**
Tug	170 dB	50 - 1,000
Pipelay vessel	180 dB	1,000 - 100,000
Supply vessel	180 dB	10 - 1,000
Export Tanker	190 dB	10 – 100
Subsea choke valve	120 dB	1,000 - 100,000

(1) McCauley R D, Fewtrell J, Duncan A J, Jenner C, Jenner M N, Penrose J D, Prince R I T, Adhitya A, Murdoch J and McCabe K (2000). Marine seismic surveys: Analysis and propagation of airgun signals and effects of airgun exposure on humpback whales, sea turtles, fishes and squid. Report produced for the Australian Petroleum Production Exploration Association. 198 pp.
(2) Sound frequency is expressed in Hertz. Sound frequency is an indication of the pitch of a sound.

Project Activity	Approximate Highest Sound Levels (dB re 1 µPa @ 1m)[(a)]	Peak Frequency Band – Indicative Ranges (Hz)[(b)]
FPSO	160 dB	1,000 - 100,000
MODU	174 to 185 dB	10 - 10,000
Notes: (a) Sound pressure is expressed on a decibel scale (dB) and referenced to 1 micro Pascal at 1 m from the source. [dB re 1 µPa @ 1m] (b) Sound frequency is expressed in Hertz. Only the approximate range of peak frequencies is presented, frequencies outside this range are likely to exist but be lower in sound level. Source: Richardson et al [(1)].		

Few noise measurements exist for FPSOs, but noise levels vary, particularly between those using dynamic positioning systems and permanent moorings. Mean sound levels recorded of six operational FPSOs ranged between 174 and 183 dB re 1 µPa @1 m for frequencies 0.02 to 2.5 kHz [(2)]. As a comparison, monitoring of the Jubilee FPSO offshore Ghana [(3)] reported sound ranging mainly from 25 Hz to 2 kHz with a broadband source level of 182 decibels (dB)[(4)]. Sound levels during oil off-loading operations ranged from mainly from 400 Hz to 16 kHz with a broadband source level of 176 dB. The broader frequency range during offloading was thought to be due to propeller noise from the handling tug with possible cavitation.

The drillship could also generate relatively high sound levels of up to 174 to 185 dB, although at relatively low frequencies. Generally noise will be at a similar level to noise from shipping activities, although drillships are generating these noises also when stationary. Kyhn et al [(5)] took underwater noise measurements of drilling and maintenance activities from the Stena Forth drillship. In general, the sound generated during maintenance was higher than drilling. The noise levels were estimated to be 190 dB re 1 µPa @1 m for maintenance work and 184 dB re 1 µPa @1 m for drilling. At a distance of 0.5 km, noise in the range of 0.1 – 10 kHz was detectable during drilling, but by 2 km noise levels were focused below 4 kHz. For maintenance activities, noise in the full range of 0.1 – 10 kHz was detectable 38 km away. In addition, Richardson et al [(6)] reported broadband levels from the dynamically positioned SEDCO 708 (154 dB re 1 µPa-m) did not exceed ambient levels beyond 1 km from a well drilling operations.

Other vessels associated with the project, such as support and pipelay vessels, will have sound levels of up to approximately 180 dB. It is expected that these sound levels would decay to a level of 120 dB within a 1 km radius of the source.

(1) Richardson W J, Greene C R, Malme C I and Thompson D H (1995). Marine mammals and noise Academic Press, San Diego, CA. 576 pp.
(2) Todd, V., Todd, I. and Gardiner, J. (2015) Marine Mammal Observer and Passive Acoustic Monitoring Handbook.
(3) ERM (2015) Environmental Impact Statement for the Tweneboa, Enyenra and Ntomme Project:https://www.tullowoil.com/Media/docs/default-source/operations/ten-eia/ten-project-environmental-impact-statement-volume-1.pdf?sfvrsn=2
(4) Sound pressure level is expressed on a decibel(dB) scale. It is an indication of the amplitude or loudness of a sound.
(5) Todd, V., Todd, I. and Gardiner, J. (2015) Marine Mammal Observer and Passive Acoustic Monitoring Handbook.
(6) Richardson W J, Greene C R, Malme C I and Thompson D H (1995). Marine mammals and noise Academic Press, San Diego, CA. 576 pp.

Project related vessel activity will be most intense during the drilling and installation phases. Activities within these phases may be undertaken simultaneously resulting in an increased vessel presence infield; however, these activities will be short term. Only the FPSO will be permanently based at the Karish field during production. A support vessel will undertake crew transfer between the FPSO and Haifa on a regular basis (1 to 2 times per week) and an export crude tanker will visit the field once every 6 to 8 weeks to undertake offloading activities. Therefore the magnitude of the impact (i.e. the change from baseline) is considered Medium for drilling / installation when most vessels are active in the field and Small for production.

Sensitive Receptors

Localised sound sources, if sufficiently loud, may be detrimental to certain marine species under some circumstances and can cause physical harm or behavioural changes. Of particular concern are the impacts of underwater sound on some species of marine mammals due to their known reliance on sound for activities such as communication and navigation. Turtles are less reliant on sound and are considered less sensitive to sound from marine activities and are not expected to be sensitive to sound generated by the project. Available information on marine fish, shellfish and birds indicate that they are not particularly sensitive to underwater sound although physical damage to fish is possible at high noise levels in the range 180 to 220 dB [(1)] which would only exist very close (a few metres) to the source and these areas are likely to be avoided by fish.

Marine mammals rely on sound for echolocation, detection of predators and prey and communication within or between social groups. Auditory damage can be caused by sudden pressure changes and ranges from minor damage with temporary (minutes to days) hearing loss, to severe damage with permanent hearing loss and damage. Repeated or continual exposure to high level sound can cause shifts of hearing thresholds (i.e. hearing impairment) in some species[(2)]. However, marine mammals are unlikely to intentionally approach activities producing continuous or semi-continuous sounds that are powerful enough to lead to auditory damage. At lower sound levels there may be behavioural changes such as changes to diving patterns and avoidance behaviour, particularly when the noise source is intermittent. Continued exposure often results in habituation to the sound, followed by a recommencement of normal behaviour.

As discussed in *Section 6*, the eastern Mediterranean commonly supports four cetacean species and one pinniped (seal) species. Those that are resident in the Levantine basin are the bottlenose dolphin (*Tursiops truncatus*), Cuvier's beaked whale (*Ziphius cavirostris*), short-beaked common dolphin (*Delphinus delphis*), and striped dolphin (*Stenella coeruleoalba*). The Cuvier's beaked whale, short-beaked dolphin and striped dolphin are all classified as Least Concern on IUCN's Red List of Threatened Species. The Aegean Sea to the north supports the largest remaining European population of globally

(1) Evans P G H and Nice H (1996). Review of the effects of underwater sound generated by seismic surveys on cetaceans. SeaWatch Foundation, Oxford. (Report commissioned by UKOOA.)
(2) Richardson W J, Greene C R, Malme C I and Thompson D H (1995). Marine mammals and noise Academic Press, San Diego, CA. 576 pp.

Endangered Mediterranean monk seal (*Monachus monachus*). The monk seal is classified as Endangered on IUCN's Red List. However, it is unlikely that the species forages in the waters of the Karish field given the distance from potential haul-out sites and therefore would not be exposed to the main long term underwater sound generating activities of the project.

In general, the sound frequencies to which a particular marine mammal is most sensitive tends to coincide with those frequencies it uses for echolocation, navigation and communication as these can be masked by anthropogenic sounds. The cetaceans that commonly occur in Israeli waters are in the med-frequency hearing group (1) (delphinidae, ziphiidae and physeteridae). This group has an estimated functional hearing frequency range from 150 Hz to 160 kHz, which is outside of the estimated peak frequency ranges for project vessels set out in *Table 8.1*.

Therefore, whilst the commonly occurring species are of conservation importance (e.g. classified on the IUCN Red List), they are not considered to be very sensitive to the sound generated by the project and are therefore considered to be of Medium sensitivity.

There are no sensitive areas for marine life identified in the vicinity of the project area and it is not considered an important area for feeding, breeding, calving or spawning.

Impact Significance

McCauley (2) suggested that auditory injury of marine mammals could occur around 220 dB and the Southall et al (3) suggests that, in order for injury to result in a permanent loss in hearing ability that is referred to as Permanent Threshold Shift (PTS), the sound level must exceed 230 dB. The project is therefore not expected to produce sound levels sufficiently high enough to cause instantaneous injury, event at very short ranges.

A 120 dB sound level threshold has been used as an indicative minimum where responses to disturbance such as avoidance of an area may be observed in some individuals. Noise levels above this level are likely from a number of project activities. As most noise sources from the offshore operations are continuous or near continuous it is considered very unlikely that marine mammals would approach the source of noise to reach a point where auditory damage could occur (i.e. more than 180 to 200 dB).

It is expected that marine mammals may exhibit avoidance reactions to the Karish FPSO and other larger project vessels. The hearing frequency sensitivity of the dolphins that commonly occur in Israeli waters is not likely to coincide with the frequency range containing most of the low frequency sound

(1) Southall, B L Bowles, A E Ellison, W T Finneran, J J Gentry, R L, Greene, C R Kastak, D Ketten, D R Miller, J H Nachtigall P E Richardson, W J Thomas, J A and Tyack, P L, (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals, 33, 1-521.
(2) McCauley RD (1994). Seismic surveys. pp 19-122 in Swann J M, Neff J M, Young, PC (eds). Environmental implications of offshore oil and gas development in Australia – the findings of an independent scientific review. APEA, Sydney, Australia, 695 p.
(3) Southall, B L Bowles, A E Ellison, W T Finneran, J J Gentry, R L, Greene, C R Kastak, D Ketten, D R Miller, J H Nachtigall P E Richardson, W J Thomas, J A and Tyack, P L, (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals, 33, 1-521.

energy from vessels or other operations. Given the scale of the area affected by noise in an open sea location, the impacts of relatively low frequency underwater sound on these dolphins is assessed as being of ***Moderate*** significance during the drilling and installation phase when most vessels will be present offshore. During the production phase, the impact is predicted to be ***Not Significant***.

A summary of this assessment is included in *Table 8.2*.

Table 8.2 Summary of Potential Impacts from Underwater Noise

Drilling and Completions	Production
Nature and Type: Direct negative **Duration of Impact:** Short term, variable intensity **Receptor Sensitivity:** Medium **Impact Magnitude:** Medium **Impact Significance (pre-mitigation):** Moderate	**Nature and Type:** Direct negative **Duration of Impact:** Long term, generally uniform intensity **Receptor Sensitivity:** Medium **Impact Magnitude:** Negligible **Impact Significance (pre-mitigation):** Not Significant

Mitigation and Monitoring

There are no specific embedded measures to mitigate the impacts from underwater noise. The management controls for reducing the impact of underwater noise principally include identifying the presence of sensitive species in the affected area and delaying noise generating activities until individuals of these species have exited the area (or reached a set distance). Active mitigation that will be used to mitigate potential underwater noise impacts are provided in *Table 8.3*.

Table 8.3 Additional Mitigation Measures for Underwater Noise

Management Control	Responsibility - Organisation	Timing
Training will be provided to crew on the drillship and FPSO on the types of marine mammals present in the area, so they can monitor the presence of sensitive species using before the onset of sound-creating activities and continue to monitor throughout construction.	Technip	Drilling and Well completions/ installation
If marine mammals are sighted congregating within 500 m of project activities, postpone works until they have moved away, allowing 20 minutes following the last sighting before recommencing.	Technip, Energean	Drilling and Well completions/ installation
Record incidental sightings of marine species from the FPSO and supply vessels and produce annual monitoring reports that document the sightings.	Energean	Production

Residual Impacts

The residual impacts from underwater noise on marine species are set out in *Table 8.4*. The mitigation measures that will be implemented by the project will prevent any deliberate disturbance to marine species.

Table 8.4 Residual Impact from Underwater Noise

	Impact Significance
Pre-mitigation	*Moderate* significance during drilling & completions / installation
	Not Significant during production
Post-mitigation	*Minor* significance during drilling & completions / installation
	Not Significant during production

8.2.3 *Potential Impacts from Operational Discharges*

Impact Description

Operational discharges are defined here as any liquid or solid discharges to sea that may occur during well drilling and completions, subsea installation, commissioning and production phases of the project. If not appropriately managed, potential impacts to marine biodiversity from waste/wastewater discharges can include degradation/destruction of habitat, and harm/death to marine flora and fauna.

Impacts are assessed from routine operational discharges that are likely to continue throughout the project lifespan and from process discharges that are mainly associated with the drilling and commissioning phases or maintenance works.

The following project vessels and installations will contribute to operational discharges:

- the drillship operating offshore during well drilling, completions or well workover activities and associated support or supply vessels;
- installation vessels such as pipe-lay vessels and associated support and supply vessels during installation and commissioning;
- the FPSO once it is installed offshore;
- support and supply vessels during operation; and
- visiting export / sales tankers.

These discharges are described in *Chapter 2*. Note that this section excludes drilling waste discharges, as these are assessed in *Section 8.2.4.*

Sensitive Receptors

The main receptors and resources that could be affected by produced water and cooling water discharges from the Karish FPSO are the marine species in the receiving surface waters surrounding the discharge location. This will include planktonic species as well as fish, cetaceans and turtles. The cetacean and turtle species include those of low to high conservation value according to IUCN. However, these species are unlikely to be sensitive to small changes in water quality and are sufficiently mobile to avoid areas that would cause them distress. Planktonic communities are likely to be the most sensitive group to impacts from the FPSO's discharges. However, the Eastern Mediterranean is oligotrophic so planktonic biomass is not expected to be present at a sufficient density to be considered important. Therefore the overall importance / value / sensitivity of the marine species occupying the surface water is considered Low.

Impact Significance

Table 8.5 sets out the operational discharges that will occur during the project including the discharge location (sea surface or seabed), a description of the impact, the embedded mitigation measures and the magnitude. Discharges that are considered to be of Negligible magnitude are not considered further in the assessment.

Table 8.5 Operational Discharges

Discharge	Location	Impact	Embedded Mitigation / Controls	Magnitude
Black water	Sea surface from project vessels.	Localised and temporary impact on water quality and marine organisms due to increase in biological oxygen demand (BOD) and visual pollution. Discharges will be intermittent.	x Blackwater will be treated prior to discharge. Approved sanitation units will achieve discharge standards of no floating solids, no discolouration and a residual chlorine content of <3 mg l-1. No discharge within 12 nmi of land.	Negligible
Grey water (including macerated food waste)	Sea surface from project vessels	Localised and temporary impact on water quality and marine organisms. Discharges may be continuous depending on water usage.	x Organic food wastes generated will be macerated to pass through a 25 mm mesh and discharged more than 12 nmi from land with no floating solids or foam.	Negligible
Deck drainage and bilge water	Sea surface from project vessels	Unmanaged discharge of this water to the sea represents a potential localised and temporary impact on local water quality and marine organisms. Treated discharges will be intermittent.	x The FPSO and drillship deck and drainage system will contain leaks, spills and contaminated wash-down water to minimise the potential for uncontrolled overboard release. The open drain system will collect oily rainwater drainage. A closed drain system will collect hazardous fluids from service areas. x The FPSO, drillship and vessels will treat oily water (eg from open and closed drain systems, bilges and slop tank water) in accordance with the MARPOL Annex I requirements (15 parts per million (ppm) oil and grease as a maximum limit) and discharge to sea. x Oil discharge monitors are used to prevent oil in water content targets being exceeded. Records will be maintained of all discharges and oil content to verify controls in place are working effectively.	Negligible
Pre-commissioning and line flushing fluids	Sea surface from FPSO and subsea from pipeline	Exposure to chemicals (oxygen scavenger, biocide). Larger volumes will result in temporary, small, localised impacts on marine organisms that contact the plume before it is greatly diluted.	x A pre-commissioning disposal plan will be developed to control the rate of discharge, chemical use and dispersion. Dispersion will be improved by optimising the discharge rate, pressure and direction of the discharge at the release point. x The volume of pre-commissioning water discharged to sea will be reduced by testing equipment onshore where possible, before it is loaded for offshore installation. x All discharges resulting from commissioning activities shall be included in a Discharge Permit issued by the Israeli MOE/MOEP.	Negligible

Discharge	Location	Impact	Embedded Mitigation / Controls	Magnitude
Hydraulic fluid	Subsea from manifold	Small scale, localised and intermittent impact from low toxicity and rapidly biodegradable fluid discharged from subsea valves.	x The hydraulic fluids used will be water-based glycol control fluids with low toxicity and bioaccumulation potential that are readily biodegradable.	Negligible
Produced water	Sea surface from FPSO	Impacts on water quality and marine organisms (as a consequence of entrained hydrocarbons and other components such as metals). Small volumes of produced water are expected from the Karish Main field therefore discharges will be intermittent. Toxicity studies on produced water discharges have shown that the concentrations of toxic chemicals in most produced waters are well below the test species 96 hour LC50 (lethal concentration for 50% of the individuals tested over a 96 hour period) indicating that acute toxicity is unlikely beyond the immediate vicinity of the discharge (3)	x The FPSO will have a produced water separation / treatment system and storage in a dedicated gravity settling tank. Residence times within the tank will be adequate to meet minimum discharge requirements i.e. concentration of dissolved oil to at or below 21 mgl-1 maximum and 15 mgl-1 maximum daily average oil content and no visible sheen on the sea surface.	Small
Cooling water	Sea surface from FPSO	Impacts on marine organisms known to populate the surface waters resulting from either the chemical content (i.e. residual chlorine) of the cooling water discharge or the temperature differential between the discharge and surface waters. Modelling was used to determine the extent of the cooling water plume. The results of the modelling are summarised in *Box 8.1*.	x FPSO cooling water will be compliant with the good industry practice guideline (2) that the temperature rise be less than 3°C within 100 m of the discharge structure	Small

Discharge	Location	Impact	Embedded Mitigation / Controls	Magnitude
Ballast water	Sea surface from project vessels	Possibility of invasive foreign marine species and pathogens introduced that can adversely affect native marine biodiversity. Ballast water can contain oil and other polluting chemicals.	x The FPSO will have segregated ballast tanks from other process systems. x Visiting export tankers and other vessels discharging ballast water will be required to undertake ballast water management measures in accordance with the International Convention for the Control and Management of Ships Ballast Water & Sediments. This includes requirements for a ballast water management plan on each vessel and ballast water exchange at least 200 nmi from the nearest land and in water at least 200 m deep to minimise the transfer of organisms. Exceptionally, discharges are permitted 50 nmi from land in water depths of less than 200 m. x All visiting vessels and tankers (including the FPSO) shall comply with the letter sent by MOE on 16th October 2017 entitled "Principles for the Prevention of Entry of Invasive Species".	As Low As Reasonably Practicable (1)

(1) The impacts of ballast water may not occur during the project and therefore a risk based approach is taken. The likelihood of introducing invasive marine species when complying with the recommendations of the 2004 Ballast Water Convention is considered low.
(2) IFC (2007) Environmental, Health and Safety (EHS) Guidelines. General EHS Guidelines: Environmental. Wastewater and Ambient Water Quality
(3) GESAMP (1993). Impact of Oil and Related Chemicals and Wastes on the Marine Environment. IMO/FAO/UNESCO/WMO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution.

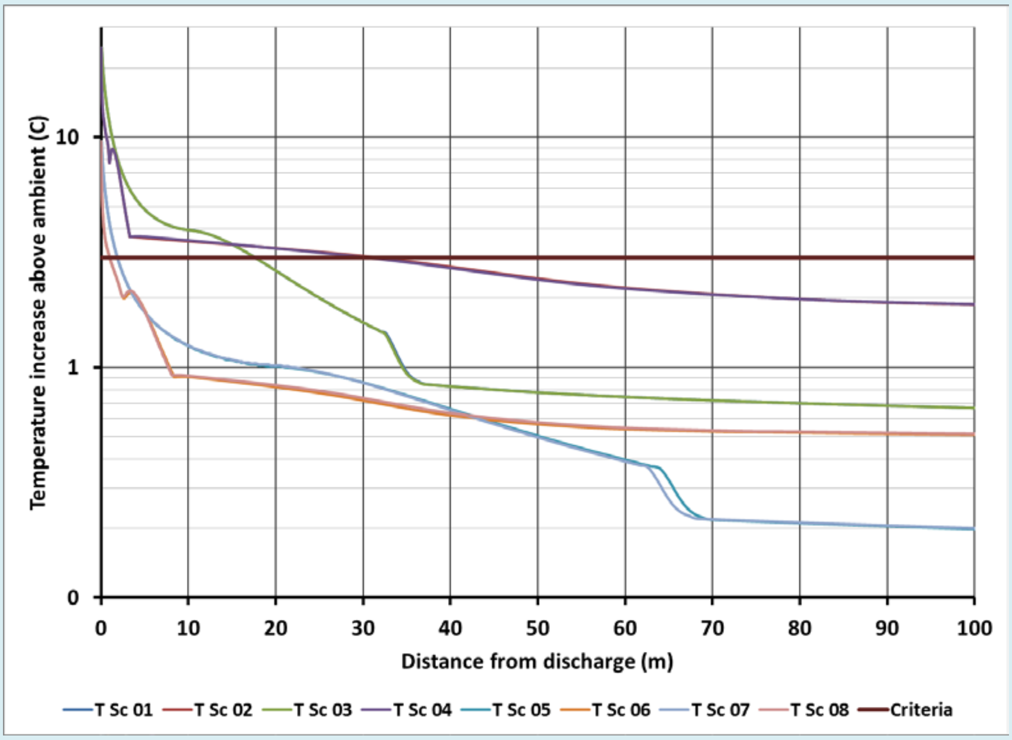
Box 8.1 *Cooling Water Modelling*

A modelling exercise has been undertaken to estimate the extent of the thermal plume from the FPSO cooling water discharge. The modelling used the US EPA approved near-field dilution model, CORMIX. Eight scenarios were modelled comprising a combination of effluent rates, temperatures, and ambient water properties and currents.

The figure below illustrates the temperature rise above ambient conditions along the centreline of the thermal plume for all scenarios. The decrease in temperature rise above ambient due to mixing is such that, for all scenarios, the rise is less than 3°C within 10 m of the discharge and less than 0.7°C for all scenarios except T Sc 02 and T Sc 04. These two scenarios show a rise of nearly 2°C at 100 m. These two scenarios include the largest initial temperature rise of 24.4°C and the smallest current (5 cm/s).

The rapid dilution is due to the relative difference in characteristics between the discharge and receiving water. The above-surface discharge location allows the discharge to 'plunge' into the receiving waters which enhances mixing. The lower density of the discharge gives it buoyancy which then drives it back to the surface, further enhancing mixing. The ambient currents aid in advecting the plume which also contributes towards the high initial dilution.

In conclusion, the thermal discharge of the cooling water will have a continuous impact on surrounding waters for the duration of the project's operation. However, this impact will be within what is considered good industry practice, reducing to a less than 3°C increase above ambient within 35 m from the point of discharge for all modelled discharge and current scenarios. Therefore the magnitude is considered small.



The impact of produced water is Small magnitude. The discharge will be relatively small and intermittent, leading to localised and short-lived impacts on water quality. The importance / sensitivity of marine species in the area is considered Low, therefore the impact from produced water discharges is assessed as ***Not Significant***.

Good industry practice for thermal discharges indicates that there should be no more than a 3˚C increase within 100 m of the discharge. The modelling shows that elevated temperatures will be experienced in the immediate vicinity of the discharge; however, cooling water discharges are not expected to exceed the good practice limit in any of the modelled scenarios. Therefore the impact from thermal discharges is assessed as ***Not Significant*.**

A summary of this assessment is included in *Table 8.6.*

Table 8.6 Summary of Potential Impacts from Operational Discharges

Nature and Type: Direct negative
Duration of Impact: Intermittent (produced water); continuous (cooling water)
Receptor Sensitivity: Low
Impact Magnitude: Negligible **-** Small
Impact Significance (pre-mitigation): *Not Significant*

Mitigation and Monitoring

The embedded mitigation measures that the project will use to mitigate impacts from FPSO discharges are presented in *Table 8.5*. Energean will be responsible the implementation of these measures as the field operator. No further active measures have been recommended.

Residual Impacts

The residual impact from operational discharges on marine species remains ***Not Significant.***

Table 8.7 Residual Impact from Operational Discharges

	Impact Significance
Pre-mitigation	*Not Significant*
Post-mitigation	*Not Significant*

8.2.4 *Potential Impacts from Drilling Waste Discharges*

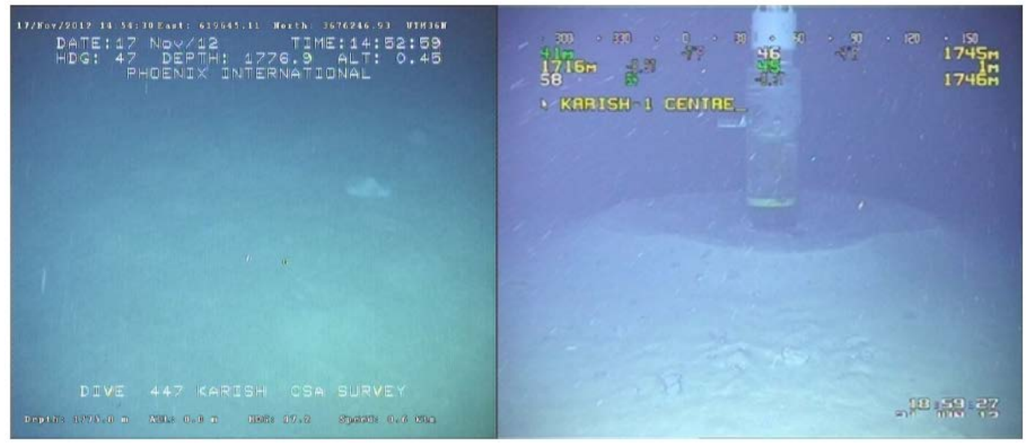
Impact Description

This section provides an assessment of the impacts from discharges of drilling mud and cuttings, cement and completion fluids. The three Karish production wells will be drilled from a single drill centre located at the manifold. As a result the drilling discharges from the wells are likely to be cumulative over a smaller affected area. A separate production well may also be drilled in Karish North, which given the distance is not likely to have any cumulative impact with the three Karish Main wells but will represent an additional area of impacted seabed.

An estimated 290 tonnes of cuttings and 8,075 bbl of drilling fluids from the 26” well sections will be discharged to the seabed. The larger particles sizes within the suspended discharge plume will settle rapidly, close to the well, forming one or several accumulations (cuttings piles). These piles will cause a small alteration to the seabed immediately adjacent to the well. Smaller particle sizes within the discharge plume are expected to settle out further from the well, resulting in changes to the sediment composition. The larger material will be formed primarily of cuttings from the wellbore, whereas the finer material will be made up of mud components such as barite.

The Karish post-drill survey [1] observed unconsolidated sediment at varying distances and grain sizes within approximately 200 m of the well site with coarser sediment becoming more prevalent closer to the well head. There was no obvious mounding of sediment or changes in seafloor depth except around the well head. Ripples were observed on the seabed 75 m from the well head, indicating a potential area of limited disturbance from cuttings deposition. The change in particle grain size between the pre-drill and post-drill survey showed weak evidence for drilling impacts, with only the silt portion of some samples increasing. *Figure 8.1* presents photographs taken of the well location before and after drilling showing the visible cuttings piles around the well.

Figure 8.1 Photographs Showing Seabed Before and After Drilling Karish-1 Well [2]



The deposition of mud and cuttings is likely to affect the benthic community in the immediate area by burying (smothering) some animals and impairing the feeding and respiratory system of others. Increased concentrations of suspended particles may also cause irritation, abrasion to protective mucous coatings and increasing susceptibility to parasites and infections. Different faunal groups are tolerant to different degrees of smothering and suspended sediment. In general, burrowing species such as polychaetes have a high tolerance to burial as they are able to burrow through the deposits, while encrusting species such as ascidians and bivalves have a lower tolerance as they are unable to avoid the effects.

The effects of cuttings deposition on benthic communities are well documented [3] [4] [5] and have been shown generally to be localised to the

(1) CSA Ocean Sciences Inc. (2014) Karish-1 Environmental Monitoring Program Post-Drill Survey Report.
(2) CSA Ocean Sciences Inc. (2014) Karish-1 Environmental Monitoring Program Post-Drill Survey Report.
(3) Neff, J.M. (2005). Composition, Environmental Fates and Biological Effect of Water Based Drilling Muds and Cuttings Discharged to Marine Environment – A Synthesis and Annotated Bibliography, Battelle Publishers.
(4) OSPAR (2007), Assessment of the impact on the marine environment of offshore oil and gas activity – an overview of monitoring results in the United Kingdom, the Netherlands and Norway. OSPAR Commission, London, 33pp.
(5)Jones et al (2007) Anthropogenic disturbance of deep-sea megabenthic assemblages, NE Atlantic. Marine Biology 151: 1731–1741. doi: 10.1007/s00227-007-0606-3

discharge point; based on the post-drill survey this is expected to be limited to within 200 m of each well. Given that the wells will be drilled less than 50 m apart from a single drill centre, the thickness of cuttings deposited on the seabed is likely to be greater but the area of affected seabed will be less compared to a situation if the three wells were to be drilled at separate locations. A conservative estimate for the area affected by cuttings is 0.283 km^2, assuming that cuttings will be present up to 300 m from the drill centre after drilling the wells.

The recovery period of benthic communities within affected areas is less well understood. Recent studies from the Norwegian Sea (1) and Faroe-Shetland Channel (2) show that the recovery of megabenthic fauna in areas covered by cuttings is poor even after 3 years and 10 years respectively, with recovery largely dependent on the rate of removal of cuttings from the seabed by natural processes. Seabed recovery at the drill centre location is likely to be long term and in the order of several decades given that the thickness of the cuttings deposits is likely to be greater given the single drill centre and the quiescent current conditions.

Other impacts associated with the discharge of WBM cuttings may include elevated levels of barium and other metals (cadmium, zinc and lead) sometimes associated with the barite used in drilling muds. These metals may leach into sediments once cuttings have settled on to the seafloor, or into the water column while cuttings are suspended as a plume following discharge. The analysis of sediment metal concentrations in the post-drill survey (3) indicated a potential drilling effect for barium. Post-drill barium concentrations showed enrichment in sediments that decreased with increasing distance from the well site. The barium concentrations were much higher than ambient concentrations within 500 m of the wellhead.

Barium is present in drilling muds as barium sulphate which is an insoluble, chemically inert mineral powder that normally contains measurable concentrations of several trace metals. As such, barium is considered virtually unavailable to biological organisms and will have no measurable effect on the benthic fauna (4) (5). The impact of other metals will depend on their concentration in the barite, which largely depends on its geological source. Discharge plumes will settle quickly out of the water column and any dissolved contaminants will disperse quickly (6), therefore impacts to water quality will be localised and short lived.

Studies of the impacts of WBM discharges have generally found the effects on seabed fauna to be very small or undetectable, and for the most part limited to physical impacts (e.g. burial) rather than toxicological, even in the presence of

(1) Gates AR, Jones DOB (2012). Recovery of Benthic Megafauna from Anthropogenic Disturbance at a Hydrocarbon Drilling Well (380 m Depth in the Norwegian Sea). PLoS ONE 7(10): e44114. oi:10.1371/journal.pone.0044114.

(2) Jones, D. Gates, A. and Lausen, B. (2012) Recovery of deep-water megafaunal assemblages from hydrocarbon drilling disturbance in the Faroe–Shetland Channel. Mar Ecol Prog Ser. Vol. 461: 71–82, 2012

(3) CSA Ocean Sciences Inc. (2014) Karish-1 Environmental Monitoring Program Post-Drill Survey Report.

(4) Neff, J.M. (2005). Composition, Environmental Fates and Biological Effect of Water Based Drilling Muds and Cuttings Discharged to Marine Environment – A Synthesis and Annotated Bibliography, Battelle Publishers.

(5) Hartley JP. (1996). Environmental monitoring of offshore oil and gas drilling discharges – A caution on the use of Barium as a Tracer. Marine Pollution Bulletin, 32 (10): 727-733.

(6) Neff, J.M. (2005). Composition, Environmental Fates and Biological Effect of Water Based Drilling Muds and Cuttings Discharged to Marine Environment – A Synthesis and Annotated Bibliography, Battelle Publishers.

chemically detectable levels of drilling material at the seabed [1]. Where toxic effects of WBM and associated cuttings have been observed they are generally thought to be caused by sulphide and ammonia by-products of organic enrichment [2]. Any toxic effects from drilling discharges are expected to be highly localised to the point of discharge, as the contaminants are rapidly diluted to below effective concentrations away from the source. There were no observed changes in infauna characteristics between the pre-drill and post-drill surveys. Species abundance and diversity in the area was low during both surveys, which reflected the overall depauperate nature of the Levantine Basin deep seabed.

The overall magnitude of discharges is considered small given the short term presence of mud and cuttings plumes and the highly localised depositional footprint. However, recovery to pre-drill conditions is expected to be slow (possibly several decades) given the low energy deep water environment and the likely thickness of the deposits. The proposed mud is also expected to have very limited ecotoxicological effects; where any effects occur they are likely to be localised to the immediate vicinity of the cuttings discharges. Cement will be discharged onto areas already affected by cuttings deposition, and is also expected to have very limited ecotoxicological effects.

Sensitive Receptors

Sediments in the project area based on the Karish-1 surveys [3][4] were composed primarily of silt and were generally classified as clayey silt, with several stations classified as sand-clay-silt, sandy-silt or silt. These grain size characteristics are expected for deepwater sediments located far from riverine discharges and terrigenous sediment sources. Species diversity was calculated as low to moderate and evenness, which reflects the equitable distribution of individuals among species, was relatively consistent. Polychaete worms were the most dominant taxa and accounted for over 58% of the total infaunal abundance, with approximately 31% of these specific to the *Notomastus* sp. Mollusks accounted for 19% of the total infaunal abundance and were primarily Bivalvia sp. The habitat and species have been assessed of Low importance and sensitivity given the generally featureless benthic habitat and relatively homogenous fauna across the project area.

No hard bottom substrate or chemosynthetic communities were observed during the Karish-1 post-drill survey [5].

Impact Significance

The impact magnitude of drilling discharges is considered small. The benthic community in this area is characterised by species considered of low to medium importance with low to medium sensitivity to burial. Organisms in the immediate vicinity of the cuttings discharges may experience limited, sub-

(1) DECC (2011). UK Offshore Energy Strategic Environmental Assessment; OESEA2 Environmental Report.
(2) Neff, J.M. (2005). Composition, Environmental Fates and Biological Effect of Water Based Drilling Muds and Cuttings Discharged to Marine Environment – A Synthesis and Annotated Bibliography, Battelle Publishers.
(3) CSA Ocean Sciences Inc. (2013) Karish-1 Environmental Monitoring Program Pre-Drill Survey Report.
(4) CSA Ocean Sciences Inc. (2014) Karish-1 Environmental Monitoring Program Post-Drill Survey Report.
(5) CSA Ocean Sciences Inc. (2014) Karish-1 Environmental Monitoring Program Post-Drill Survey Report.

lethal toxic effects; this will not result in population level effects or reductions in biomass at the site, but may cause some changes in the species present at discharge points. Therefore the impact of drilling discharges for the three Karish wells on marine species is assessed as being of ***Not Significant*.**

A summary of this assessment is included in *Table 8.8*.

Table 8.8 ***Summary of Potential Impacts from Drilling Waste Discharges***

Nature and Type: Direct negative
Duration of Impact: Long term
Receptor Sensitivity: Low
Impact Magnitude: Small
Impact Significance (pre-mitigation): *Not Significant*

Mitigation and Monitoring

The embedded mitigation measures that the project will use to mitigate impacts from drilling discharges are presented in *Table 8.9*. No additional active mitigation measures have been recommended.

Table 8.9 ***Embedded Mitigation Measures for Drilling Waste Discharges***

<table>
<tr><th>Management Control</th><th>Responsibility - Organisation</th><th>Timing</th></tr>
<tr><td>Ensure that the drill centre location (and location for drill cutting disposal) is included in the EBS scope. The EBS survey will be done pre- and post-drilling.</td><td>Energean</td><td>Prior to drilling and completions</td></tr>
<tr><td>Only Water Based Muds will be used. The mud programme will be designed to take into account the concentration, toxicity, bioavailability and bioaccumulation potential of its components. MSDS will be submitted to the Israeli authorities as part of a Pollution Permit before drilling commences.</td><td>Drilling contractor</td><td rowspan="4">Drilling and completions</td></tr>
<tr><td>High-efficiency solids control equipment (shale shakers) will be used to reduce the need for fluid change out and amount of residual fluid adhered in drilled cuttings.</td><td>Drilling contractor</td></tr>
<tr><td>Drilling fluids to be discharged to sea (including as residual material on drilled cuttings) will be subject to tests for toxicity, barite contamination, and oil content. Barite contamination by mercury (Hg) and cadmium (Cd) will be checked to ensure compliance with IFC requirements (See Table 1, in the World Bank's EHS Guidelines for Offshore Oil and Gas Development) and Israeli discharge limits defined in the approved discharge permit.</td><td>Drilling contractor</td></tr>
<tr><td>WBM and treated drilled cuttings will be discharged via a caisson submerged below the sea surface for suitable dispersion.</td><td>Drilling contractor</td></tr>
</table>

Residual Impacts

The residual impact from drilling discharges on marine species remains ***Not Significant****.*

Table 8.10 Residual Impact from Drilling Waste Discharges

	Impact Significance
Pre-mitigation	*Not Significant*
Post-mitigation	*Not Significant*

8.2.5 *Potential Impacts from the Subsea Infrastructure (Excluding Pipeline)*

Impact Description

The installation of the subsea production system and FPSO mooring anchors will result in habitat loss or disruption to defined areas of the seabed and impacts to benthos (animals living in or on the seabed) and demersal fish. The drillship will be dynamically positioned so will not require anchoring.

The main impacts are expected to arise from the following sources.

- Short-term disturbance directly to the seabed (e.g. from sediment suspension), with secondary impacts on the benthic and demersal community, during installation of the subsea production system.

- Permanent habitat and associated species loss or damage from coverage of areas of seabed by moorings, manifolds, well heads, riser base, flowlines and umbilicals.

- Permanent changes to the habitat arising from the physical presence of subsea equipment (e.g. sediment disturbance and reef effects from marine organisms growing on subsea infrastructure).

Effects from sediment disturbed during infrastructure installation. Sediment may become disturbed and suspended in the water column by project activities undertaken on or near the seabed such as installation of flowlines, moorings, manifolds, and the riser base. Suspended sediment could lead to the smothering of sessile species and possible secondary effects such as impacts to the respiration of benthic organisms and demersal fish. The duration of installation activity is relatively short-term and localised. The overall magnitude of the impact is considered to be small.

Loss of or damage to marine habitats. The positioning of subsea infrastructure will result in the loss of or damage to seabed habitats and associated communities. The total area of seabed that will be directly affected by the physical presence of subsea infrastructure is relatively small at approximately 0.0062 km^2. For comparison the Karish Main field is approximately 42 km^2 therefore the area of direct impact represents approximately 0.0148% of this area. Mortality of all individuals immediately beneath installed infrastructure is likely, particularly for sessile species (which are typical to benthic communities) where avoidance and vertical migration is generally not possible. The impact on seabed habitats and species will be localised with the area affected being small in relation to the similar habitats in the offshore location and consequently the loss of areas of habitat is considered to be of small magnitude.

Loss of fish prey organisms. The loss of or damage to seabed habitats and associated communities will reduce prey availability to demersal deep water fish species in the area. The impacts to benthic organisms are considered to be localised and the total loss will represent a very small portion of the available food to fish predators. In addition, the fish species impacted are highly mobile, travel large distances for food and will be able to source prey from other locations. The impact is therefore considered to be of small magnitude.

Changes to sediment structure and composition. Changes to sediments may occur from a variety of processes, e.g. from compaction or changes to water current flow caused by the presence of the infrastructure. Any change to habitat conditions is anticipated to be localised and small scale (i.e. limited to the footprint of subsea infrastructure).

Barriers precluding movement / migration of benthic organisms. Flowlines and pipelines of significant linear length have the potential to create a physical barrier to mobile benthic organisms such as crustaceans. However, the height of the flowlines (up to 10" inch diameter) is not expected to create a significant barrier, especially as flowlines are likely to settle into the soft sediments by approximately 30 to 50% of their diameter. The impact is therefore considered to be of small magnitude.

Creation of new substrate and potential habitat. The placement of seabed equipment, in an otherwise uniform and relatively featureless habitat, could also provide some positive benefits by providing solid relief features on the seabed offering a protective and stable substrate which could be colonised over time. This 'reef effect' will be at a small scale and localised but nevertheless would add to local biodiversity.

Sensitive Receptors

Sediments in the project area based on the Karish-1 surveys (CSA Ocean Sciences Inc. 2013) were composed primarily of silt and were generally classified as clayey silt, with several stations classified as sand-clay-silt, sandy-silt or silt. These grain size characteristics are expected for deepwater sediments located far from riverine discharges and terrigenous sediment sources. Species diversity was calculated as low to moderate and evenness, which reflects the equitable distribution of individuals among species, was relatively consistent. Polychate worms were the most dominant taxa and accounted for over 58% of the total infaunal abundance, with approximately 31% of these specific to the *Notomastus* sp. Mollusks accounted for 19% of the total infaunal abundance and were primarily Bivalvia sp. The habitat and species have been assessed of Low importance but of Medium sensitivity given the generally featureless benthic habitat and relatively homogenous fauna across the project area that will be unable to avoid the impacts.

Impact Significance

The installation and presence of structures on the seabed constitute small magnitude impacts to marine habitats and species which are assessed as being of low conservation value and medium sensitivity. The negative impacts of seabed structures on benthic communities are assessed as being of ***Minor*** significance within the project area. There will be positive impacts from the small scale introduction of new substrates for colonisation by benthic organisms.

A summary of this assessment is included in *Table 8.11*.

Table 8.11 Summary of Potential Impacts from the Subsea Infrastructure (Excluding Pipeline)

Nature and Type: Direct negative
Duration of Impact: Permanent
Receptor Sensitivity: Low to medium
Impact Magnitude: Small
Impact Significance (pre-mitigation): *Minor*

Mitigation and Monitoring

No specific measures will be implemented to reduce impacts on seabed habitats and species. A pre-construction survey will be undertaken of the proposed infrastructure locations to confirm the suitability of the seabed and absence of any sensitive features. The area will also be covered in the Environmental Baseline Survey (EBS) to be conducted.

Residual Impacts

The residual impacts from project footprint on marine species are set out in *Table 8.12.*

Table 8.12 Residual Impact from the Subsea Infrastructure (Excluding Pipeline)

	Impact Significance
Pre-mitigation	*Minor*
Post-mitigation	*Minor*

8.2.6 *Potential Impacts from the Gas Export Pipeline*

Impact Description

The impacts from the gas export system will be similar to those associated with the installation of the subsea production system described in *Section 8.2.5*. There will be three distinct sections of the gas export system as described in *Section 2.3.3*, namely the deep water section, the INGL-owned shallow water section and the onshore section. This Section applies only to the deepwater and shallow water sections.

The deep water section will be installed using the S-lay technique directly on top of the seabed. The nearshore section (60 m water depth) will be trenched and backfilled for approximately 7.5 km. Microtunnelling will be used to cross the nearshore section in water depths of 10 to 12 m. Rock dumping will be used to protect the pipeline where coverage is less than 1.2 m and for a short 200 m section between the microtunnel exit location and the trenched section, and also to prevent any areas of free spanning along the entire pipeline length. Both the rock dumping and backfilling will be achieve a 1.2 m as per TAMA 37/H.

Despite the different installation techniques the impacts will remain similar across the pipeline length:

- Short-term disturbance (e.g. sediment suspension) directly to the seabed with secondary impacts on the benthic and demersal community.

- Permanent habitat and associated species loss or damage in areas covered by the pipeline, equipment and rock dumping.

- Permanent changes to the habitat arising from the physical presence of subsea equipment and rock dumping.

The impacts will be small-scale, localised but long term for areas covered by the project infrastructure. The permanent seabed footprint of the gas export system will be approximately 0.058 km^2; the trenching will temporarily increase this footprint. However, the affected area will be inconsequential when compared to Israel's continental shelf and Exclusive Economic Zone (EEZ). Smothering and other secondary effects will also be localised and temporary. The installation of the pipeline system is unlikely to remove or damage any discrete habitat type; it is considered more likely to only remove a small proportion of a more widely available habitat type. The trenching, rock dumping and microtunnelling activities will occur in relatively shallow water areas near the coast that are generally understood to be more dynamic. Therefore the recovery of these areas is likely to be quicker (within months or a year) compared to deep water areas were bottom current conditions are quiescent where recovery can take several years or possibly decades.

The overall magnitude of the impacts resulting from the installation of the gas export system is unlikely to be large unless a significant proportion (i.e. one that affects its ecosystem function) of a discrete habitat feature of value, that is rarely present, is removed or damaged. The magnitude is likely to be small, and installation will only involve the removal or damage to only a very small proportion of a habitat type that is widely available offshore Israel. Moreover, microtunnelling will be used to cross the nearshore area where there is a higher potential for more valuable habitat to be located.

Sensitive Receptors

The habitat along the pipeline route is not known at this stage. Given this, the receptor sensitivity could be considered High.

Impact Significance

Taking a conservative approach the habitat and the species may be of potentially high value / importance and sensitivity. Depending on the proportion of these habitats are removed or damage, the impacts from installation of potentially ***Major*** significance.

Mitigation and Monitoring

An environmental baseline survey (EBS) is being undertaken that will confirm the habitat types present along the pipeline route as well as identify and locate any discrete habitat of value. These habitats will then be avoided in the final design of the pipeline route.

Table 8.13 Mitigation Measures for Installation of Gas Export Pipeline

Management Control	Responsibility - Organisation	Timing
Energean has commissioned an Environmental Baseline Survey (EBS) for the offshore project area. If the EBS identifies any high value and/or high sensitivity habitats along the proposed pipeline route, then the pipeline route will be modified to avoid these areas by 150 m.	Energean	Prior to pipeline construction
If re-routing of the offshore pipeline is required beyond the area covered in the EBS, conduct a pre-lay survey to confirm that the modified route is clear of any high value and / or high sensitivity habitats.	EPC, Energean	

Residual Impacts

The residual impacts from project footprint on marine species are set out in *Table 8.14*.

Table 8.14 Residual Impact from the Gas Export Pipeline

	Impact Significance
Pre-mitigation	*Major*
Post-mitigation	*Not Significant to Minor*

8.3 AIR QUALITY

8.3.1 *Overview*

This section assesses the potential impacts of air emissions on human receptors. The key project activities considered include:

- gas-fired turbines generating power on the FPSO during the production phase;
- non-continuous flaring of gas at the FPSO for safety reasons during the production phase; and
- diesel-fired generators, pumps and compressors used onshore during the pipeline commissioning phases.

The offshore emissions at the FPSO will occur throughout the lifetime of the project. The onshore emissions from the diesel engines will occur over a three month period during the pipeline commissioning phase.

A number of project activities that will generate emissions to air have been scoped out from further assessment (i.e. considered to be ***Not Significant***) per the Project's Scoping Report (included with the Field Development Plan). These include:

xoffshore flaring for well completion;
xonshore site clearance for CVS and DVS;
xonshore dead man anchor installation and piling;
xonshore pipeline installation;
xhelicopter transportation; and
xroad transportation.

A detailed dispersion modelling was undertaken for the potentially significant offshore and onshore activities only to predict potential impacts on air quality. Technical details on the model can be found in *Annex C*. Impacts have been assessed using the methodology included in *Annex A.* Note that when applying this methodology, as presented in *Section 6.4.2*, the airshed is considered to be undegraded for all pollutants and averaging periods.

8.3.2 ***Potential Impacts from Onshore Pipeline Commissioning***

Impact Description

Impacts to ambient air quality arise from the emissions produced when operating the diesel engines used to power compressors, pumps and generators for the pipeline's dewatering and drying. The pollutants of interest are NO_2 and as PM_{10}. Sulphur dioxide emissions are assumed to be negligible, as diesel cannot contain more than 10 ppm of sulphur in Israel [(1)]. There will be an estimated thirty-six diesel-fired engines used during this phase. They will be located in either Staging Area 1 or Staging Area 2 near the pipeline landfall. The majority of these engines (27) will be used to power primary compressors and boosters. The rest of the engines power smaller compressors, generators and pumps.

All the identified engines will comply with the Stage IIIB emission limits as set out in the European Directive 97/68/EC[(2)] for non-road mobile machinery emissions.

Sensitive Receptors

The closest sensitive human receptors from the onshore facility are nearby settlements to the north and east. Those settlements are described in details in *Section 6.4.5* and their respective locations are shown in *Figure 6.22.* The nearby beach is also a sensitive receptor for short-term impacts, as it is used for recreational purposes.

The closest sensitive ecological receptors from the onshore facility are the adjacent grasslands and dunes, as described in *Section 6.4.4*.

(1) Ministry of Energy, Fuel and the Environment
http://energy.gov.il/English/Subjects/Subject/Pages/GxmsMniFuelAndTheEnvironment.aspx
(2) Directive 97/68/EC of the European Parliament and of the Council of 16 December 1997 on the approximation of the laws of the Member States relating to measures against the emission of gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machinery, as amended.

Impact Significance

The emissions from the onshore engines have been modelled using the USEPA dispersion model AERMOD. The worst-case scenario was considered, i.e. all thirty-six engines running simultaneously. The model parameters are set out in *Table 2.5* and *Annex C.*

Impacts on Human Health

The maximum predicted concentrations of NO_2 and PM_{10} were compared to the Israeli air quality standards listed in *Table 8.15* to determine the predicted impact magnitude.

Table 8.15 Predicted Human Health Impacts on Air Quality from Onshore Pipeline Commissioning

Location	Israeli Air Quality Standard [4]	Maximum Process Contribution (μg/m^3)	Process Contribution % of Standard	Magnitude of Impact	Significance
Nitrogen dioxide (NO_2)					
Near the site	200 μg/m^3 1 hour average, 8 allowable exceedances per year	1067	534%	Large	***N/A*** [3]
At the beach		196	98%	Large	***Major***
Eastern settlements[1]		92	46%	Medium	***Moderate***
Northern settlements[2]		104	52%	Medium	***Moderate***
Particulates (PM_{10})					
Anywhere off-site	130 μg/m^3 24-hour average, 18 allowable exceedances per year	8.41	6.5%	Negligible	***Not Significant***
Eastern settlements[1]		0.13	0.1%	Negligible	***Not Significant***
Northern settlements[2]		0.22	0.2%	Negligible	***Not Significant***

Notes:

(1) The eastern settlements include: Fureidis, Zichron Ya'akov and Ma'ayan Tzvi

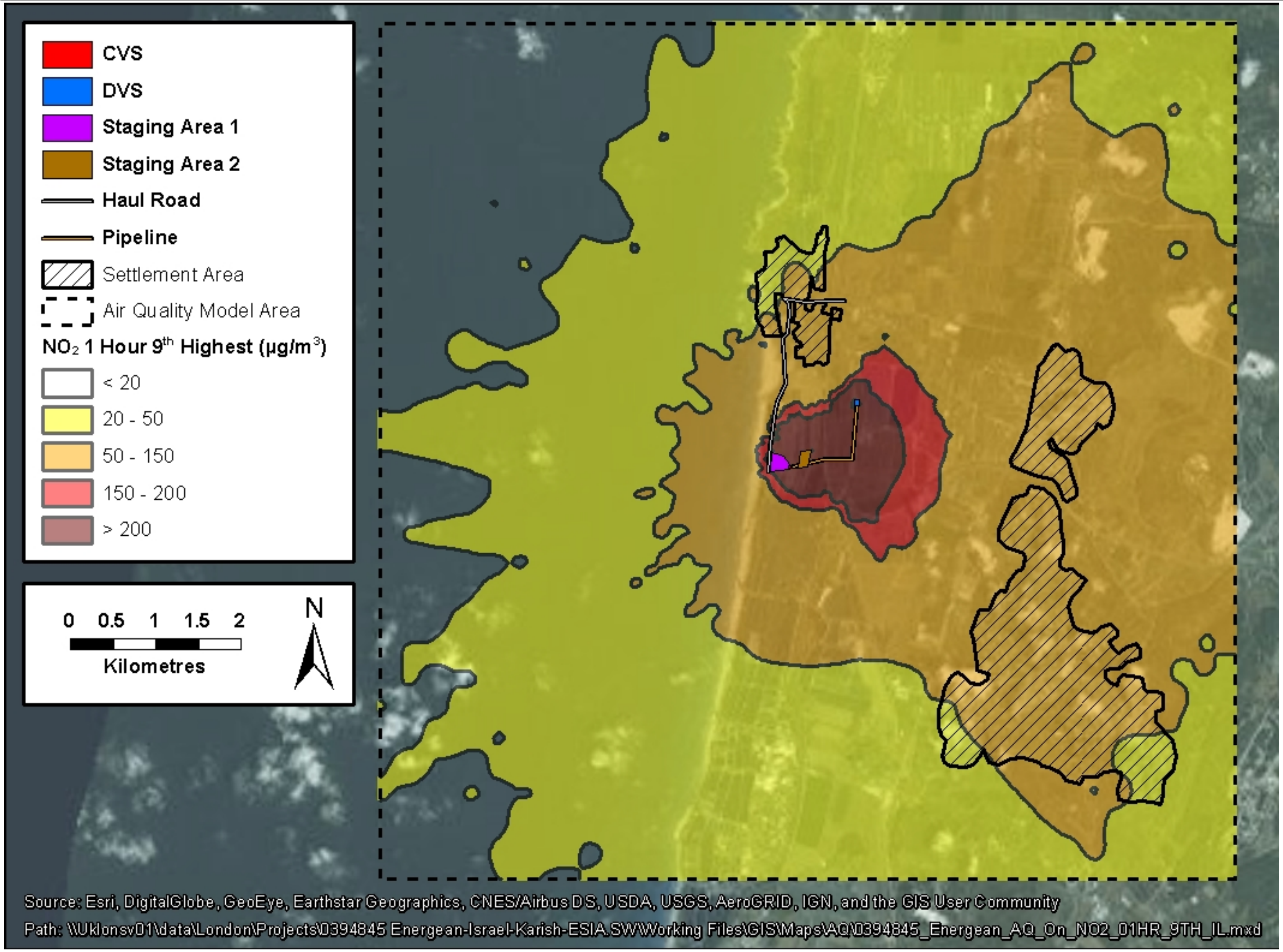
(2) The northern settlements include: Dor and Nahsholim.

(3) Because no community presence is expected immediately near the fenceline where this concentration is predicted, impact significance has not been evaluated here.

(4) Because the emission activities will only occur for several months, only short-term standards have been evaluated.

As indicated above, during the worst case (i.e. worst meteorological conditions and when all engines are operating simultaneously) ground level concentrations of NO_2 are predicted to be of Medium magnitude in some locations in the surrounding settlements and of Large magnitude on the beach in the immediate vicinity of the Staging Area 1, when evaluated against the Israeli one hour standard. The Israeli air quality standard will be met at all locations where people are expected to routinely be located (i.e. the settlements and the beach). The contour plot in *Figure 8.2* shows maximum predicted concentrations of NO_2 across the modelled domain. No significant impacts are predicted for PM_{10}.

Figure 8.2 Hourly Average NO_2 Concentrations, 9th Highest Hour, for Onshore Pipeline Commissioning



Impacts on Ecology

For ecological receptors, the contour plot in *Figure 8.3* shows maximum 24-hour average concentrations for NO_x across the modelled domain. NO_x concentrations are predicted to exceed the WHO guideline for eco-toxic effects from NO_x emissions (i.e. 75 µg/m^3) in the area of influence defined for the terrestrial ecology (see *Section 6.4.4*).

As described by the World Bank Group[(1)], NO_x are precursors of acid precipitation, which can have a negative effect in the vegetation. However, this is difficult to estimate, since it can vary according to the soil type, plant species and atmospheric conditions. The most common negative effect on plants from NO_x is the reduction of the photosynthesis activity[(2)]. The most evident damage from acid depositions is to freshwater ecosystems, where it can lower the pH of the water, with serious consequences for fish, other animal and aquatic plant. In case of nitrogen deficient soils, NO_x can result in precipitation of nitrates, which could increase the vegetation growth.

Despite these potentially adverse effects, the predicted impact on the vegetation and habitats from emissions to air in the area of influence is considered to be of Small magnitude using the terrestrial biodiversity methodology set out in *Annex A* (i.e. the disturbance is considered minimum and no loss of viability or function of the habitat is expected). It should be noted that criteria of impact magnitude is the one defined for terrestrial ecology (habitats). The rationale for assigning this magnitude is as follows:

- It is a temporary impact (commissioning activities will only take about 3 months).
- The modelling predicts the worst-case concentrations (highest concentrations across all meteorological conditions and assuming operation of all of the engines simultaneously). Actual daily NOx concentrations will vary and in most situations will be below the concentrations predicted by the model.
- No freshwater ecosystems are identified in the area of influence, excluding the Dalia River, where no relevant ecological features were described.

As described in *Section 6.4.4*, the area of influence is characterised in most of the cases by modified habitats of Low sensitivity. Therefore, the impact significance is considered to be ***Not Significant***. In the case of the sandy beach, being a natural habitat, its sensitivity is considered to be Medium. The Impact Significance results in this case to be ***Minor***.

(1) Pollution Prevention and Abatement Handbook. World Bank Group. July 1998.
(2) Effect of CO, NOx and SO2 on ROS production, photosynthesis and ascorbate–glutathione pathway to induce *Fragaria×annasa* as a hyperaccumulator. Sowbiya Muneera, Tae Hwan Kim, Byung Chul Choi, Beom Seon Lee, Jeong Hyun Lee. Redox Biology. Volume 2. Pages 91-98. 2014.

Figure 8.3 24-hour Average NO_x Concentrations, Maximum, for Onshore Pipeline Commissioning

Summary

Table 8.16 gives a summary of the impact to air quality.

Table 8.16 Summary of Potential Impacts on Air Quality from Onshore Pipeline Commissioning

Nature and Type: Direct negative **Duration of Impact:** During dewatering and drying of the pipeline (commissioning) **Receptor Sensitivity:** Medium (human health), Low – Medium (Ecology) **Impact Magnitude:** *Human Health -* For NO_2: Large close to the site, Medium - Large on the beach, Medium – Small at the settlements; For PM_{10}: Negligible at all modelled locations *Ecology -* Small **Impact Significance (pre-mitigation):** *Human Health -* For NO_2: *Major* close to the site, *Moderate - Major* on the beach, *Moderate – Minor* at the settlements; For PM_{10}: *Not Significant* at all modelled locations *Ecology - Not Significant – Minor*

Mitigation and Monitoring

The embedded mitigation measures that the project will use to mitigate air quality impacts are presented in *Table 8.17.* Active mitigation that will be used to mitigate potential air quality impacts are provided in *Table 8.18*. Note that even though the predicted impacts on ecological receptors are expected to be ***Not Significant – Minor***, because these impacts will occur within a critical habitat as defined by the IFC's Performance Standard 6, several additional mitigations measures will be applied by the project to further reduce potential residual impacts.

Table 8.17 Embedded Mitigation Measures for Air Quality Impacts from Onshore Pipeline Commissioning

Management Control	Responsibility - Organisation	Timing
All non-road engines rated at greater than 300 kW that are used onshore will comply with the European Union's Stage IIIB NO_x emission standards for non-road engines.	Energean, EPC	Pipeline commissioning
Only use low sulphur diesel fuel (i.e.10 ppm or less) for the onshore non-road engines.	Energean, EPC	Pipeline commissioning

Table 8.18 Additional Mitigation Measures for Air Quality Impacts from Onshore Pipeline Commissioning

Management Control	Responsibility - Organisation	Timing
Avoid placement of the engines along the eastern border of Staging Area 2 to avoid elevated concentrations of NO_2 in the villages to the east.	Energean, EPC	Pipeline commissioning
Restrict access of the beach in the vicinity (e.g. with 200 m) of Staging Area 1 if multiple engines over 300 kW are operating.	Energean, EPC	Pipeline commissioning
Conduct vegetation surveys pre-commissioning and post-commissioning, in order to assess potential effects in the vegetation in the sandy beach.	Energean, EPC	Pipeline pre-commissioning, and post-commissioning
If negative effects are observed in the existing vegetation, appropriate measures to rehabilitate the habitat will be planned and implemented. Energean will engage a trained ecologist to support on the development of any such measures.	Energean, EPC	After pipeline commissioning
Schedule commissioning activities to avoid, as much as feasible, the breeding bird season and the marine turtle nesting season (i.e. avoid March – August).	Energean, EPC	Pipeline commissioning

Residual Impacts

When applying the additional mitigations provided above, the largest predicted residual impacts are expected to be of ***Moderate*** significance for short-term NO_2 and ***Not Significant*** for PM_{10}.

Table 8.19 Residual Impact of Air Emissions from Onshore Pipeline Commissioning

	Impact Significance
Pre-mitigation	*Major - NO_2 short-term, any people at the beach immediately near Staging Area 1*
	Moderate - Minor - NO_2 short-term, surrounding settlements
	Not Significant – PM_{10}, all locations
	Not Significant - Minor NO_x short term, ecological receptors
Post-mitigation	*Moderate - Minor - NO_2 short-term, surrounding settlements and beach*
	Not Significant – PM_{10}, all locations
	Not Significant - NO_x short term, ecological receptors

8.3.3 *Potential Impacts from Offshore FPSO Operation*

Impact Description

Impacts to air quality can arise from the operation of operation of gas fired-turbines and flaring on the FPSO. Because gas is low in particulates and sulphur, the only pollutant of potential significance is NO_2. Two scenarios have been assessed for the offshore operations:

- Turbines only : Three turbines running at the same time on the FPSO; and
- Turbines and flaring: Three turbines running while flaring occurs.

A summary of the emissions characteristics of the turbines and the flare are set out in *Table 2.4.* All the turbines installed on the FPSO will comply with the emission limits set out in the European best available techniques conclusions for large combustion plants[1], in particular those for existing open-cycle gas turbines. Emissions of the flare have been calculated from the gas composition and typical flaring volume expected.

Sensitive Receptors

There are no nearby permanent sensitive receptors within the vicinity of the offshore FPSO as the surrounding is open sea. However, occasionally vessels may approach, including fishing boats. As no precise location can be determined for those boats, the whole area within 15 km from the FPSO was assessed, as detailed in *Annex C*. The nearest onshore receptors are approximately 70km from the FPSO. At this distance, the magnitude of impact from the FPSO's emissions will be Negligible. Onshore receptors have therefore not been included in the assessment of offshore operations' impacts.

Impact Significance

The emissions to the air from the three turbines and the flare were modelling using the USEPA dispersion model AERMOD. Two scenarios were considered, considering the impact of the turbines alone and combined with the flare. The model parameters are set out in *Table 2.4* and *Annex C.* The model predicts the maximum ambient concentrations of NO_2 within 15 km of the FPSO. These predicted concentrations were then compared to the Israeli air quality standards (see *Table 3.1*) to determine magnitude following the methodology presented in *Annex A*. *Table 8.20* gives a summary of the predicted impacts to air quality.

Table 8.20 Summary of Potential Impacts on Air Quality from Offshore FPSO Operations

Nature and Type: Direct negative
Duration of Impact: During operation
Receptor Sensitivity: Medium
Impact Magnitude: Negligible (outside of safety exclusion zone around the FPSO)
Impact Significance (pre-mitigation): *Not Significant*

The detailed results can be found in *Table 8.21*. Note that the maximum concentrations provided in *Table 8.21* are within the immediate area of the

(1) European Commission (2017). Best available techniques conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants.

FPSO as indicated by the maximum distances required to achieve Negligible impact magnitudes levels presented in *Table 8.22.*

The baseline levels of air quality within the whole 15 km study area were considered as non-degraded as set out in *Section 6.2.2.*

For the hourly mean NO_2, Negligible impacts are predicted beyond 160 m of the FPSO, with or without flaring occurring. This is well within the safety exclusion zone that will be maintained around the FPSO. For the annual mean NO_2 concentrations, Negligible impacts are predicted beyond approximately 120 m of the FPSO, with or without flaring occurring. Again, this is within the safety exclusion zone that will be maintained around the FPSO.

Table 8.21 Maximum Predicted Impacts on Air Quality from Offshore FPSO Operations

Scenarios	NO_2 Air quality standard	Maximum Process Contribution ($\mu g/m^3$)	Process Contribution as % of Standard	Magnitude of Impact	Significance	Significance Outside Exclusion Zone
Nitrogen dioxide (NO_2), 1 hour average						
Turbines only	200 $\mu g/m^3$ 1 hour average, 8 allowable exceedances per year	38.4	19%	Small	***Minor***	***Not Significant***
Turbines and flare		38.4	19%	Small	***Minor***	***Not Significant***
Nitrogen dioxide (NO_2), annual average						
Turbines only	40 $\mu g/m^3$	18.4	46%	Medium	***Moderate***	***Not Significant***
Turbines and flare		18.4	46%	Medium	***Moderate***	***Not Significant***

Table 8.22 Maximum Distance from the FPSO to Negligible Magnitude of Impact

Scenarios	Concentration Level Considered as Negligible ($\mu g/m^3$)	Maximum Distance from the FPSO to Reach Negligible Impact Magnitude (m)
Nitrogen dioxide (NO_2), 1 hour average		
Turbines only	20	157
Turbines and flare	20	157
Nitrogen dioxide (NO_2), annual average		
Turbines only	4	116
Turbines and flare	4	116

Mitigation and Monitoring

The embedded mitigation measures that the project will use to mitigate air quality impacts are presented in *Table 8.23.*

Table 8.23 Embedded Mitigation Measures for Air Quality Impacts from Offshore FPSO Operations

Management Control	**Responsibility - Organisation**	**Timing**
Flaring will only be used for emergency/upset conditions (e.g. depressurisation of the FPSO topsides hydrocarbon inventory and the pipeline and flowline depressurisation).	Energean	Production
All gas-fired turbines used on the FPSO will not emit more than 50 mg/Nm^3 of oxides of nitrogen on average over a year, which corresponds to the European limits given in best available techniques conclusions for large combustion plants (1) .	Energean	Production

Residual Impacts

As no additional mitigation will be applied, the residual impacts will be the same as the pre-mitigation impacts.

Table 8.24 Residual Impact of Air Emissions from Offshore FPSO Operations

	Impact Significance
Pre-mitigation	*Not Significant (beyond safety exclusion zone)*
Post-mitigation	*Not Significant (beyond safety exclusion zone)*

8.4 NOISE AND VIBRATION

8.4.1 Overview

This section assesses the effects of ambient noise to human receptors during construction and commissioning activities undertaken at onshore worksites.

Activities that have been scoped in for assessment are as follows:

- Site clearance and construction of the CVS and DVS extension;
- Earthworks (including reinstatement) and installation of the onshore pipeline;
- Horizontal drilling of the nearshore pipeline from the onshore CVS staging area;
- Operation of onshore winch to pull in offshore pipeline for connection with the onshore gas sales pipeline

(1) European Commission (2017). Best available techniques conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for large combustion plants.

Operation of a dewatering and drying spread at the onshore CVS staging area to facilitate the hydro-testing of onshore pipeline, and the dewatering and drying of offshore and onshore pipeline; and

- Construction traffic along haul route running through the village of Dor.

Human annoyance impacts and structural damage due to groundborne vibration from typical construction works are rarely experienced at distances more than 100 m from the worksite. Studies indicate that levels from vibration generating construction activities such as driven piling, fall below peak particle velocity (PPV) 0.3 mm/s, a level that may be perceptible in a residential environment within a distance of 100 m (1) . The British Standard BS 5228 (2) also provides guideline threshold value of 15 mm/s – 20 mm/s above which structural damage to buildings may occur. Empirical calculations of vibration from construction activities indicate that this level would only be exceeded for receptors at close proximity to the works (i.e. < 5 m). The nearest structure to any of the worksites is the wastewater treatment facility that is 60 m east of the DVS, and all other properties are located at least 250 m from a project worksite. On this basis, these potential impacts have been scoped out as having negligible significance.

During the production phase, noise sources will largely comprise overhead helicopter traffic to and from the FPSO. The helicopter will be used for ad-hoc transport of personnel to the offshore FPSO, i.e. frequency of overhead aircraft will be less than once a day. The CVS and DVS are not expected to be significant sources of operational noise. If the design changes and noise generating equipment is installed at either location, a revision of this assessment will be necessary. Noise sources during the production phase have therefore been scoped out from further assessment.

There are no IFC noise level guidelines specific to construction activities. Potential noise impacts have therefore been assessed using criteria adopted from a review of international guidance such as the British Standard BS 5228. These criteria are summarised in the noise methodology included in *Annex A*.

8.4.2 *Potential Impacts from Onshore Construction & Commissioning Activities (Excluding Traffic)*

Impact Description

A summary of the onshore activities that have been assessed is presented in *Table 8.25.*

Table 8.25 Summary of Onshore Activities Assessed

Activity(3)	Scheduled period	Worksite location	Duration (mth)	Working hours
Construction phase				

(1) D.M. Hiller & G.I. Crabb. (1995) Groundborne Vibration Caused by Mechanised Construction Works. TRL Report 429. Highways Agency 1995.
(2) British Standards Institution (2014) Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration. BS 5228-2:2009+A1:2014.

Activity(3)	Scheduled period	Worksite location	Duration (mth)	Working hours
CVS & DVS construction	Onshore civils / Onshore mechanical	CVS & DVS	12	10 hr/d, 6 d/wk (1)
Horizontal drilling and jacking of 56" casing pipe	Beach crossing	Staging area	2	12 hr/d, 6 d/wk (1)
Onshore 24" pipeline installation	Pipeline install	Onshore pipeline route	6	10 hr/d, 6 d/wk (3)
Shore pull of 30" pipeline using onshore winch	Pipeline install	Staging area	0.5	24 hr/d, 7 d/wk
Dewatering & drying spread for pipeline during S-lay activities (2)	Pipeline install	Staging area	0.25	24 hr/d, 7 d/wk
Commissioning phase				
Pipeline flood, clean & hydrotest	Pipeline drying	Staging area	0.25	24 hr/d, 7 d/wk
Pipeline dewatering & drying	Pipeline drying	Staging area	0.75	24 hr/d, 7 d/wk

Notes:
(1) Undertaken during the daytime between 06:00 to 22:00 only.
(2) For contingency purposes in the event of a wet buckle during offshore S-lay activities.
(3) Reinstatement works comprising earthworks and landscaping works at the CVS, DVS and onshore pipeline route, will be undertaken after the pipeline commissioning. As the plant team associated with these works are similar to that used during the construction phase, noise generated from this activity has been conservatively assumed to be similar to the worst case scenario.

To assess potential impacts from noise generated by these activities, the SoundPLAN noise prediction software, version 7.4 was used to predict noise levels generated from the onshore construction and commissioning activities. The software implements the standard BS 5228-1 that is widely used for simulating noise from construction worksites.

Sensitive Receptors

The key noise sensitive receptors for this assessment are the village of Dor and properties near the interchange for Highway 2. These represent a mixture of residential, commercial and industrial receptors. These were identified by ERM following review of satellite imagery, a site reconnaissance and consultation with Energean. Abandoned properties, such as the fish farm located immediately north and west of the project, are not considered in the assessment.

Impact Significance

The noise modelling assessed a number of scenarios, based on the noise generating activities that will be undertaken. The scenarios assessed include:

x **Worst case scenario** (including concurrent noise generating activities):

   o CVS and new DVS construction/;

   o Onshore pipeline installation;

   o Sheet piling for installation of onshore winch;

   o Shore pull of offshore pipeline; and

- o Dewatering and drying spread for offshore pipeline during S-lay activities.

- **Onshore civils:** construction of CVS and DVS;
- **Sheet piling:** installation of the onshore winch;
- **Beach crossing:** horizontal drilling and jacking of casing pipe;
- **Pipeline commissioning (Phase 1):** operation of pumps, compressors, generators etc. to support the flooding, cleaning and hydrotesting of offshore and onshore pipeline; and
- **Pipeline commissioning (Phase 2):** operation of pumps, compressors, generators etc. to support the dewatering and drying of offshore and onshore pipeline.

The equipment used for each activity is listed in *Table 2.8*. Details such as the number of equipment per plant team, sound power level per equipment, and operation time were provided by the project engineers.

Based on the modelling, the magnitude of potential noise impacts from construction and commissioning activities, excluding traffic, are considered Negligible. These are detailed further in *Table 8.26* and *Table 8.27*. The worst case modelling scenarios are provided in *Figure 8.4* and *Figure 8.5*.

Table 8.26 Summary of Potential Impacts from Onshore Construction & Commissioning Activities (Excluding Traffic)

Nature and Type: Direct negative **Duration of Impact:** During construction and commissioning phases **Receptor Sensitivity:** Residential, commercial and industrial properties **Impact Magnitude:** Negligible **Impact Significance (pre-mitigation):** *Not Significant* for all receptors.

Table 8.27 Predicted Noise Impacts at Identified Receptors

Residential property number	Threshold for Significant Impact, dB(A) (Day / Night(2))	PNL, façade, dB(A)	Impact significance (Day)	Impact significance (Night)
Worst case scenario (Pipeline install & Onshore mechanical works)				
1 – Village of Dor	65 / 50	39	Not Significant	Not Significant
2 – Properties at interchange for Highway 2	70 / - (1)	36	Not Significant	Not Significant
Onshore civils				
1 – Village of Dor	65 / 50	34	Not Significant	Not Significant
2 – Properties at interchange for Highway 2	70 / - (1)	31	Not Significant	Not Significant
Sheet piling				

Residential property number	**Threshold for Significant Impact, dB(A) (Day / Night[(2)])**	**PNL, façade, dB(A)**	**Impact significance (Day)**	**Impact significance (Night)**
1 – Village of Dor	65 / 50	38	Not Significant	Not Significant
2 – Properties at interchange for Highway 2	70 / - [(1)]	34	Not Significant	Not Significant
Beach crossing				
1 – Village of Dor	65 / 50	33	Not Significant	Not Significant
2 – Properties at interchange for Highway 2	70 / - [(1)]	28	Not Significant	Not Significant
Pipeline commissioning (Phase 1 & Phase 2)				
1 – Village of Dor	65 / 50	40	Not Significant	Not Significant
2 – Properties at interchange for Highway 2	70 / - [(1)]	35	Not Significant	Not Significant

Notes:

(1) Receptor sensitive to noise during the daytime only.

(2) Whilst night-time work is only anticipated for the shore pull and the commissioning activities, as a precautionary approach, night-time standards have been assessed for all construction actiivties as well.

Figure 8.4 Daytime Noise Contours During Worst Case Modelling Scenario

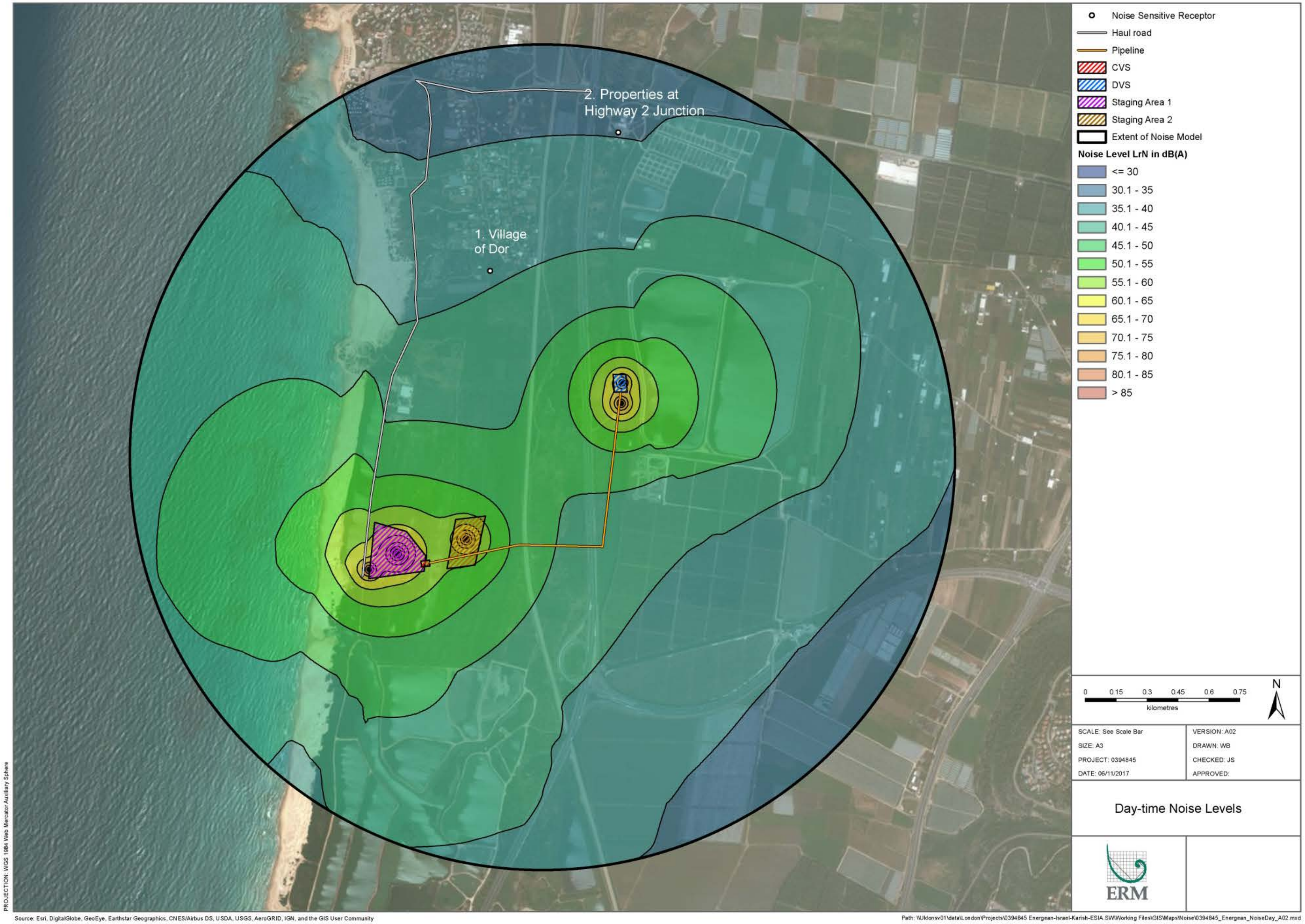
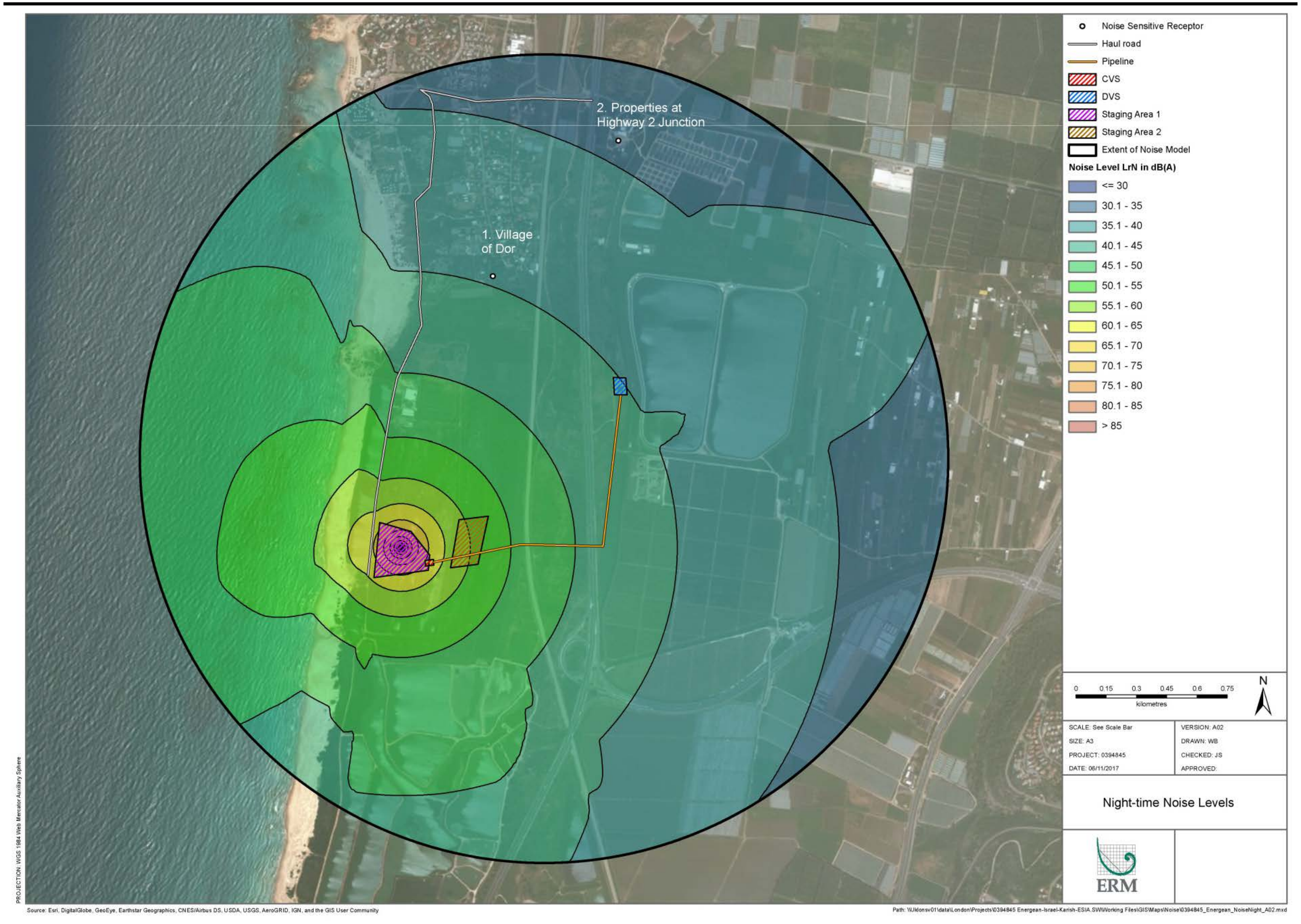


Figure 8.5 Night-time Contours During Pipeline Commissioning Phase



Mitigation and Monitoring

The embedded mitigation measures that the project will use to mitigate noise are presented in *Table 8.28*. Active mitigation that will be used to mitigate potential noise impacts are provided in *Table 8.29.*

Table 8.28 Embedded Mitigation Measures for Noise from Onshore Construction & Commissioning Activities (Excluding Traffic)

Management Control	Responsibility - Organisation	Timing
Verify that equipment suppliers undertake measurements to certify that construction equipment to be mobilised on site are compliant with the applicable Israeli guidance: *Abatement of Nuisances Regulations (Unreasonable Noise from Construction Equipment), 1979*.	EPC, Energean	Prior to pipeline construction

Table 8.29 Additional Mitigation Measures for Noise from Onshore Construction & Commissioning Activities (Excluding Traffic)

Management Control	Responsibility - Organisation	Timing
Install site hoardings to provide screening between the public (e.g. recreational users of the beach) and activities at the onshore worksites.	EPC	Pipeline construction and commissioning
Undertake periodic visual checks of the active worksites to ensure that, for any construction equipment that is fitted with noise abatement, abatement is operating as designed, and that equipment panelling is not left open while operating.	EPC	Pipeline construction and commissioning
Maintain Energean's grievance procedure to collect and manage potential complaints from local communities with regards to noise, and seek appropriate solutions to resolve the grievance.	Energean	Pipeline construction and commissioning
Work with Energean to respond to any grievances received from the local community.	EPC	Pipeline construction and commissioning

Residual Impacts

On the base of the Impact Assessment Methodology set out in *Section 5*, the potential residual impacts related to noise emissions during construction and commissioning (excluding traffic) are considered to be ***Not Significant.***

Table 8.30 Residual Impact of Noise from Onshore Construction & Commissioning Activities (Excluding Traffic)

	Impact Significance
Pre-mitigation	*Not Significant*
Post-mitigation	*Not Significant*

8.4.3 *Potential Impacts from Construction Traffic*

Impact Description

Traffic associated with the construction and commissioning activities will be using the haul route shown in *Section 6, Figure 6.11*. The haul route is an existing asphalt road which is used for access to the recreational beach and Michal Hill. Noise from traffic movement has been predicted for the activities summarised in *Table 8.31*.

Table 8.31 Vehicular Movements

Activity	Duration (mth)	Estimated offsite vehicular movement per day
Earthworks associated with CVS construction	12	16
Earthworks associated with onshore pipeline installation and CVS construction	6	32
Construction of foundation for onshore winch	< 1	10
Mobilisation of equipment for shore pull	< 1	6
Mobilisation and demobilisation of equipment at staging area, for commissioning phase	< 1	40

Earthworks associated with the CVS construction and the onshore pipeline installation will occur at the same time. During this period, a maximum of 32 vehicular movements per day is estimated.

Sensitive Receptors

The key noise sensitive receptors for this assessment are the village of Dor and properties near the interchange for Highway 2. These represent a mixture of residential, commercial and industrial receptors.

Impact Significance

Traffic noise levels resulting from the construction and commissioning of the project are calculated using the method for mobile plants on haul road as described in the British Standards Institution's *Code of practice for noise and vibration control on construction and open sites* (BS 5228)[(1)]. It was assumed that mobile plants would only comprise Heavy Goods Vehicles (HGV) which would travel at an average speed of 30 km/h along the haul road. A typical sound power level for an articulated truck or tipper truck, i.e. 104 dB(A) was used based on information provided by the project engineers.

Traffic will travel along the haul route to/from the staging area worksite and a minor road leading to/from Highway 2. This haul road does not currently experience heavy traffic, and runs west and north of the village of Dor. Estimated offsite vehicular movements during construction and commissioning are summarised in *Table 8.32* along with resultant noise levels calculated at the closest sensitive receptor i.e. residential property in Dor, which is located

[1] British Standards Institution (2014) **Code of practice for noise and vibration control on construction and open sites – Part 1: Noise.** BS 5228-1:300++A1:2014.

approximately 25 m south of the haul road. Construction traffic will occur during the daytime only.

Table 8.32 Vehicular Movements and Predicted Noise Levels

Activity	Duration (mth)	Estimated Offsite Vehicular Movement	Threshold for Significance, $L_{Aeq,Day}$, dB(A)	Calculated Façade Noise Level, $L_{Aeq,Day}$, dB(A)
Earthworks associated with CVS construction	12	16 per day	55	46
Earthworks associated with onshore pipeline installation and CVS construction	6	32 per day	65	49
Construction of foundation for onshore winch	< 1	10 per day	70	44
Mobilisation of equipment for shore pull	< 1	6 per day	70	42
Mobilisation and demobilisation of equipment at staging area, for construction and commissioning phases	< 1	40 per day	70	50

Noise levels at noise sensitive land uses around the haul road are predicted to be below the threshold for a significant impact. Disturbance impacts due to traffic during the construction and commissioning phase of the project are assessed to be of Negligible magnitude***.***

Table 8.33 Summary of Potential Impacts from Construction Traffic

Nature and Type: Direct negative
Duration of Impact: During construction and commissioning phases
Receptor Sensitivity: Residential, commercial and industrial properties
Impact Magnitude: Negligible
Impact Significance (pre-mitigation): *Not Significant* for all receptors.

Mitigation and Monitoring

Active mitigation that will be used to mitigate potential noise impacts are provided in *Table 8.29.*

Table 8.34 Additional Mitigation Measures for Noise from Construction Traffic

Management Control	Responsibility - Organisation	Timing
Maintain Energean's grievance procedure to collect and manage potential complaints from local communities with regards to noise, and seek appropriate solutions to resolve the grievance.	Energean	Pipeline construction and commissioning
Work with Energean to respond to any grievances received from the local community.	EPC	Pipeline construction and commissioning

Residual Impacts

On the base of the Impact Assessment Methodology set out in *Section 5*, the potential residual impact related to noise from construction traffic is considered to be ***Not Significant***.

Table 8.35 Residual Impact of Noise from Construction Traffic

	Impact Significance
Pre-mitigation	*Not Significant*
Post-mitigation	*Not Significant*

8.5 CLIMATE CHANGE

8.5.1 Increased GHG Emissions

Overview

This assessment of GHG emissions associated with the Project is in accordance with the methodology described in *Annex A*.

Because climate change affects global receptors, the impact magnitude and receptor sensitivity cannot be determined in the same way it can be for other topic areas. For this reason, impact significance is only determined to be ***Significant*** or ***Not Significant*** using the IFC threshold value of 25,000 tonnes of carbon dioxide equivalent (tCO_2e).

Impact Description

The estimate of the Project GHG footprint was done based on the Greenhouse Gas Protocol Corporate Accounting Standard (1).

GHGs included in the GHG assessment methodology are the gases under the UNFCCC/Kyoto Protocol. Of these, carbon dioxide (CO_2), methane (CH_4) and

(1) The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard, Revised, World Resources Institute.

nitrous oxide (N_2O) are considered the main GHG pollutants for the Project based on the planned activities.

The GHG Protocol defines three emissions 'scopes' for GHG accounting and reporting purposes: Scope 1, Scope 2 and Scope 3. Scope 1 includes direct GHG emissions coming from the Project. Scope 2 includes indirect GHG emissions associated with consumption of energy produced off-site (i.e. electricity from the grid). Scope 3 includes all other indirect GHG sources.

A summary of the Scope 1, Scope 2 and Scope 3 emissions included in the Project is provided in *Box 8.2*.

Box 8.2 Scope 1, 2 and 3 Emissions Related to the Project

Scope 1 emissions include combustion sources (i.e. gas turbine). **For this initial GHG inventory, Scope 1 emissions have been included for the four gas turbine generators on the FPSO and flaring. For the gas turbines, two scenarios have been evaluated: an initial electricity demand of 18 MW (Phase 1) and an ultimate electricity demand of 27.9 MW (Phase 2). For flaring, on full flow relief event and six pilot flares have been included.**

Scope 2 emissions include all emissions associated with electricity imports, heat imports, as well as with cold imports and compressed air imports. **Because the main power demands for the project during operational stage will be on the FPSO, which supplies its own power, minimal electricity imports will be required. The CVS and DVS will have some ongoing power usage from the nation grid (e.g. for lighting and security measures); however, this electricity usage will be very small and will not be associated exclusively with the Energean pipeline, but rather all pipelines using this designated corridor (i.e. the existing pipeline and the future Noble pipeline for Leviathan). For this reason, these emissions have not been quantified for the purposes of this preliminary GHG inventory.**

Scope 3 emissions include all other indirect emissions, such as (but not limited to) contracted and other associated activities. As an example, this includes emissions associated with any machine or vehicle operated by a supplier. **For this initial GHG inventory, no Scope 3 emissions associated with the Project have been included.**

Impact Significance

The annual estimate of GHG emissions, using the assumptions stated, are reported in the following *Table 8.36*. Note that these are estimates only, and actual emissions would vary depending on factors such as the actual operating schedule. This emissions estimate also does not include consideration of any gas fugitive losses that may occur.

Table 8.36 Estimated GHG Emissions per Year

Activity	**GHG Emissions** (tonnes/year)			
	CO_2	CH_4	N_2O	all GHGs, CO_2e
Gas Turbines (Routine Emissions)				
Phase 1 – 18 MW	70,650	6	2	71,632
Phase 2 – 27.9 MW	109,507	9	3	110,611
Flare				
Six Pilot Flares (Routine Emissions)	1,089	7	7	3,350
Flare 90s Full Relief (Flare Event, ~1 per year)	48	0.31	0.0014	57
Emergency Blowdown (Flare Event, ~2 per year)	235	2	0	273

Where the following have been assumed for the gas turbines:

- *Emission factors (from AP-42, Fifth Edition, Volume I, Chapter 3.1 (2000))*
    - *CO_2: 110 lb/MMBTU fuel input*
    - *N_2O: 0.003 lb /MMBTU fuel input*
    - *CH_4: 0.0086 lb /MMBTU fuel input*
- *Global warming potentials (from 2007 IPCC AR4)*
    - *N_2O: 298*
    - *CH_4: 25*
- *162 MMBTU/hr fuel input (calculated for open cycle mode to deliver 18 MW)*
- *251 MMBTU/hr fuel input (calculated for open cycle mode to deliver 27.9 MW)*
- *Approximately 8760 hours of operation per year*
- *Heating value of natural gas estimated as 1020 MMBTU/MMSCF*
- *80% combustion efficiency for the open-cycle turbines*

Where the following have been assumed for the flares:

- *Emission factors (from EEMS Atmospheric Emissions Calculations, Issue 1.10a (2008))*
    - *CO_2: 2.8 kg/kg*
    - *N_2O: 0.000081 kg/kg*
    - *CH_4: 0.018 kg/kg*
- *Global warming potentials (from 2007 IPCC AR4)*
    - *N_2O: 298*
    - *CH_4: 25*
- *Approximately 90 seconds of operation per year for the full flow relief flare*
- *Approximately 42 tonnes of gas flared during a single blowdown event*
- *Approximately 8760 hours of operation per year for the six pilot flares*

Annual GHG emissions will be greater than 25 000 tCO_2e. On the basis of this preliminary GHG emission inventory, the Project's GHG emissions during the production phase are considered ***Significant*** (See *Table 8.37*).

Table 8.37 Impact Assessment: Climate Change

Nature and Type: Direct negative
Receptor Sensitivity: N/A (because receptors for this impact are global, the methodology in *Section 5: Methodology* does not specifically consider receptor sensitivity)
Impact Magnitude: N/A (the methodology in *Section 5: Methodology* does not specifically consider impact magnitude)
Impact Significance (pre-mitigation): Significant

Mitigation and Monitoring

To comply with the IFC Performance Standards, projects with GHG emissions greater than 25,000 tCO_2e must quantify GHG emissions annually in accordance with internationally recognised methodologies and good practice.

The following mitigation measures will be implemented during the construction and production phases (see *Table 8.38*).

Table 8.38 Mitigation Measures for Potential Climate Change Impacts

Management Control	Responsibility - Organisation	Timing
Develop and implement a routine maintenance plan for all key GHG emission sources identified in the annual GHG inventory.	Energean	Production
Have a system in place to periodically review annual GHG performance and evaluate options for improving energy efficiency over the life of the Project.	Energean	
Quantify GHG emissions annually in accordance with internationally recognised methodologies and good practice.	Energean	

Residual Impacts

On the base of the Impact Assessment Methodology set out in *Section 5*, the potential residual impacts related to GHG emissions are considered to be ***Significant*** and annual quantification of GHG emissions is required (See *Table 8.39*).

Table 8.39 Climate Change Residual Impact

	Impact Significance
Pre-mitigation	*Significant*
Post-mitigation	*Significant*

8.6 TERRESTRIAL BIODIVERSITY

8.6.1 *Overview*

There are a number of activities considered as potential sources of impact on the terrestrial ecology include the following:

- Site clearance for CVS (Coastal Valve Station) and pipeline corridor and installation of pipeline;
- Activities in the staging area for HDD (Horizontal Directional Drilling);
- Road transportation of supplies, equipment and construction workforce; and
- Small scale spill onshore from construction activities.

For the purposes of this impact assessment, the following potential impacts have been considered:

- degradation and loss of habitat;
- loss of flora;
- loss of fauna;
- disturbance to fauna;
- impacts to Protected / Internationally Designated Areas; and
- impacts to critical habitat as defined by IFC PS6.(1)

8.6.2 *Degradation and Loss of Habitat*

Impact Description

Site clearance activities for the CVS and for the pipeline corridor will result in the removal of the existing vegetation (vegetation clearance). This will result in a direct degradation and loss of the habitat under the Project footprint.

Linear infrastructure such as pipelines can also contribute disproportionately towards habitat fragmentation, resulting in the isolation of one fragment of habitat from another, separation of a larger habitat into smaller fragments, increase in the edge to interior habitat size ratio, and decrease in the average size of remaining fragments(2) (3).

Sensitive Receptors

As described in *Section 6.4.4*, most of the habitats within the AoI (former aquiculture areas, human infrastructures, agricultural land and ruderal areas) are considered to be modified habitats. As a result, the sensitivity/value of the above habitats is considered to be Low. They are expected to have a high level of tolerance and adaptability to the changes resulting from the project.

The sandy coastal beach and dune system is a natural habitat, and is therefore considered to be of Medium sensitivity/value. However, the pipeline's landfall will be done using HDD to avoid any habitat destruction on the beach. This means that no trenching will be required within the beach habitat.

Impact Significance

The CVS will require an area of approximately of 1,000 m^2 to be cleared. In addition to this, clearance will also occur in the pipeline corridor, limited to the construction right of way (RoW). The onshore section of the pipeline will have a length of about 1.4 km. Since the RoW will have an approximate width of 60 m, the resulting surface to be cleared will be approximately 84,000 m^2.

(1) IFC 2012. Performance Standards on Environmental and Social Sustainability, published January 2012. Available in English at: http://www.ifc.org/wps/wcm/connect/115482804a0255db96fbffd1a5d13d27/PS_English_2012_Full-Document.pdf?MOD=AJPERES.
(2) Bissonette, J. A. and I. Storch. 2002. Fragmentation: is the message clear? Conservation Ecology 6(2): 14. [online] URL: http://www.consecol.org/vol6/iss2/art14/
(3) Robert M. Ewers and Raphael K. Didham. Confounding factors in the detection of species responses to habitat fragmentation. Cambridge University Press. Vol. 81, Issue 1. Published in February 2006, pp 117-142.

Therefore the total surface cleared of existing vegetation will be approximately 85,000 m^2 (85 ha).

Impacts from habitat loss under the CVS will be permanent. The degradation and loss of habitat along the RoW will be a temporary impact. Existing vegetation cleared in the pipeline corridor will recover, following a natural succession process, and will eventually support scrub and bushland habitats similar to those present elsewhere in the AoI. Because of the limited surface affected and because of the temporary nature of the impact, the magnitude of the impact is considered Small.

As mentioned above linear developments like pipelines can result in habitat fragmentation. In this situation though, there are a number of factors that reduce the potential of this. These include:

- the limited section of the on-shore pipeline (1.4 km); and
- the temporal effect, during the construction period only (estimated to be about 12 months);

When considering these factors, the magnitude of habitat fragmentation is considered to be Negligible.

When considering the impact magnitude (Small – Negligible) and the sensitivity of the habitats within the project footprint (Low), the impact is considered to be ***Not Significant*****.** *Table 8.40* summarises the impact assessment done for the impact on the habitats: degradation and loss of habitat.

Table 8.40 Summary of Potential Impacts: Degradation and Loss of Habitat

Nature and Type: Direct negative **Duration of Impact:** During pipeline construction and installation – site clearance activities **Receptor Sensitivity:** Low **Impact Magnitude:** Small - Negligible **Impact Significance (pre-mitigation):** Not Significant

Mitigation and Monitoring

As the effects will be ***Not Significant***, no additional mitigation and monitoring beyond the embedded mitigation outlined in *Table 8.41* is required.

Table 8.41 Embedded Mitigation Measures to Reduce Degradation of Habitat

Management Control	Responsibility - Organisation	Timing
Conduct Horizontal Directional Drilling (HDD) for the pipeline landfall to avoid conducting open trenching within the beach habitat.	Energean	Pipeline construction

Residual Impacts

The residual impacts from degradation and loss of habitat are set out in the *Table 8.42*.

Table 8.42 Residual Impact: Degradation and Loss of Habitat

	Impact Significance
Pre-mitigation	*Not Significant*
Post-mitigation	*Not Significant*

8.6.3 Loss of Flora

Impact Description

Vegetation clearance occurring in the site clearance activities for the CVS and for the pipeline corridor, as described in *Section 8.6.2*, will result in the loss of individuals of a range of flora species.

In addition to this, the presence of invasive flora in the AoI, up to 10 different plant species (as described in the baseline in *Section 6.4.4*), can also result in the loss of autochthonous flora due to an ecological competition process.

Sensitive Receptors

As described in the baseline in *Section 6.4.4*, desk based studies have identified up to 451 different species of plants would be present in the AoI. Most of them correspond to common species with a widespread and global distribution, and therefore are considered to be of Low sensitivity/value.

There are forty species reportedly present in the AoI that are nationally protected or listed as Vulnerable in the "Red Data Book: Endangered Plants of Israel[(1)]". These species are considered to be of Medium sensitivity/value.

Nine species that are listed as Endangered or Critically Endangered in the "Red Data Book: Endangered Plants of Israel" are also reportedly present in the AoI. These species are considered to be of High sensitivity/value.

Impact Significance

Taking into account the limited surface area and the temporary nature of most of the habitat loss, the magnitude of the impact is considered Small.

Taking into account the sensitivity/value of the flora receptors identified, impacts are considered to be of:

- ***Moderate*** significance on high sensitivity Endangered and Critically Endangered species*;* and
- ***Minor*** significance on medium sensitivity Vulnerable and protected species; and
- ***Not Significant*** for other flora within the AoI.

The *Table 8.43* summarises the impact assessment for loss of flora.

(1) Red Data Book: Endangered Plants of Israel. Shmida et al., 2011.

Table 8.43 Summary of Potential Impacts: Loss of Flora

Nature and Type: Direct negative
Duration of Impact: During pipeline construction and installation – site clearance activities
Receptor Sensitivity: Low to High
Impact Magnitude: Small
Impact Significance (pre-mitigation): Not significant to Moderate

Mitigation and Monitoring

To avoid, reduce and mitigate impacts on medium and high sensitivity flora, additional mitigation measures have been identified and are presented in *Table 8.44*.

Table 8.44 Mitigation Measures: Loss of Flora

Management Control	Responsibility - Organisation	Timing
Identification of areas to be cleared prior to the beginning of the onshore works.	Energean	Pipeline construction
Restricted access for the machinery to the areas out of the clearing limits	Energean	Pipeline construction
Ecological awareness training should be provided to all personnel, with a focus on medium and high sensitivity flora.	Energean	Pipeline construction
Flora check surveys will be undertaken onshore prior to the start of vegetation clearance in order to identify: (1) the presence of medium or high sensitivity flora in the Project footprint; and (2) invasive flora.	Energean	Pipeline construction
If medium or high sensitivity flora is identified during the onshore flora check survey that cannot be avoided during vegetation clearance and construction, then the plants will be translocated to suitable nearby habitat to avoid their destruction.	Energean	Pipeline construction
If medium or high sensitivity flora is identified during the onshore ecological survey, a Restoration and Monitoring Plan will be developed with the objective of restoring populations of these species following construction. Energean will consult a trained ecologist to support on the development and implementation of this Plan.	Energean	Pipeline construction
If invasive flora is identified during the onshore ecological survey, an Invasive Species Management Plan will be developed with the objective of avoiding the spread/ additional introduction of these invasive species.	Energean	Pipeline construction

Residual Impacts

The residual impacts from the loss of flora are set out in the *Table 8.45*. The mitigation measures that will be implemented by the project will reduce residual impacts to ***Not Significant***.

Table 8.45 Residual Impact: Loss of Flora

	Impact Significance
Pre-mitigation	*Not Significant to Moderate*
Post-mitigation	*Not Significant*

8.6.4 *Loss of Fauna*

Impact Description

The following project activities may result in the loss of fauna:

- direct mortality during site clearance for CVS and pipeline corridor; and
- direct mortality as a result of collisions during road transportation of supplies, equipment and personnel.

Direct mortality of fauna as a result of the site clearance will depend on the level of mobility of the fauna species, as summarised below:

- Small fauna with a lower level of mobility (i.e. amphibians, slow moving reptiles and small mammals) cannot easily avoid the machinery involved in vegetation clearance. Therefore, incidental loss of fauna is more likely to be more frequent in these groups.
- Large and medium size mammals, with a higher level of mobility, will be able to avoid the vegetation clearance activities, so that the loss of large / medium mammals and fast moving reptiles is likely to be lower.
- Due to their high mobility, direct mortality of adult birds is considered unlikely. However, the nests, eggs and unfledged young of birds are vulnerable to direct mortality if vegetation clearance and construction activity is undertaken during the breeding season (typically from March to August, although there are differences between species).

Direct mortality of fauna from site clearance is also related to the scale of vegetation clearance. As presented previously, site clearance will affect relatively small area of the AoI (approximately 85,000 m^2).

The project will results in a maximum increase of 46 vehicles a day (see *Section 2*). According to some available information from the State of Israel[(1),] the daily traffic volume in the roads within the AoI ranges from 5,000 to 50,000 vehicles per day. The maximum increase in the traffic would therefore represent approximately 0.1 – 1% of the total traffic in the area.

Sensitive Receptors

The sensitivity and the value of the fauna present in the AoI is dependent on the type of fauna, as presented below.

The majority of reptile species present within the project AoI are not of conservation concern and are considered to be low sensitivity/value. Schreiber's fringe-fingered lizard (*Acanthodactylus schreiberi*) is reported to

(1) State of Israel. Daily traffic volume on non urban roads in selected road sections. http://www.cbs.gov.il/shnaton66/map/24_01e.pdf

occur coastal habitat within the AoI. It is listed as Endangered by the IUCN and as Critically Endangered by The Red Book of Israel and is therefore considered to be of High sensitivity/value.

Most of the bird species identified in the AoI are common and widespread species which are considered to be of Low sensitivity/value. However, up to eleven species of conservation concern were identified in the AoI, as presented in *Section 6.4.4*. Of these, four are listed as nationally Vulnerable (Medium sensitivity/value) and seven as Endangered or Critically Endangered (High sensitivity/value) in the Red Book of Vertebrates in Israel. During spring and autumn migration and over winter, large concentrations of migratory water birds pass through or overwinter within the AoI as part of the Carmel Coast IBA.

The majority of mammal species which occur in the AoI are common species with a widespread and global distribution and are considered to be of Low sensitivity/value. Two species of conservation concern are reported to occur in the AoI. Jungle cat (*Felis chaus*) is listed as Vulnerable in the Red Book of Vertebrates in Israel (2010) and is considered to be of Medium sensitivity /value. Honey badger (*Mellivora capensis*) is listed as Endangered in the Red Book of Vertebrates in Israel (2010) and is considered to be of High sensitivity/value.

Impact Significance

As a result of the small area of habitat affected from site clearance and the relatively low increase in traffic, the magnitude of the impact is considered to be Negligible for all receptors excluding birds and Schreiber's fringe-fingered lizard (*Acanthodactylus schreiberi*).

As the numbers of birds affected may be higher if vegetation clearance is undertaken during the breeding bird season, the magnitude of impacts on birds is considered to be Small.

Schreiber's fringe-fingered lizard has a small relict population and the loss of a single individual may represent a substantial percentage change in the remaining population. As a result the magnitude of the loss of individuals of this species is considered to be Small.

For all receptors apart from birds and Schreiber's fringe-fingered lizard, the impact significance is therefore considered to ***Not Significant***. For birds, the impact significance will vary from Not Significant to Moderate depending on the sensitivity of the species (***Moderate*** for the seven Endangered or Critically Endangered species in the area, Minor for the four nationally Vulnerable species, and ***Not Significant*** for all others). For Schreiber's fringe-fingered lizard, the impact significance is considered to be ***Moderate***. See *Table 8.46* for a summary of these impacts.

Table 8.46 Summary of Potential Impacts: Loss of Fauna

Nature and Type: Direct negative **Duration of Impact:** x During pipeline construction and installation – site clearance activities x During pipeline construction and installation – road transportation of supplies x During production – leak from pipeline **Receptor Sensitivity:** Low to High **Impact Magnitude:** Small (birds and Schreiber's Fringe-fingered Lizard), Negligible (all other fauna) **Impact Significance (pre-mitigation):** Not Significant – Moderate (birds), Moderate (Schreiber's fringe-fingered lizard), Not Significant (all other fauna).

Mitigation and Monitoring

To avoid, reduce and mitigate impacts on medium and High sensitivity breeding birds, additional mitigation measures have been identified and are presented in *Table 8.47*.

As the effects on other fauna groups will be ***Not Significant***, no additional mitigation and monitoring is required for these fauna groups.

Table 8.47 Mitigation Measures: Loss of Fauna – Breeding Birds and Schreiber's Fringe-Fingered Lizard

Management Control	Responsibility - Organisation	Timing
Schedule onshore vegetation clearance works outside of the breeding bird season where practicable (outside March – August).	Energean	Pipeline construction
If the breeding season (March – August) cannot be avoided for vegetation clearance, then a qualified ornithologist will undertake pre-vegetation clearance surveys of areas to be cleared. Identify and cordon off any nests identified with a 25 m buffer until chicks have fledged from the nest or it is abandoned. Energean will engage a trained ecologist to oversee the management measures for any nesting birds identified.	Energean	Pipeline construction
Undertake onshore pre-vegetation clearance reptile check surveys in order to identify the presence of any high sensitivity Schreiber's fringe-fingered lizard.	Energean	Pipeline construction
If Schreiber's fringe-fingered lizard is identified during the check survey, vegetation clearance in the suitable areas for the Schreiber's fringe-fingered lizard will be done by hand. Artificial reptiles' refuges would be placed in the proximity of the clearing areas, to facilitate the movement of the reptiles out of the clearing areas.	Energean	Pipeline construction
If Schreiber's fringe-fingered lizard is identified during the check survey, a Restoration Plan will be developed by a trained ecologist with the objective of restore the habitat increasing its suitability to host populations of the Schreiber's fringe-fingered lizard. Energean will engage a trained ecologist to support the implementation of this Plan.	Energean	Pipeline construction

Residual Impacts

The residual impacts from loss of fauna are set out in the *Table 8.48*.

Table 8.48 Residual Impact: Loss of Fauna

	Impact Significance
Pre-mitigation	*Not Significant to Moderate*
Post-mitigation	*Not Significant*

8.6.5 *Disturbance to Fauna*

Impact Description

The following project activities may result in the disturbance to fauna:

- Site clearance for CVS and pipeline corridor: by increasing the levels of noise and vibration.
- Activities in the staging area for HDD: by increasing the levels of noise, vibration and artificial light.

Sensitive Receptors

The sensitivity of the fauna described in *Section 8.6.4* is also applicable to this impact.

In addition, two turtle species, loggerhead turtle (*Caretta caretta)* and green turtle (*Chelonia mydas*), have been identified with the potential of nesting in the beaches of the AoI. Both of them are described as Critical Endangered according to the Red Book of Vertebrates in Israel (2010), and therefore considered of High sensitivity/value.

Impact Significance

The equipment and machinery involved in construction that will result in increased noise and vibration levels are described in *Section 2*. The noise and vibration impact assessment is presented in *Section 8.4*. Increased noise and vibration will be restricted to vicinity of the Project footprint.

Disturbance from artificial lighting in the staging area will be limited to those activities working at night. Night-time working is only anticipated for the shore pull work (estimated duration of 14 days), and the commissioning activities (both Phase 1 and Phase 2 each have an estimated duration of approximately 4 months).

The magnitude of light impacts will depend on the fauna present in the project area. If nesting birds are identified in the site clearance fauna check surveys, this magnitude will be considered Large. Otherwise, the magnitude will be Small – Medium depending on the species identified in the fauna check survey.

Based on receptor sensitivity and the magnitude of the impact, the predicted significance of disturbance impacts to fauna is as follows:

- ***Minor*** – *potential* ***Major*** impact for breeding bird species of conservation concern (***Major*** significance is only triggered if nesting birds are identified in the fauna check survey);

Moderate impact results from the disturbance to Schreiber's fringe-fingered lizard;
- ***Moderate*** impacts resulting from potential disturbance to nesting turtle species of conservation concern; and
- ***Not Significant*** for all other species.

See *Table 8.49* for a summary of these impacts.

Table 8.49 Summary of Potential Impacts: Disturbance to Fauna

Nature and Type: Direct negative
Duration of Impact:
- During pipeline construction and installation – site clearance activities
- During drilling – HDD activities

Receptor Sensitivity: Low to High
Impact Magnitude: Small-Large (depending on results of fauna check survey)
Impact Significance (pre-mitigation): Minor – potentially Major (bird species of conservation concern), Moderate (turtles), Moderate (Shreiber's fringe-fingered lizard), and Not Significant (all other fauna)

Mitigation and Monitoring

To mitigate impacts on medium and high sensitivity fauna, additional mitigation measures have been identified and are presented in *Table 8.50*. Mitigation measures presented in *Table 8.47* are also relevant to reducing impacts related to disturbance of fauna.

As the effects on other fauna groups will be ***Not Significant***, no mitigation and monitoring other than the embedded mitigation outlined in *Table 8.41* is proposed for other fauna groups.

Table 8.50 Mitigation Measures: Disturbance to Fauna

Management Control	Responsibility - Organisation	Timing
Identification of areas to be cleared prior to the beginning of the works.	Energean	Pipeline construction
Restricted access for the machinery to the areas out of the clearing limits	Energean	Pipeline construction
Ecological awareness training should be provided to all personnel, with a focus on high and medium sensitivity fauna.	Energean	Pipeline construction
Undertake periodic visual checks of the active worksites to ensure that, for any construction equipment that is fitted with noise abatement, abatement is operating as designed.	Energean	Pipeline construction and commissioning
Artificial lighting at the HDD compound will only be used outside of the turtle nesting season (May – August).	Energean	Pipeline construction and commissioning
Low-level or directional lighting will be used to avoid light spill near the beach and near any nesting bird sites identified in the fauna survey checks.	Energean	Pipeline construction and commissioning
If nesting birds are identified in the fauna check survey, Energean will consult a trained ornithologist to determine what additional measures may be required to manage impacts from light disturbance.	Energean	Pipeline construction and commissioning

Residual Impacts

The mitigation measures that will be implemented by the project will reduce the significance of the impact as shown in the *Table 8.51*, where the residual impacts from the disturbance to fauna are set out.

Table 8.51 Residual Impact: Disturbance to Fauna

	Impact Significance
Pre-mitigation	*Not Significant to Moderate*
Post-mitigation	*Not Significant*

8.6.6 *Impacts to Nationally Protected and Internationally Designated Areas*

Impact Description

As described in *Section 6.4.4* there are two nationally protected areas (Carmel Coast Kurkar Reserve and Dalia River Natural Reserve) and one internationally recognised area (Carmel Coast IBA) that overlap with the Project AoI. Impacts to the qualifying features (habitats, flora and fauna) of these areas will result from the impacts described in the previous sections: degradation and loss of habitat, loss of flora, loss of fauna and disturbance to fauna.

The Carmel Coast IBA supports internationally important numbers of migratory and overwintering birds. The IBA covers approximately 25 km of coastline, is approximately 2,400 ha in size. Passage and overwintering birds temporarily displaced by construction activity will move to abundant other suitable nearby habitat.

Sensitive Receptors

As nationally protected areas, both the Carmel Coast Kurkar Reserve and the Dalia River Natural Reserve are considered to have Medium sensitivity/value. As an internationally designated area, the Carmel Coast IBA is considered to have a High sensitivity/value.

Impact Significance

The Project footprint area is within the Carmel Coast Kurkar Reserve. As described in *Section 6.4.4,* a section of about 700 m including some agricultural lands (avocado fields) and the DVS is within the limits of this nature reserve. Since it´s a very small section and, considering that the habitats crossed by the pipeline in that section are modified habitats not suitable for relevant fauna and flora, the impact magnitude is considered to be Negligible.

The Dalia River Natural Reserve is located at about 500 m from the Project footprint (CVS). Because of this, the impact occurring on this natural reserve will be limited to the disturbance of fauna. Taking into account the distance, the impact magnitude is considered to be Negligible.

The entire Project footprint is within the limits of the Carmel Coast IBA. As described in *Section 6.4.4,* the habitats within in the Project footprint are modified habitats, including some infrastructures (highway, train line, existing buried pipeline). Because of this, the impact magnitude is considered to be Small.

The impact significance in the two national protected areas and the internationally designated area is therefore considered to be ***Not Significant.*** See *Table 8.52* for a summary of this impact.

Table 8.52 Summary of Potential Impacts: Nationally Protected Areas / Internationally Designated Areas

Nature and Type: Indirect negative
Duration of Impact:

- During pipeline construction and installation – site clearance activities
- During pipeline construction and installation – road transportation of supplies
- During pipeline construction and installation – small scale spill onshore from construction activities
- During pipeline construction and installation – generation of wastes
- During drilling – HDD activities

Receptor Sensitivity: Medium to High
Impact Magnitude: Negligible to Small
Impact Significance (pre-mitigation): Not Significant

Mitigation and Monitoring

As the effects will be ***Not Significant***, no additional mitigation and monitoring is required.

Residual Impacts

The residual impacts from degradation and loss of habitat are set out in the *Table 8.53*.

Table 8.53 Residual Impact: Nationally Protected Areas / Internationally Designated Areas

	Impact Significance
Pre-mitigation	*Not Significant*
Post-mitigation	*Not Significant*

8.6.7 *Impacts to Critical Habitat*

The Project will be developed on modified rather than natural habitat. However as described in *Section 6.4.4*, the AoI has also been determined to be Critical Habitat, as defined by IFC PS6, based on the presence of the following features:

- Flora: due to the potential presence in the project footprint area of the following plant species: *Crocus aleppicus*, *Erodium subintegrifolium*, *Ipomoea sagittata* and *Sarcocornia perennis,* listed as Endangered or Critically Endangered by the Israel Red Book. Designation as Critical Habitat, under the Criterion 1 (Tier 2).
- Fauna: due to the potential presence in the project footprint area of the Schreiber's fringe-fingered lizard (*Acanthodactylus schreiberi*), listed as Endangered by the IUCN and as Critically Endangered by the Israel

Red Book and with a restricted range of distribution (less than 500 km^2). Designation as Critical Habitat, under the Criterion 1 (Tier 2) and Criterion 2 (Tier 2).

- Internationally important assemblage of migratory birds defined for Carmel Coast IBA, which supports over 25,500 migratory soaring birds. Designation as Critical Habitat, under the Criterion 3 (Tier 2).
- High conservation priority within the ecoregion "Southwestern Asia: Along the coast of the Mediterranean Sea in Turkey, Jordan, Israel, and Syria", where the Israeli Coastal Plain is located. Designation as Critical Habitat, under the Criterion 4.

A summary of the impacts on each element is summarised in *Table 8.54,* referring to the corresponding impact where the impact was previously discussed, when applicable.

Table 8.54 Summary of Potential Impacts on Critical Habitat

Critical Habitat Feature	Criterion IFC PS6	Impact discussion
Flora: *Crocus aleppicus, Erodium subintegrifolium, Ipomoea sagittata and Sarcocornia perennis*	Criterion 1 – Tier 2	*Section 8.6.3* – Loss of flora Residual impact: Not Significant
Fauna: Schreiber's fringe-fingered lizard (*Acanthodactylus schreiberi*)	Criterion 1 - Tier 2 Criterion 2 - Tier 2	*Section 8.6.4* – Loss of fauna Residual impact: Not Significant *Section 8.6.5* – Disturbance to fauna Residual impact: Not Significant
Fauna: important assemblage of migratory birds defined for Carmel Coast IBA	Criterion 3 - Tier 2	Section 8.6.6 - Affection to Protected Areas / Internationally Designated Areas Residual impact: Not Significant
Ecoregion: "Southwestern Asia: Along the coast of the Mediterranean Sea in Turkey, Jordan, Israel, and Syria", where the Israeli Coastal Plain is located – high conservation priority	Criterion 4	*Section 8.6.2* - Degradation and Loss of Habitat Residual impact - Not Significant
Notes: (1) https://www.worldwildlife.org/ecoregions/pa1207		

As the Project is located in Critical Habitat, Paragraph 17 of IFC Performance Standard 6 applies to the development of the Project:

"In areas of critical habitat, the client will not implement any Project activities unless all of the following are demonstrated":

- *"No other viable alternatives within the region exist for development of the Project on modified or natural habitats that are not critical;*
- *The Project does not lead to measurable adverse impacts on those biodiversity values for which the critical habitat was designated, and on the ecological processes supporting those biodiversity values;*
- *The Project does not lead to a net reduction in the global and/or national/regional population of any Critically Endangered or Endangered species over a reasonable period of time; and*

A robust, appropriately designed, and long-term biodiversity monitoring and evaluation program is integrated into the client's management program."

The assessment of impacts and mitigation and monitoring measures set out in *Sections 8.6.2 - 8.6.6* above demonstrate the above for the Project.

Additionally, in areas of critical habitat the Project is expected to demonstrate net gains of the biodiversity values for which the critical habitat has been designated.

The project will not result in any significant residual effects on critical habitat features. However, in order to align with the expectations of PS6 with regards to critical habitat, the additional conservation actions presented in *Table 8.55* are proposed to promote the conservation of biodiversity features within the Carmel Coast IBA. The additional conservation actions and all biodiversity mitigation, management and monitoring measures for the project should be presented in a Project Biodiversity Action Plan (BAP).

Table 8.55 Proposed Biodiversity Action Plan and Additional Conservation Actions

Additional Conservation Action	Responsibility - Organisation	Timing
Capture all biodiversity mitigation, management and monitoring measures in a Project Biodiversity Action Plan (BAP)	Energean	Pipeline construction
Work with relevant stakeholders including the Society for the Protection of Nature in Israel (Birdlife Israel) to raise awareness of the importance of the Carmel Coast IBA	Energean	Pipeline construction

8.7 SOCIO-ECONOMIC

8.7.1 *Overview*

This section describes the potentially significant impacts on the socio-economic environment for the construction and operation phases of the project. The key project activities considered include:

- construction and commissioning of the onshore and offshore export pipeline from the Karish field to the Dor Valve Station;
- installation offshore;
- drilling and well completion in the offshore area; and
- well production.

The assessment focuses on the impacts of highest significance, while impacts with a significance rating of Negligible are described in less detail. Potential impacts that were scoped-out during the scoping phase are not assessed in this section. *Table 8.56* below lists the impacts that have been left out and the justification for it.

Table 8.56 Scoped Out Socio-economic Impacts and Justification

Potential Impact	Project Phase	Justification for Scoping Out
Temporary economic impacts from workforce expenditure and procurement of goods and services by the Project.	Production	Assumed no or very limited employment during operation for maintenance tasks.
Long term economic impacts from payment of taxes and royalties to the Israeli government.	Phases besides production	No or very limited fees or taxes are expected to be paid to the government at the construction stage.
Decreased economic activity and opportunity in tourism and recreation sectors.	Production	Potential impacts on tourism and recreation during operations may arise from noise of helicopter transportation of workforce to the offshore facilities. However helicopter trips will be limited to occasional crew exchanges. On the basis that the helicopter used is already in operation, noise emissions from this activity will not represent an increase in baseline conditions.
Temporary loss of fishing livelihoods and household income due to land acquisition.	Production	During operation no impacts to artisanal and nearshore fishing livelihoods are anticipated.
Permanent loss of fishing livelihoods and household income during operations.	Production	Exclusion zones are not located within shipping lanes and will only include 500 m around the well. No significant disruption to fishing activities anticipated.
Temporary disruption to road and railway traffic.	Production	No impacts anticipated on road traffic during the operation phase after road and railway rehabilitation.
Temporary disruption of utility supply (wastewater and irrigation).	Production	No impacts anticipated on local infrastructure and services. No presence of workforce.
Disruption to marine traffic.	Production	Crew exchange will take place via helicopter primarily and limited and occasional marine transportation is expected. Also, exclusion zones are not located within shipping lanes and will only include 500 m around the well.
Impacts on workforce rights and health and safety.	Production	No workforce expected onshore during operations. Offshore, there will be limited workforce numbers for maintenance and operation activities (75 to 80 approx.).

8.7.2 *Potential Impacts from Job Creation and Employment Opportunities*

Impact Description

During pipeline construction, the number of personnel required for onshore drilling and construction activities is approximately 100, including a portion of Israeli workers. This represents a small Israeli workforce which will be contracted for construction activities during a short timeframe. For offshore operations, the personnel required for drilling and installation activities are approximately 1,000, however the majority of these positions will be filled with skilled expatriate workers, who will be employees of the offshore contractor companies. As for the production phase, no personnel are required at the CVS and DVS location onshore, except possibly for potential maintenance tasks as needed. There will be approximately 25 to 40 staff located in Haifa. Offshore operations will employ approximately 150 employees during commissioning with the majority of positions filled with expatriate workers of the offshore contractor companies. There will, however, still be a substantial number of jobs available to Israelis, the number of which is expected to grow as more are trained to take operational positions during production.

Sensitive Receptors

The majority of the population in Israel is employed in the services sector (81.6% in 2015) while less than a third is employed in the industry sector (17.3%). The unemployment rate in Israel is of 4.1% in 2017, with a higher rate of 8.6% for youth between 15 and 24 years old. Youth employment opportunities may therefore be considered a priority.

Impact Significance

Considering the number of employment opportunities for the Israeli labour force for onshore and offshore activities during construction and operation, relatively few jobs can be expected at the local or national level and for a limited duration. The impact magnitude is therefore considered negligible or minor.

Table 8.57 Summary of Potential Impacts from Job Creation and Employment Opportunities

Nature and Type: Direct positive **Duration of Impact:** During pipeline construction **Receptor Sensitivity:** Medium - High **Impact Magnitude:** Negligible **Impact Significance (pre-mitigation):** *Positive*

Mitigation and Monitoring

The following measures may be implemented to enhance the positive impact of job creation and employment at national and local level.

Table 8.58 Enhancement Measures for Job Creation and Employment Opportunities

Enhancement Measures	Responsibility - Organisation	Timing
Develop requirements and procedures for maximising local and regional employment (priority will be placed on hiring skilled, semi-skilled and unskilled labour from within the project area of influence (first priority), Haifa region (second priority), and then nationally).	Energean	Prior to offshore and onshore pipeline construction
Outline and require a fair and transparent recruitment process for all openings including working with regional and local authorities to advertise openings as early as possible in ways that are accessible to local communities and with clear information on skills requirements.	Energean and contractors	
Disclose clear information on the number and limited timescales of employment opportunities.	Contractors	

Residual Impacts

The residual impacts from job creation and employment opportunities are set out in *Table 8.59*. The enhancement measures implemented by the Project will attempt to enhance some of the positive impacts.

Table 8.59 Residual Impact from Job Creation and Employment Opportunities

	Impact Significance
Pre-mitigation	*Positive*
Post-mitigation	*Positive*

8.7.3 *Potential Impacts from Workforce Expenditure, Local Procurement and Payment of Taxes and Royalties*

Impact Description

Workforce Expenditure during Pipeline Construction

Local direct and indirect employment may lead to induced economic effects of spending by construction workers who will have increased disposable income and the ability to spend more money in the local economy. However, considering the small size of the onshore workforce during construction (~100) and the short duration of onshore construction activities, the impact magnitude is expected to be Negligible. Similarly for offshore construction, although the workforce is considerably larger (~1000), the workforce will be housed on the offshore platform with limited expenditure opportunities, also resulting in a negligible impact magnitude with respect to spending.

Local Procurement during Pipeline Construction

Spending on goods and services for the project construction phase is expected to contribute to the economy to the extent that these outputs are purchased locally, regionally, or nationally. Outputs and services include transport, catering, laundry, food supply, security services, construction vehicles and machinery, construction materials, etc. In particular, local procurement opportunities may include food supply for offshore employees and construction material for Project activities. However, given the short duration of onshore and offshore construction works, the magnitude of local procurement impacts on the economy is considered small.

Taxes and Royalties during Production

It may be assumed that exploitation of the Karish field will generate tax returns and royalty payments for the Israeli government and thereby contribute to the country's GDP. Payment of taxes will generate a long-term (project duration) impact. The amount of taxes and royalty payments to the government are unknown at this stage, and the significance of the impact will depend on the magnitude of the payments and how these translate into economic activity.

Sensitive Receptors

National labour employed by the project will perceive an increase in disposable income which may translate into increased household expenditure.

Cement, plastics, construction, and metal products are primary industries in Israel and they may constitute a source of supply for the Project. Procurement of construction material and machinery can therefore be sourced nationally to the extent possible, and therefore contribute to the national and local economy.

Impact Significance

Considering the limited employment opportunities for Israelis and the limited duration of contracts, impacts from workforce expenditure on the local economy are expected to be Negligible. As for local procurement, given the local and national opportunities to supply goods and services, in particular construction materials, the impact significance should be minor considering the short-term duration. Finally, the amount of taxes and royalty payments to the government are unknown at this stage, however they may be assumed to represent a small but significant amount of government revenue from a single project and over a long-term period. Nevertheless, it should be noted that government revenues only imperfectly translate into economic activity, which would result in a ***Minor*** to *Moderate* significance depending on the magnitude of the payments and their contribution to the national economy.

The impact significance for each of these sub-impacts is summarised in the table below.

Table 8.60 Summary of Potential Impacts from Workforce Expenditure, Local Procurement, and Taxes and Royalties

Workforce Expenditure	Local Procurement	Taxes and Royalties

Nature and Type: Indirect Positive **Duration of Impact:** short term, during pipeline construction **Receptor Sensitivity:** Low **Impact Magnitude:** Negligible **Impact Significance (pre-mitigation):** *Positive*	**Nature and Type:** Indirect Positive **Duration of Impact:** short term, during pipeline construction **Receptor Sensitivity:** Medium **Impact Magnitude:** Small **Impact Significance (pre-mitigation):** *Positive*	**Nature and Type:** Indirect Positive **Duration of Impact:** long term, during production **Receptor Sensitivity:** Medium **Impact Magnitude:** Small - Medium **Impact Significance (pre-mitigation):** *Positive*

Mitigation and Monitoring

The following measures may be implemented to enhance the positive impacts of local procurement.

Table 8.61 Enhancement Measures for Impacts from Workforce Expenditure, Local Procurement, and Taxes and Royalties

Management Control	Responsibility - Organisation	Timing
Develop a *Local Procurement Plan* including a comprehensive demand-and-supply-side analysis to identify which of the goods and services can be supplied locally and within Israel and to identify contractors and suppliers that are able to comply with the project's requirements.	Energean	Prior to drilling, installation and pipeline construction
In line with the *Local Procurement Plan*, advance information on tendering opportunities will be provided to local businesses through trade and industry chambers and local business organisations in the Project's area of influence.	Energean	
Break tendering opportunities into smaller components to increase the likelihood of granting individual pieces of work to Israeli companies.	Energean	
As part of the tendering process, require contractors to develop a *Local Procurement Strategy* that stipulates how national and local purchase of goods and services will be optimized to maximise local procurement. Priority will be placed on procuring goods and services from within the area of influence, then the Haifa region, and then Israel.	Energean and contractors	

Residual Impacts

The residual impacts from workforce expenditure, local procurement and tax and royalty payments are set out in *Table 8.62*. The measures implemented by the Project will attempt to enhance some of the positive impacts.

Table 8.62 ***Residual Impact from Workforce Expenditure, Local Procurement, and Taxes and Royalties***

	Impact Significance
Pre-mitigation	*Positive* for workforce expenditure
	Positive for local procurement
	Positive for taxes and royalty payments
Post-mitigation	*Positive* for workforce expenditure
	Positive for local procurement
	Positive for taxes and royalty payments

8.7.4 *Potential Impacts from Decreased Economic Activity and Opportunity in Tourism and Recreation Sectors during Construction*

Impact Description

Potential disruption to tourism and recreational activities may result from site clearance for CVS and DVS, pipeline trenching, drying and land reinstatement, and to a limited extent by road transportation of Project supplies. The closest marina is Marinali (Marina Hertsyla) approx. 60 km to the south of the landfall. The nearest tourist beach is Dor Beach, located less than 500 m north of the landfall and is considered one of the most beautiful beaches in Israel. The beach attracts tourists to the area and is connected to the same road which also passes the landfall site and leads to the Dalia River Natural Reserve. This coastal plain area is also a biking and hiking route. Recreational activities include sailing, wind surfing, camping, biking, and other activities. It is estimated that approximately 300 tourists per day visit Dor for the beaches and approximately 10 hikers per day.

Sensitive Receptors

The large majority of the Israeli labour force (81.6%) is employed in the service sector as of 2015. Stakeholder consultations are ongoing to identify data sources regarding employment in the settlements in the AoI in particular with regards to the weight of tourism in the local labour market. However, considering the variety of recreational and tourism related activities and attractions in the area, it is assumed that such activities represent an important sector of the local economy, resulting in a medium to high importance for local receptors.

Impact Significance

Considering the short duration of onshore construction activities and the limited project footprint (2 km of new pipeline), the impact magnitude is considered small resulting in an overall Minor to Moderate impact significance.

Note: Whilst some informal stakeholder consultation has been conducted, the presence of additional touristic or recreational activities in the vicinity of the landfall area as well as along the coast and offshore (e.g. recreational sailing, diving, etc.) could not be confirmed. It is therefore recommended that a copy *of the grievance mechanism be provided to local tourist businesses and operators to enable comment and feedback on project activities.*

Table 8.63 Summary of Potential Impacts from Decreased Economic Activity and Opportunity in Tourism and Recreation Sectors

Nature and Type: Direct negative
Duration of Impact: During construction
Receptor Sensitivity: Medium - high
Impact Magnitude: Small
Impact Significance (pre-mitigation): *Moderate*

Mitigation and Monitoring

Table 8.64 Mitigation Measures for Decreased Economic Activity and Opportunity in Tourism and Recreation Sectors

Management Control	Responsibility - Organisation	Timing
As part of the *Stakeholder Engagement Plan*, conduct additional stakeholder consultations with local authorities, tourism associations if any, and village heads to address information gaps regarding nearshore and offshore recreational activities.	Energean	Prior to pipeline construction
Implement appropriate measures to project design to minimise the footprint of onshore and coastal /offshore project activities to minimise the potential impacts on tourism and recreational activities in the area of influence.	Energean	Prior to pipeline construction
As part of the *Stakeholder Engagement Plan*, and in-line with previous engagement activities, ensure ongoing consultation with stakeholders including regional and local authorities, managers of protected areas, relevant ministry departments and village heads on proposed project activities and its expected impacts on the area.	Energean	All project phases
Provide local tourist operators and village heads with the project Grievance Procedure, as well as information on how they can give feedback and raise concerns about project activities.	Energean	Prior to pipeline construction

Residual Impacts

Table 8.65 Residual Impact from Decreased Economic Activity and Opportunity in Tourism and Recreation Sectors

	Impact Significance
Pre-mitigation	*Moderate*
Post-mitigation	*Minor*

8.7.5 *Potential Impacts from Loss of Fishing-Related Livelihoods during Pipeline Construction*

Impact Description

The temporary land acquisition at the landfall area as well as nearshore and offshore construction activities may result in potential loss of livelihoods related to fish farms, coastal artisanal fishing, and offshore fishing.

Aquaculture

With respect to fish farms, historically, the area crossed by the pipeline east of the landfall used to be a fish farm but is not currently active. The closest active fish farms are predominantly located 250 m south of the pipeline landfall area and one area immediately west/northwest of the pipeline corridor. As such, impacts on the operation of fish farms from project construction activities should be limited.

Coastal fishing

Coastal artisanal fishing activities were not directly observed in the AoI during the Reconnaissance Survey however it is possible that small scale commercial or subsistence artisanal nearshore fishing may occur along the coastal strip where the pipeline will be built. Interaction with project construction vessels in the nearshore may result in restricted fishing grounds and potential damage to fishing gears. Nevertheless, the nearshore HDD pipeline construction activities are only expected to last 2 to 3 weeks and should therefore result in short-term nearshore restrictions.

Offshore fishing

In the offshore area near the FPSO, potential interaction of project vessels with offshore fishing crews and exclusion zones may occur, resulting in disruption to fishing activities offshore and potential damage to fishing gears and equipment. This being said, exclusion zones are not located within shipping lanes and will only include 500 m around the well, which result in a negligible to small impact magnitude.

Sensitive Receptors

Similar to other locations in the Israeli coastal plain, aquaculture is an important livelihood for communities in the AoI, and is based upon the use of cooperative “kibbutz” fish farms.

Although these have not been observed along the coast of the AoI, small scale coastal artisanal fishing is known to occur along the entire Israeli coast, either drawn up on the beaches or in small protected inlets as well as the major ports and / or marinas. In contrast, purse seine fishing is primarily located in the major ports and is mostly concentrated in the north near Haifa.

Similarly, no fishing activities have been identified offshore near the FPSO; however, fishing does occur in Israeli waters, and the possible presence of offshore trawlers cannot be discarded.

Impact Significance

Considering the distance of active fish farms from the landfall area and the short duration of construction activities in the landfall area, impacts on the operation of fish farms from project construction activities is expected to be negligible to minor. Similarly, potential disruption to coastal fishing activities will be limited in time and result in a minor impact on small scale artisanal fishing livelihoods. As for offshore fishing, given the small exclusion zones and their location outside shipping lanes, the resulting potential impact on offshore fishing will be of minor significance.

Note: whilst some informal stakeholder consultations have been conducted, the presence of coastal and offshore fishing in the AoI could not be confirmed at this stage. It is recommended that additional stakeholder engagement is undertaken throughout construction with the local fishing authority to seek feedback and to monitor potential impacts to fishing activity.

Table 8.66 Summary of Potential Impacts from Loss of Fishing-Related Livelihoods during Construction

Nature and Type: Direct negative
Duration of Impact: During construction
Receptor Sensitivity: Medium
Impact Magnitude: Small
Impact Significance (pre-mitigation): ***Minor***

Mitigation and Monitoring

Table 8.67 Mitigation Measures for Loss of Fishing-Related Livelihoods during Pipeline Construction

Management Control	Responsibility - Organisation	Timing
Limit exclusion zones around Project infrastructure and vessels to those required legally, without compromising safety measures.	Energean	During nearshore and offshore pipeline construction
As part of the *Stakeholder Engagement Plan*, conduct additional stakeholder consultations with local authorities, including the fishing authority, and village heads (including the villages of Dor, Nahsholim, Fureidis and Ma'ayan Tzvi) to address information gaps regarding coastal and offshore fishing.	Energean	Prior to pipeline construction

Management Control	Responsibility - Organisation	Timing
Implement the *Grievance Procedure* to collect and address potential grievances and claims from fishers, in particular with respect to compensation for any proven damage to fishing gear due to project activities. Provide village heads (including the villages of Dor, Nahsholim, Fureidis and Ma'ayan Tzvi) and the fishing authority with the project Grievance Procedure, as well as information on how they can give feedback and raise concerns about project activities.	Energean	Prior to and throughout pipeline construction (possibly extend to production)
A vessel transit route will be agreed with Israeli Maritime Authorities and communicated to fishers and other marine users. Project vessels will keep within the agreed routes.	Energean	Prior to and throughout construction (possibly extend to production)

Residual Impacts

Table 8.68 Residual Impact from Loss of Fishing-Related Livelihoods during Construction

	Impact Significance
Pre-mitigation	*Minor*
Post-mitigation	*Not Significant*

8.7.6 *Potential Impacts from Loss of Agricultural Livelihoods during Pipeline Construction and Production*

Impact Description

Pipeline Construction Phase

The temporary land acquisition along the onshore pipeline corridor from the landfall water line up to the DVS during the construction phase may result in temporary disruption to agricultural activities and potential loss of agricultural livelihoods.

The land along the pipeline Energean pipeline route has been designated by the government for various pipeline projects and as such, all lots and parcels along the corridor are formally owned either by the Government of Israel, the Development Authority, or the Jewish National Fund. Nevertheless, whilst the local community does not own the land, the presence of existing olive groves and filled-in fish ponds show that the community has used the land in the past for agricultural purposes. This being said, based on the unmaintained state of the land, it is assumed that the land is not currently in use for agricultural purpose. Indeed, field observations have shown that the area is surrounded with thick vegetation, olive trees have grown wild and are not being cultivated. The state of the Dor wheat field east of the land fall and the Cotton fields in the vicinity of the DSV also suggests that they have been abandoned.

In addition, an avocado plantation is located 80 m to the east of the pipeline laydown area and within the TAMA 37/H designated corridor but there will be no disturbance of land. Considering its distance to the construction site, this plantation is not expected to be significantly impacted by dust emissions from construction machinery and vehicles. These impacts were scoped out as part of the air quality assessment in the Scoping Report included in the Field Development Plan.

Operation Phase

During operation no impacts to local agricultural livelihoods are anticipated, except for a small pipeline corridor which will result in a permanent project footprint.

Sensitive Receptors

Agriculture represents an important sector of the economy for the settlements in the AoI. The *kibbutz* of Nahsholim and the settlement of Dor grow bananas, avocado, cotton, and olives. Although, as previously stated, with regards to the project footprint where the pipeline will be established, field observations have shown that these areas designated in the past for agricultural use are currently uncultivated or neglected. However, given the land use in the Area of Influence, agriculture is still expected to represent an important sector of the local economy.

Impact Significance

Based on the assumption that the land along the pipeline route is not currently in use for agricultural purposes, and considering the temporary nature of onshore construction activities (2 years) and the small size of the pipeline construction corridor, any potential impact on agricultural livelihoods during construction should be of Minor significance. As for the operations phase, although the land take will be permanent, it will be very limited in size, resulting in Not Significant to Minor potential impacts.

Table 8.69 Summary of Potential Impacts from Loss of Agricultural Livelihoods during Construction and Operation

Nature and Type: Direct negative **Duration of Impact:** During construction and operation **Receptor Sensitivity:** Medium **Impact Magnitude:** Small **Impact Significance (pre-mitigation):** ***Minor***

Mitigation and Monitoring

Mitigation measures are presented in the *Table 8.70* below.

Table 8.70 Mitigation Measures for Loss of Agricultural Livelihoods during Pipeline Construction and Production

Management Control	Responsibility - Organisation	Timing
As part of the Stakeholder Engagement Plan, conduct additional stakeholder consultations with village heads (including the villages of Dor, Nahsholim, Fureidis and Ma'ayan Tzvi) and relevant farmers' associations, if any, to confirm the status of land ownership and land use in the area of influence.	Energean	Prior to onshore construction and ongoing during construction and operation
Implement a Livelihood Restoration Plan (LRP) for the project that identifies previous users of the land. The LRP ascertain the extent of livelihood impacts and specify options for livelihood restoration.	Energean	Prior to onshore construction

Residual Impacts

Table 8.71 Residual Impact from Loss of Agricultural Livelihoods during Pipeline Construction and Production

	Impact Significance
Pre-mitigation	*Minor*
Post-mitigation	*Not Significant*

8.7.7 *Potential Impacts on Infrastructure and Services during Pipeline Construction*

Impact Description

Traffic and Road Infrastructure

Project-related road traffic generated by the movement of construction machinery and vehicles along the local and regional road networks may potentially lead to traffic disruptions. The peak of project related vehicular movement is planned to occur during earthworks activities associated with onshore pipeline installation and the CVS construction, which is expected to be of relatively short duration (6 months) and will consist of 32 additional vehicular movements per day. Earthworks activities for construction of the CVS will take 12 months and will add an additional 16 vehicular movements. These two activities may overlap at some point creating a peak of 48 vehicular movements. The remaining activities are short term (less than 1 month) and will require fewer vehicular movements (see *Section 2.8*).

While the exact transportation routes for the Project are not known at this stage, it is assumed that Highway 2 connecting Haifa to Tel Aviv may be used. Considering the regional importance of this motorway, the daily increase of vehicular movement resulting from Project activities is not expected to constitute a change in the order of magnitude of road movements, thereby significantly affecting other road users.

In addition, the project will utilise existing roads and potentially the existing railroad network, which will not require any civil works or associated disruption to road infrastructures and traffic. Similarly, whilst the pipeline corridor is planned to cross the Haifa TLV railway and the main motorway connecting Haifa to Tel Aviv (Highway 2), the project design includes horizontal drilling below these two transportation routes, which will avoid any disruption of service along these two transportation routes.

Wastewater and Irrigation

The pipeline runs very close to Ma'ayan Tzvi wastewater treatment plant and treated wastewater reservoir, which are located within the pipeline corridor to the south-east of the DSV. Construction may result in temporary disruption of wastewater services in case of accidental damage to the infrastructure.

Similarly, the AoI also presents evidence of irrigation systems including a deep wet trench between the Ma'ayan Tzvi avocado plantation and the pipeline corridor. Project construction activities may also potentially result in accidental damages to irrigation infrastructure not previously identified.

No additional pressure on infrastructure is expected from the presence of the workforce considering the small number (~100) and temporary nature of the works.

Sensitive Receptors

Sensitive receptors primarily include road users of the local and regional road and railway networks, and the road and railway infrastructures themselves which may be vulnerable to damages from construction activities.
Sensitive receptors also include local communities who depend on the Ma'ayan Tzvi wastewater treatment plant for treatment of their wastewater, as well as local farmers who rely on irrigation infrastructure in the area to water their fields.

Impact Significance

Considering the daily increase of vehicular movement resulting from Project activities and the relatively short term duration of peak vehicular movements, this increase is not expected to constitute a change in the order of magnitude of road movements in the area. Receptor sensitivity is considered low resulting in ***Not Significant*** impact significance.

As for wastewater and irrigation infrastructure, the probability / magnitude of such impacts occurring is considered small resulting in Negligible impact significance.

Table 8.72 Summary of Potential Impacts on Infrastructure and Services during Construction

Road infrastructure and traffic	Wastewater and irrigation infrastructure

Nature and Type: Direct negative **Duration of Impact:** During construction **Receptor Sensitivity:** Low **Impact Magnitude:** Small **Impact Significance (pre-mitigation):** *Not Significant*	**Nature and Type:** Direct negative **Duration of Impact:** During construction **Receptor Sensitivity:** Low **Impact Magnitude:** Small **Impact Significance (pre-mitigation):** *Not Significant*

Residual Impacts

Table 8.73 Residual Impact from Impacts on Infrastructure and Services during Construction

	Impact Significance
Pre-mitigation	*Not Significant* for road infrastructure and traffic
	Not Significant for wastewater and irrigation infrastructure
Post-mitigation	*Not Significant* for road infrastructure and traffic
	Not Significant for wastewater and irrigation infrastructure

8.7.8 *Potential Impacts on Marine Traffic and Offshore Navigation during Pipeline Construction*

Impact Description

Potential interaction of construction and security vessels with other sea users and offshore fishermen may potentially increase the risk of offshore navigation accidents. As discussed previously in *Section 8.75*, no fishing activities have been identified offshore near the FPSO; however offshore fishing and trawling activities are known to occur in Israeli waters. This being said, exclusion zones are not located within shipping lanes and will only include 500 m around the well.

Shipping lanes exist parallel and perpendicular to the coast of Israel, some leading to the port of Haifa. The FPSO construction will utilise these existing marine shipping lanes, however Marine Traffic data has confirmed low incidence of marine traffic in the areas where the FSPO is located and where the marine pipeline will be established. The duration of offshore pipeline and FPSO construction activities is also considered short-term. As such, Project-related marine traffic is not expected to result in a material increase from the existing baseline levels of traffic in the area, and therefore, potential impacts to existing marine traffic are not considered significant.

Sensitive Receptors

The eastern Mediterranean Sea is a busy navigation area that concentrates high number of routes where multiple sea users from merchant ships, tankers (oil, gas, chemical), ferries, large cruises, fishing vessels, war ships and other recreational ships coexist. In the Project offshore AoI however, marine traffic intensity is considered less intense compared to the traffic further north, resulting in a Medium receptor sensitivity.

Impact Significance

Considering the temporary nature of offshore construction activities and the relatively lower intensity of marine traffic in the area, the increase in marine traffic generated by the Project is expected to result in an impact of Minor significance.

Note: The presence and intensity of offshore fishing activities in the offshore project AoI could not be confirmed at this stage. Additional stakeholder engagement with appropriate fishing and maritime authorities and associations is necessary to address these gaps and confirm the impact assessment presented in this section.

Table 8.74 Summary of Potential Impacts from Disruption to Offshore Navigation and Marine Traffic during Construction

Nature and Type: Direct negative
Duration of Impact: During pipeline construction
Receptor Sensitivity: Medium
Impact Magnitude: Small
Impact Significance (pre-mitigation): *Minor*

Mitigation and Monitoring

Table 8.75 Mitigation Measures for Impacts from Disruption to Offshore Navigation and Marine Traffic during Construction

Management Control	Responsibility - Organisation	Timing
As part of the *Stakeholder Engagement Plan*, conduct additional stakeholder consultations with maritime and fishing authorities, and other relevant stakeholders to disclose project information regarding timeframes, schedules, and use of shipping lanes by Project vessels, etc.	Energean	Prior to and during offshore pipeline construction (potentially extend to production)
The proposed pipeline route does not include crossing the MED Nautilus fibre optic cable route; however, Energean will engage with MED Nautilus prior to any subsea construction activities to ensure no damage to the cable occurs.	Energean	
Interaction with fishermen and other users will be monitored through the fishing authority, meetings with village heads, and through the Project's grievance procedure.	Energean	

Residual Impacts

Table 8.76 Residual Impact from Disruption to Offshore Navigation and Marine Traffic during Construction

	Impact Significance
Pre-mitigation	*Minor*
Post-mitigation	*Not Significant*

8.7.9 *Potential Impacts on Workforce Rights and Health and Safety during Pipeline Construction*

Impact Description

The maintenance of a workforce during construction may imply impacts on workforce rights including health and safety in relation to the nature of the work performed and the risk of work-related accidents and injuries, as well as potential contractual and employment violations such as remuneration and living conditions.

The greatest safety risks are associated with the following:

- workers involved in the use of heavy equipment during construction, traffic risks, working at heights and waste disposal; and
- workers living offshore in the FPSO may also be at risk of acquiring communicable diseases and sexually transmitted infections.

Due to the stage of Project development, the following aspects of the Project are yet to be defined, and will be influencing factors with regards to the risks associated to workers:

- quality and standards of worker accommodation arrangements onshore and offshore; and
- the sourcing of the labour force.

Sensitive Receptors

This section considers impacts to workers employed directly by Energean and its Contractors as well as along the supply chain and considers worker management and rights within the context of Israeli law and / or international best practice (whichever is more stringent).

Given that Israel has ratified all eight core ILO fundamental and governance conventions and has a strong labour and working conditions framework supported by existing national labour laws and health and safety legislation, which are generally in line with international standards, sensitivity is considered low.

No issues with respect to child labour and the use of forced labour in Israel were identified.

Impact Significance

Considering the temporary nature of construction activities, the limited size of the onshore and offshore construction workforce, and the embedded mitigation measures already in place with respect to HSE management (see mitigations below), the impact significance is considered Minor.

Table 8.77 Summary of Potential Impacts on Workforce Rights, Health and Safety during Construction

Nature and Type: Direct negative **Duration of Impact:** During construction **Receptor Sensitivity:** Low **Impact Magnitude:** Medium **Impact Significance (pre-mitigation):** *Minor*

Mitigation and Monitoring

As part of its embedded mitigation measures, Energean will operate an HSE Management System that has been developed in accordance with the principles of OHSAS 18001:2007 Standard for Occupational Health and Safety Management Systems. Implementation of this HSE Management System and compliance with the Karish Report on Major Hazards, is intended to allow Energean to ensure that the risk to employees and contractors associated with occupational hazards and the consequences of major accident hazards, are reduced to As Low As Reasonably Practicable (ALARP).

Additional mitigation measures are presented in *Table 8.78* below.

Table 8.78 Mitigation Measures for Impacts on Workforce Rights, Health and Safety during Construction

Management Control	**Responsibility - Organisation**	**Timing**
Facilities and activities will be developed, planned and maintained such that robust barriers are in place to prevent accidents. All employees have the duty to stop any works if adequate systems to control risks are not in place.	Energean / Contractor	Prior to and during pipeline construction
Ensure that Energean's *HSE Management System* covers all contractors and sub-contractors including identification and provision of PPE, training and monitoring as well as ongoing safety checks and safety audits.	Energean	
Development of a Workers Health and Safety Plan that should consider the following: x Employee should not be under the influence of intoxicants which could adversely affect the ability of that Employee to perform the work or adversely affect the health and safety of other Employees, other persons or the environment. x Surveillance programs for health status shall be established and implemented. x Those involved in the handling and management of waste will be provided with appropriate personal protective equipment (PPE) and training in handling of waste materials.	Energean / contractor	Prior to and during pipeline construction
In all Contractor and supplier contracts explicit reference will be made to the need to abide by Israeli law, international standards and Energean's policies in relation to health and safety. Energean will undertake periodic due diligence of contractors and suppliers to monitor compliance.	Energean / contractor	Prior to construction and during pipeline construction
As part of the Contractor and supplier selection process Energean will take into consideration performance with regard to worker health and safety and Human Rights.	Energean	Prior to pipeline construction
Energean will provide support to contractors and sub-contractors to ensure that labour and working conditions are in line with Israeli law. Contractor contracts will establish the right for Energean to monitor and audit all contractors and sub-contractors and clearly articulate the consequences for the contractor if they are found to be breaching national legal requirements, international standards. Contractor contracts will specify that the same standards will be met by their sub-Contractors and suppliers.	Energean Energean	Prior to and during pipeline construction During pipeline construction

Residual Impacts

Table 8.79 Residual Impact on Workforce Rights, Health and Safety during Construction

	Impact Significance
Pre-mitigation	*Minor*
Post-mitigation	*Not Significant*

8.8 *COMMUNITY HEALTH AND SAFETY*

8.8.1 ***Overview***

This section describes the primary community health and safety impacts identified for the construction phase. Project activities during the operations phase are not expected to generate impacts on community health and safety. This impact was therefore scoped out.

During operations, any air quality impacts from flaring will be located within the vicinity of the flares (i.e. within 10 km, based on international guidance). Because there are no human receptors within this area, given how far offshore the flaring will be located, no significant impacts to community health are predicted. There will be no interaction between community and offshore workforce as they will be accommodated on the FPSO vessel.

8.8.2 ***Potential Impacts from Site Trespass, Road Accidents and Interaction with Project Workforce during Construction***

Impact Description

Potential impacts on community health and safety may occur during onshore construction as a result of potential site trespass during site clearance activities for CVS and DVS and pipeline trenching activities and land reinstatement.

To address this impact the Project has established imbedded mitigation measures which include securing the construction sites by establishing appropriate fences and barriers and through the employment of security guards to control access. The presence of security guards may pose a risk to community safety if not properly trained in the Voluntary Principles on Security and Human Rights (VPSHR).

The additional traffic generated by the movement of project construction machinery and vehicles may increase the risk of road accidents in the AoI, which would present a greater risk for children. However, considering the small number of vehicular movements and the short duration of onshore construction activities (see *Section 8.7.7* on infrastructure and services impacts) this impact should be limited.

In addition, impacts on community health and safety from interaction with onshore construction workforce and the related risk of disease transmission is considered negligible considering the small size of the workforce and temporary nature of the work.

Sensitive Receptors

Sensitive receptors are primarily the local communities of Dor and Nahsholim, including farmers, fish farmers, and children in particular, who may be most vulnerable to potential accidents.

Impact Significance

The short duration of onshore construction activities (6 to 12 months) and the project-embedded mitigation measures in place to secure the construction sites (see *Mitigation and Monitoring* below) would result in a Minor impact significance. The potential for road accidents related to the transport of project supplies and the movement of construction machinery and vehicles, is also considered to be of Minor significance considering the small number of vehicular movement and the short duration of onshore construction activities as previously discussed.

Impacts from disease transmission due to interaction with the onshore construction workforce are considered Not Significant given the small size of the workforce and temporary nature of the work.

Table 8.80 Summary of Potential Impacts from Site Trespass and Interaction with Project Workforce during Construction

Physical injury due to site trespass	Road accidents from increased project-related traffic	Disease transmission from interaction with onshore construction workforce
Nature and Type: Direct negative **Duration of Impact:** During construction **Receptor Sensitivity:** Medium **Impact Magnitude:** Low **Impact Significance (pre-mitigation):** *Minor*	**Nature and Type:** Direct negative **Duration of Impact:** During construction **Receptor Sensitivity:** Medium **Impact Magnitude:** Low **Impact Significance (pre-mitigation):** *Minor*	**Nature and Type:** Direct negative **Duration of Impact:** During construction **Receptor Sensitivity:** Medium **Impact Magnitude:** Negligible **Impact Significance (pre-mitigation):** *Not Significant*

Mitigation and Monitoring

As part of the Project's embedded mitigation measures, appropriate temporary perimeter fences and barriers will be installed during onshore construction to maintain site security and protect the public from the potential dangers associated with construction activities. Energean also plans to employ security guards to control access to the construction site(s) and to patrol the perimeters. Both the landfall CVS and onshore DVS will have perimeter security fencing and a locked gate access, which will provide access to authorised personnel only.

Additional applicable measures are summarized in *Table 8.81* below.

Table 8.81 Mitigation Measures for Physical Injury due to Site Trespass and Interaction with Project Workforce during Construction

Management Control	Responsibility - Organisation	Timing

Management Control	Responsibility - Organisation	Timing
In line with Energean's embedded measure regarding site protection, develop a *Community Health and Safety Plan* including measures such as: x Fencing camps and storage facilities. x Undertaking a programme of education on risks of trespass at local schools and in the community. x Providing access to health care for those injured by Project activities. x Ensure that signs are put up around work fronts and construction sites advising people of the risks associated with trespass. x Community education programs and awareness programs targeted particularly at young girls in the community. x Implement the project *Traffic Management Plan* with measures controlling vehicle speed, vehicle maintenance and driver behaviour.	Energean / Contractor	Prior to and during pipeline construction
As part of the *Stakeholder Engagement Plan* and *Grievance Mechanism*, inform village heads (including the villages of Dor, Nahsholim, Fureidis and Ma'ayan Tzvi) of the grievance mechanism in place.	Energean	
During the contractor selection process implement the following measures: • Conduct a pre-employment worker health screening and regular health screenings including for employees of contractors and sub-contractors making sure that in the case of communicable diseases, workers will commence treatment and be non-infectious before taking-up their post. • Conduct induction training for workers on the Worker Code of Conduct including guidelines on worker-community interactions, alcohol consumption, and illegal activities. • As part of the induction process provide consistent training and education to all workers to ensure awareness of transmission routes and methods of prevention of STDs and other diseases of concern such as TB as well as early symptoms of such diseases. • Provide access to confidential and voluntary HIV/AIDs testing.	Energean / contractor	Prior to and during pipeline construction

Residual Impacts

Table 8.82 *Residual Impact from Physical Injury due to Site Trespass and Interaction with Project Workforce during Construction*

	Impact Significance
Pre-mitigation	*Minor* for physical injury due to site trespass
	Minor for road accidents
	Not Significant for disease transmission from interaction with onshore construction workforce
Post-mitigation	*Not Significant for* physical injury due to site trespass
	Not Significant for road accidents
	Not Significant for disease transmission from interaction with onshore construction workforce

8.9 VISUAL AMENITY

8.9.1 Potential Impacts from Physical Presence Onshore

Impact Description

Project infrastructure will be sited at various locations, some of which will be exposed and visible; there will also be some associated visible activity connected to the construction activities in respect to this infrastructure, such as traffic movement and stored excavated material. The activities that were identified as having the potential to impact key viewpoints known for tourism, and also commercial and residential visual receptors are summarised in *Table 8.83.* Note that given the distance of offshore project activities, potentially significant visual impacts are limited to onshore activities only.

Table 8.83 *Potential Impacts to Visual Amenity*

Pipeline Construction	**Production**
x Land-take for worksites, site access and access roads. x Site activities (excavation, tunnelling, construction, rehabilitation). x Site offices and welfare facilities. x Transport (workers, equipment, heavy/hazardous loads). x Waste disposal (excavated material, "domestic"; and hazardous).	x Operation of valve stations x Physical presence in the environment

The onshore construction worksite within the TAMA 37/H corridor will include use of access roads, laydown areas, construction buffer zones, vehicle parking areas, and spoil areas. There will be no construction activity on Dor Beach itself, and access to the beach will not be restricted. During construction this fenced area will be visible to beach goers. Visual impacts from these activities will be for a limited duration (i.e. during the pipeline construction and commissioning phase).

The onshore pipeline will have no visual impact, as it will be buried underground, and the only permanent above ground infrastructure will be the CVS and DVS.

Receptor Sensitivity

Offshore and onshore permanent infrastructure associated with the developments has the potential to result in a visual impact. Visual impact concerns were raised previously by community and regulatory stakeholders during the TAMA 37/H public disclosure and consultation process.

The town of Dor, with a population of approximately 390, is the closest settlement to the onshore project activities and lies approximately 500m to the northwest of the DVS. Nahsholim is another small village located immediately north of Dor. Both Dor and Nahsholim are heavily dependent on recreational tourism from a socio-economic perspective. Given the relative distances of Dor and Nahsholim from the onshore infrastructure, the general sensitivity of these visual receptors is assessed as Medium and Low respectively.

Nahsholim Seaside Resort sells tourism options that utilise the beach for wildlife viewing and sports activities, which may perceive a loss of customers during construction activities as a result of visual impact. Consequently the beach area is assessed as a specific visual receptor of Medium sensitivity.

Fureidis is an Arab town located approximately 3km to the east of the landfall site, overlooking the project area due to its higher elevation. Given the distance of Fureidis from the onshore infrastructure, the sensitivity of this visual receptor is assessed as Low.

Ma'ayan Tzvi is a town located approximately 3km to the southeast of the landfall site, also overlooking the project area due to its higher elevation. Given the distance of Ma'ayan Tzvi from the onshore infrastructure, the sensitivity of this visual receptor is assessed as Low.

Impact Significance

The potential visual impacts arising from the construction and operation of onshore infrastructure are summarised in *Table 8.88*.

Table 8.84 Potential Impacts on Visual Amenity

Pipeline Construction	Production
Nature and Type: Direct Negative **Receptor Sensitivity:** Low to Medium **Impact Magnitude:** Small **Impact Significance (pre-mitigation):** *Not significant to Minor significance*	**Nature and Type:** Direct Negative **Receptor Sensitivity:** Low to Medium **Impact Magnitude:** Negligible **Impact Significance (pre-mitigation):** *Not significant*

During the two year onshore construction phase for the Project there will be multiple work sites including road closures and areas which will be fenced off for security reasons causing visual impacts during Project construction.

The worst-case unmitigated impact to visual amenity arising from the construction of the onshore components is assessed as Small, given the short duration and height of the equipment that will be used. Based on this magnitude, the impact significance in Nahsholim, Fureidis, and Ma'ayan Tzvi is considered as ***Not Significant***. For the more sensitive receptors of Dor and the Nahsholim Seaside Resort, the unmitigated impact significance is considered to be ***Minor***.

Mitigation and Monitoring

The visual assessment has not identified any impacts of Moderate or Major significance. Notwithstanding, the GIIP design measures described in *Table 8.85* will contribute to minimising the visibility of the onshore components.

Table 8.85 Mitigation Measures for Impacts on Visual Amenity

Management Control	Responsibility - Organisation	Timing
During the engineering design process for the onshore installations (i.e. Staging Area 1, Staging Area 2, CVS, and DVS) the site elevation should be designed either at the same grade as the surrounding area or lower, to minimise to visual impacts to the surrounding communities.	Energean	Embedded Mitigation
For onshore construction activities and for the long-term operation of the CVS and DVS, all external lighting should be low level, and/or directed downwards. For the CVS and DVS, the design should ensure that the external facility walls facing the coast (whether parallel or diagonally) are not illuminated directly, except for flashing collision-avoidance lights for air and sea craft.	Energean	Embedded Mitigation
The following mitigation measures will be implemented where practicable throughout the construction phase to minimise visual impacts: x machinery and materials will be stored tidily during the works – tall machinery will not be left in place for longer that required for construction purposes, in order to minimise impacts on views; x temporary roads providing access to site compounds and work areas will be maintained and where feasible free of dust; x unsightly works and stockpiles areas shall be screened to minimise adverse visual impacts at close range(especially near tourist areas/or near residential areas from where direct views are available); x outdoor construction lighting, where required shall be unobtrusive as possible, will be directional and shall not allow light to shine upwards or into residents windows; and x use of tall mast lights shall be carefully assessed and avoided wherever possible during both construction and operation.	EPC contractor	Pipeline construction

Residual Impact

The implementation of the identified mitigation measures will result in residual impacts that are Negligible in magnitude at all receptors. The residual impacts will therefore be considered as ***Not Significant*** (see *Table 8.107)*.

Table 8.86 Residual Impact Significance

	Impact Significance
Pre-mitigation: onshore visual	*Not Significant to Minor*
Post-mitigation: onshore visual	*Not Significant*

8.10 CULTURAL HERITAGE

8.10.1 *Potential Impacts on Cultural Heritage from Construction Activities*

Impact Description

No identified cultural heritage resources have been identified within the project's footprint. However, there is a potential for impacts to features of tangible cultural heritage that have not been identified previously during construction activities. These are described in *Table 8.87*.

Table 8.87 Sources of Potential Impacts on Cultural Heritage

Project Component	**Construction Activity**
Onshore pipeline	x The clearance, levelling and excavation of the pipeline route to approximately 2m depth. x The clearance and levelling of approximately 1,000m^2 of land for the CVS. x The clearance and levelling of approximately 2,000m^2 of land for the DVS. x The clearance and levelling of approximately 60,500m^2 of land for staging areas.
Offshore pipeline	x Placement of pipeline on seabed. x Rock placement of coarse gravel and stones to reshape the seabed to provide support under the pipeline and prevent 'free spans'.

The route of the onshore pipeline crosses land that has been disturbed by either existing agricultural or former fish farming activities. The fish ponds have now been infilled with 'made ground' to a depth greater than the 2m pipeline excavation depth. The potential magnitude of impact is considered Negligible, given the ground has already been subject to significant disturbance and alteration. Additionally, the land adjacent to the onshore pipeline route has previously been disturbed during the construction of a gas distribution pipeline routed to the existing DVS facility.

The construction of the offshore pipeline will not require excavation of the seabed. A pipelay vessel will place the pipeline on the seabed, and the pipeline will not be buried. The rock placement activities will involve only minor intervention on the seabed.

Receptor Sensitivity

No historical or archaeological sites have been identified along the onshore pipeline route from previous studies. The land along the onshore pipeline route has also undergone significant physical alteration from the former fish farming activities, and existing agricultural activities. Sensitivity of the onshore receptors is therefore assessed to be Low.

The potential for the discovery of historical or archaeological sites is known to exist along the offshore pipeline route, from survey work carried out for previous offshore infrastructure projects. The potential to encounter such sites cannot, therefore, be ruled out. The sensitivity of the potential offshore receptors is therefore assessed to be Medium.

Impact Significance

The potential impacts arising from the construction of the onshore and offshore pipeline relate to ground and seabed disturbance during the installation of the pipelines. The identified impacts are summarised in *Table 8.88*.

Table 8.88 Potential Impacts on Cultural Heritage

Onshore	Offshore
Nature and Type: Direct Negative **Receptor Sensitivity:** Low **Impact Magnitude:** Negligible **Impact Significance (pre-mitigation):** *Not Significant*	**Nature and Type:** Direct Negative **Receptor Sensitivity:** Medium **Impact Magnitude:** Negligible **Impact Significance (pre-mitigation):** *Not Significant*

The worst-case unmitigated impact to cultural heritage assets arising from the construction of the onshore and offshore pipelines is assessed as Negligible. The Negligible impact combined with the Low and Medium sensitivity of the onshore and offshore cultural heritage assets, will result in effects that are ***Not Significant***.

Mitigation and Monitoring

Although the likelihood of encountering buried archaeology during the construction of the onshore and offshore pipelines is Low, there are some industry good practice measures that could be applied to further reduce and prevent potential impacts. The Project will therefore operate a ‘Chance Finds’ procedure (*Table 8.89)*. Additionally an offshore pipeline route survey will be carried out using a Remotely Operated Vehicle (ROV) to identify any cultural heritage assets that may be present on the seabed. Where cultural heritage assets are identified, the pipeline route will be modified to avoid disturbance.

Table 8.89 Mitigation Measures for Cultural Heritage

Management Control	**Responsibility - Organisation**	**Timing**
The Project will develop and operate a Chance Finds procedure in accordance with IFC Performance Standard 8.	EPC	Prior to and during pipeline construction
The scope of the EBS and pre-lay survey (if required), will also include an evaluation of the presence of any sensitive marine archaeology. If identified, the project will either re-route the pipeline (preferred) or implement the Chance Finds Procedure.	EPC	Prior to pipeline construction

Residual Impact

The implementation of the identified mitigation measures will result in residual impacts that are Negligible in magnitude. The residual impacts will therefore remain ***Not Significant*** (see *Table 8.90)*.

Table 8.90 Residual Impact Significance

	Impact Significance
Pre-mitigation: onshore and offshore	*Not Significant*
Post-mitigation: onshore and offshore	*Not Significant*

8.11 WASTE MANAGEMENT

8.11.1 Potential Impacts from Management, Storage and Disposal of Waste

Most types of waste have the potential to cause environmental impacts if not adequately managed or improperly disposed. The scale of the Project means that the quantities of waste that will be generated are also limited, although, because of the nature of some of the wastes, there is still the potential for significant impacts without appropriate management. In addition to the direct impacts of wastes, there will be potential for impacts associated with, for example, waste transportation. The potential impacts associated with the management, storage and disposal of wastes are assessed collectively (i.e. not separated by specific waste streams). This is due in part because 1) mitigation measures used to manage impacts associated with wastes of do not apply to only one waste type, and 2) the project design is not yet fully detailed with regards specific waste volumes and the waste management facilities that will be utilised.

Impact Description

The largest quantity of excavated material arising from the onshore construction activities will be generated from the pipeline trench and from the microtunnelling of the pipeline across the beach and nearshore area.

In general, the material excavated onshore will be backfilled into the trench. Excess material will be spread out and re-profiled along the length of the pipeline route. As such little or no excavated material is likely to be disposed offsite.

In addition to excavated material there will be general construction waste, which will comprise a variety of non-hazardous materials including wood (used timber), excess concrete, vehicle tyres and packaging materials (plastic, card, etc), together with a small amount of hazardous wastes such as used oils (from vehicles and machinery), vehicle batteries, fluorescent light bulbs and contaminated containers (old oil tins, etc.).

General refuse, similar in nature to domestic waste, will be generated by the construction workforce; both at the accommodation camp and at the work sites. This will comprise a range of mainly non-hazardous materials including food, paper, used containers (bottles, cans, etc.) and packaging.

During the production phase, general refuse will be generated by the staff responsible for the operation and maintenance of the facilities. This will comprise general domestic waste (food, packaging, etc) and office waste (mainly paper). The quantities of general waste generated during the production phase will be relatively small because of the small numbers of, mainly maintenance, staff employed.

The inappropriate handling or disposal of waste can give rise to a number of potential health impacts and adverse effects on the environment as follows:

Figure 8.6 Potential Impacts from Poor Waste Handling or Disposal

Offshore (e.g. from the drillship, FPSO and the support vessels):
- marine pollution caused by the deposit of wastes at sea e.g. plastics, food waste, sewage.

Onshore e.g. waste generated at the supply base and waste generated offshore that is shipped to the supply base via the PSVs, and waste arising from the construction and operation of the onshore gas pipeline and the CVS:
- lighter fractions such as paper are prone to being blown by the wind, potentially causing a litter nuisance over a wide area;
- food waste attracts vermin and other disease carriers;
- gaseous emissions, either direct or from uncontrolled burning of combustible items, can be potentially toxic and/or create nuisance due to odours;
- pollution of water courses/drinking water supplies either directly by waste materials or from degradation products;
- health impacts through direct contact with toxic components or uptake through the food chain (e.g. heavy metals, or organic compounds); and
- excavated material can be prone to being blown by the wind, potentially causing a soiling nuisance and smothering crops close to the project.

The impacts of many materials classified as hazardous wastes are similar to those of general refuse, except that the effects are often more severe or more immediate. Oily wastes, for example, have the potential for pollution of land and water (marine and freshwater) and the consequences are more serious than pollution by other (non-hazardous) wastes (e.g. food waste).

Other hazardous wastes create very specific health or environmental risks that need to be avoided by ensuring the waste is appropriately isolated from the environment and treated/disposed to remove the hazard. Examples of such wastes include acids (e.g. from vehicle batteries), and some organic wastes that are toxic.

Potentially hazardous medical waste may also arise from the first aid and medical facilities on the Drill Ship and PSVs and at the supply base. Typically this waste will comprise syringes, soiled bandages (from treatment of minor injuries, etc.), and possibly expired medications. Medical wastes need to be carefully managed to avoid transmission of infectious diseases and to avoid aesthetic nuisance.

Receptor Sensitivity

There are multiple marine-based receptors that could be impacted by the inappropriate management of waste during the offshore operations, each of which have varying levels of sensitivity to environmental impacts. As a reasonable worst-case a Medium resource value has been assigned to the offshore environment.

The Dor Beach is a highly used area for tourism by multiple users. These tourists use the beach area and engage in activities that draw upon businesses and resources of the area.

The nearshore and onshore Dor Beach site will be impacted by Project site works and civil construction activities that will generate waste. During the construction period if waste management is not carried out properly there could be nuisance impacts on these resources with a Medium amenity value.

Impact Significance

Wastes generated offshore may be transported to shore in supply vessels during their routine trips and will not generate additional air emissions, discharges, or other impacts. Solid waste disposal volumes for the drilling and completion program are expected to be negligible relative to the available services and landfill capacity in Israel.

The Project's general philosophy and policies for managing waste, such as adopting the waste hierarchy, are in line with IFC Performance Standard 3 and in accordance with general good practice for management of waste. The approach to waste minimisation and reuse/recycling is demonstrated by the way in which recyclable wastes will be stored separately for subsequent collection by recycling companies.

For wastes that can be safely treated onboard the drillship, with the residues being discharged to sea, this option will be adopted to avoid unnecessary transport of the wastes. All wastes that need to be treated or disposed by third party contractors will be segregated at source, transferred to shore and taken to appropriate, licensed, sites that also meet Energean's expected standards of HSE. Use of such sites will minimise the environmental impacts of the Project's wastes.

The proposals to use a transfer note system for tracking the movement of individual loads of waste and to audit the performance of the waste management system, including third party service providers, is also in line with GIIP and demonstrates Energean's commitment to meet its duty of care with respect to waste management.

The potential impacts arising from inadequate management and improper disposal of wastes are summarised in *Table 8.91*.

Table 8.91 Significance of Impacts from Management, Storage and Disposal of Waste

Offshore	Onshore
Nature and Type: Direct Negative **Receptor Sensitivity:** Medium **Impact Magnitude:** Medium **Impact Significance (pre-mitigation):** *Moderate significance*	**Nature and Type:** Direct Negative **Receptor Sensitivity:** Medium **Impact Magnitude:** Medium **Impact Significance (pre-mitigation):** *Moderate significance*

Mitigation and Monitoring

All waste management activities associated with the Project will be conducted in line with Good International Industry Practice (GIIP) and, in particular, will ensure that all generated waste is disposed in compliance with legal regulations and IFC Performance Standard 3, and General EHS Guidelines.

The waste management policy clearly states that waste will be stored, handled and disposed of in ways that do not harm the environment, people or society. All applicable permits for conducting waste management related activities will be obtained before the start of project activities.

In general, Energean will minimise the impacts of waste generation by applying the waste management hierarchy, a commonly used GIIP model for the regulation and management of wastes [(1)]. In order of preference, the waste hierarchy promotes the following methods for managing waste.

- *Remove* – do not generate waste.
- *Reduce* – generate less waste by better management.
- *Reuse* – reuse waste in its original form.
- *Recycle* – recycle/reprocess the waste.
- *Recover* – extract material or recover energy from waste.
- *Treat* – mitigate any hazards arising from the waste.
- *Dispose* – relocate waste to another location.

(1) Revised Waste Framework Directive (2008/98/EC)

As much waste as possible will be managed by the higher levels of waste hierarchy (Removal through to Recovery), with the need for Treatment and Disposal being avoided wherever practicable. However, it is inevitable that some wastes will require treatment and/or disposal.

Box 8.3 Preparation of a Waste Management Plan

A Waste Management Plan (WMP) will be developed and sent to the Israeli Authorities for comment. The WMP will define how wastes will be reduced, re-used, collected, managed, recycled and disposed of in an appropriate manner and in accordance with good international practice.

The WMP will provide the basis for all the waste management arrangements and act as a central point of reference for how wastes will be managed by the Project. Appropriate disposal routes have already been identified for the whole range of wastes that are likely to be generated by the Project. The WMP will include:

- clear objectives and targets with respect to waste management;
- an analysis of types/quantities of waste that will be produced by the drilling operation and support activities;
- an analysis of potential opportunities to reduce, reuse or recycle waste in accordance with the waste hierarchy (reduction, re-use, recycling, disposal) and a description of how this will be achieved at the Project sites;
- a description of roles, responsibilities and resources to ensure that the objectives and targets are achieved;
- procedures governing the handling, treatment and disposal of all wastes; and
- verification procedures for appropriate assessment of contractors and third-party facilities used for waste transport, management and disposal.

A requirement of the WMP will be a comprehensive waste inventory will be prepared detailing information about the types and quantities of each type of waste generated by the Project as well as statistics regarding the amounts of waste recycled, treated, incinerated and landfilled. This information will be used for the declaration of the hazardous wastes generated and will be submitted to the Israeli authorities on an annual basis.

The WMP will also set out how all potential third party waste or recycling contractors will be evaluated by Energean prior to contract award. As well as requiring that the organisation and/or facility have all the necessary permits and authorisations, Energean will check that it meets acceptable health, safety and environmental standards. This will apply to all waste streams but audits will be focussed on more hazardous wastes.

The opportunities for waste reduction, re-use or recycling will be identified, developed and implemented where practicable and appropriate within the restrictions of the offshore operations. Where waste generation cannot be avoided, appropriate facilities will be provided for the collection and segregation of different waste materials and their safe storage and transport pending treatment or disposal. Audits will be undertaken at planned intervals to assess compliance and to ascertain the effectiveness of the WMP. *Table 8.92* presents an indication of the potential categories of waste that will likely need to be segregated and stored separately.

Table 8.92 Wastes to be Segregated and Stored Separately

Waste Type	Offshore	Onshore	Fate
Inert construction wastes.		✓	Reuse on other construction/on-site roads.

Waste Type	Offshore	Onshore	Fate
Scrap metal – ferrous and non-ferrous.	✓	✓	Recycled.
Timber and other recyclables.		✓	Use elsewhere on the Project, donation to local communities or sale.
General, non-recyclable wastes from accommodation areas and offices.	✓	✓	Combustible wastes generated on the drill ship will be incinerated. Other wastes and wastes from the supply base and onshore construction will be disposed at a licensed landfill.
Specific types of hazardous waste such as: lead-acid batteries; paints; used oils; and oil-contaminated materials (filters, PPE, etc.).	✓	✓	Wastes generated on the drill ship will be incinerated if within the capability of the incinerator. Other wastes will be shipped ashore for treatment/disposal at licensed waste management facilities.

Table 8.93 presents the anticipated management measures for specific waste types. These measures will need to be confirmed within the WMP.

Table 8.93 Anticipated Management of Specific Wastes

Waste Type	Management
Water based mud	The largest volume of waste generated during drilling will be cuttings from the lower well sections. Most of the water based mud will be separated from the cuttings using shale shakers and reused in the drilling process. The separated cuttings will be discharged overboard. The assessment of this discharge on the marine environment is presented in *Section 8.2.4 Potential Impacts from Drilling Waste Discharges*.
Waste oils	Waste oils will be stored separately prior to transfer to the supply base. The onshore transport, treatment and disposal of waste oils will be undertaken by suitably licensed contractors and at appropriately licensed facilities. Used lubricating oils, hydraulic oils and grease will be reused as fuel or incinerated, while oil filters, oily rags and contaminated Personal Protection Equipment (PPE) will be landfilled or incinerated. Any materials used for mopping up or cleaning a minor spill will be incinerated.
Unused chemicals	All unused chemicals will either be retained for future work or returned to the suppliers. If neither of these options is possible, they will be disposed of to a licensed waste management facility. Solid and/or liquid chemical residues will be chemically treated or incinerated at an appropriately licensed waste management facility.
Paint residue	Paint residue (solid or liquid) will be used as fuel (Refuse Derived Fuel [RDF]) or incinerated.
Pipe dope	Pipe dope will be incinerated.
Contaminated metal drums	Contaminated metal drums will be cleaned and recycled.
Fluorescent tubes/ lamps	Fluorescent tubes/ lamps will be treated at an appropriately licensed waste management facility.
Used batteries	Used batteries will be returned to the supplier for recycling. Small batteries will be recycled in accordance with Israeli regulations.
Incinerator ash	Incinerator ash from the Drill Ship's incinerator will be disposed of in a Class I landfill.
Recyclable wastes	Recyclable wastes including scrap metal, plastic, wood, packaging (paper and cardboard), drinks containers (cans and small plastic bottles) and glass will be transferred to shore, cleaned (if required) and recycled by a licensed contractor.
Electrical wastes	Electrical wastes will be stored separately from other wastes and will be transported to a licensed waste management facility.

Waste Type	Management
Cement	Used cement will be recycled if possible or discharged to sea (if clean). Unused cement will be retained and used for future work or disposed of in a landfill.
Domestic solid waste	Domestic solid waste will be incinerated on-board the Drill Ship, or sent for disposal in a municipal landfill if on-board incineration is not available.
Used edible oil	Used edible oil will be collected and stored separately from other waste oils in line with relevant legislation. Licensed waste contractors will transport the oil from the supply base to suitable waste facilities.
Food waste	Food waste on the Drill Ship and PSVs will be macerated to the point of being able to pass through a 25mm mesh screen and discharged to sea in accordance with the MARPOL requirements. Food waste and other non-hazardous wastes generated at the supply base will be disposed of at local licensed waste management facilities.
Sewage	Sewage generated on the Drill Ship and PSVs will be treated in an on-board treatment system and the treated effluent will be discharged to sea in accordance with the MARPOL requirements. The supply base will be connected to the local municipal sewer and sewage will be treated at the local wastewater treatment plant.
Medical wastes	Medical wastes will be stored in dedicated medical waste bags and will not be mixed with other wastes. These will be periodically transferred to a licenced medical waste disposal facility in line with relevant legislation.

In addition to the waste management measures set out in the WMP, the project will implement the mitigation presented in *Table 8.94*. Energean will be ultimately responsible for requiring the implementation of these measures as the field operator.

Table 8.94 Mitigation Measures for the Management of Waste

Management Control	Responsibility - Organisation	Timing
On-board the drillship, waste materials that can be incinerated on board will be kept separate from wastes that need to be returned to shore for recycling, treatment or disposal. To comply with Israeli law and to maximise the potential for reuse and recycling of waste materials, and to ensure proper disposal of other wastes, strict segregation of different waste materials will be practised. Specifically, *Table 8.92* presents the categories of waste that will be segregated and stored separately.	Drillship and PSV operator	Embedded Mitigation
Waste storage areas will be designated on the drillship in areas isolated from other operations. Waste containers will be stored in these areas prior to processing or shipment to the contract waste management vendor.	Drillship and PSV operator	Embedded Mitigation
All waste materials will be stored properly in containers that are non-leaking and compatible with the waste being stored. All containers will have their lids, rings, covers, bungs, and other means of closure properly installed at all times except when waste is being added or removed.	Drillship and PSV operator	During drilling

Management Control	Responsibility - Organisation	Timing
Information from the transfer notes will be collated on a Project Waste Tracker to enable a comprehensive waste inventory to be prepared detailing information about the types and quantities of each type of waste generated by the Project as well as statistics regarding the amounts of waste recycled, treated, incinerated and landfilled. This information will be used for the declaration of the hazardous wastes generated and will be submitted to the Israeli authorities on an annual basis.	Drillship and PSV operator, and EPC contractor	Embedded Mitigation
A Waste Management Plan (WMP) will be developed and sent to the Israeli Authorities for comment. The WMP will define how wastes will be reduced, re-used, collected, managed, recycled and disposed of in an appropriate manner and in accordance with good international practice. At a minimum, the WMP will include the elements presented in *Box 8.3.*	Energean/EPC	Prior to pipeline construction
In accordance with Energean's general philosophy for managing wastes, waste generation will be avoided as far as is practicable, and as much waste as possible, will be reused and recycled to reduce the amount of waste that needs to be treated and/or disposed.	Drillship and PSV operator	During pipeline construction and production
Implement the Waste Management Plan	Energean, EPC	During drilling, installation, pipeline construction, pipeline commissioning, and production
Verify that the Waste Management Plan is being correctly implemented.	Energean	During drilling, installation, pipeline construction, pipeline commissioning
Waste collection points will be provided on board the drill ship, other project vessels and at the onshore construction worksites, and these will be clearly marked to ensure segregation of different types of waste. Waste will be removed from work areas at regular intervals and will not be allowed to accumulate in undesignated areas.	Drill Ship and vessel operators	During drilling, pipeline construction and production
A dedicated area will be created at the supply base and onshore construction areas for the storage of segregated wastes prior to their transfer to recycling, incineration or landfill facilities.	Drill Ship and PSV operator, and EPC contractor	Prior to pipeline construction
A waste tracking system will be used to monitor the transfer of all consignments of project waste. The transfer notes will be used to record movements of hazardous waste. All transfers of waste, from the point of arising through to the final disposal point, will be documented using this system. Each individual load of waste will have a waste transfer note that will detail the source, type and quantity of waste as well as the date of transport, the carrier being used to transport the waste, and the final destination. Use of the form will provide confirmation that each load of waste has reached the intended storage, treatment or disposal facility.	Drillship and PSV operator, and EPC contractor	Prior to drilling or pipeline construction

Management Control	Responsibility - Organisation	Timing
Any organisations contracted to transport, manage or dispose of waste, and any facility used for the processing, storage or disposal of waste, will only be used if it has all the necessary permits and authorisations. All permits and authorisations will be checked by Energean before using any waste management facility. Regular audits will be undertaken of on-site waste management practices as well as of third party waste management contractors to ensure that all practices are in compliance with the WMP and in line with Energean's expectations. Any inappropriate practices will be identified and steps will be taken to rectify them and avoid their reoccurrence.	Energean	Prior to drilling or pipeline construction

Residual Impact

Assuming that the different wastes are segregated, stored, transported and treated/disposed in accordance with the Israeli legal requirements, MARPOL requirements and Energean's general policies, then the impacts from the waste generated by the Project are assessed as ***Not Significant***. (See *Table 8.95*).

Table 8.95 Residual Impact Significance

	Impact Significance
Pre-mitigation: waste management	*Moderate*
Post-mitigation: waste management	*Not Significant*

8.12 UNPLANNED EVENTS

8.12.1 Overview

Based on the Project activities, the potential unplanned events that are considered to have the highest potential risks to the Project in the onshore and offshore environments during the construction and production phases are shown in *Table 8.96*.

Table 8.96 Sources of Potential Unplanned Events

Project Phase	Project Component	Activity
Drilling, Pipeline Construction, Commissioning	Onshore	x Small scale spill from construction activities x Damage to other gas pipelines x Damage to telecommunications cables x Traffic collision
	Offshore	x Vessel fuel tank ruptures from collision x Loss of well control/well blowout x Damage to other gas pipelines
Production	Onshore	x Leak from pipeline

Project Phase	Project Component	Activity
	Offshore	x Leak from pipeline x Supply vessel fuel tank rupture from collision x Spill resulting from collision between tanker and FPSO x Non-routine flaring of natural gas x Loss of well control/well blowout x Offshore vessels traffic collision

Potential impacts from these events are described in detail in the following section. These potential impacts have been classified using the risk-based impact assessment methodology for unplanned events included in *Section 5: Methodology*. Note that this methodology is different than that applied to potential impacts from planned activities, as the assessment of potential impacts from unplanned events must consider likelihood as well. Because a risk-based assessment methodology has been used, worst case scenarios have been considered.

Some of the separate activities identified in *Table 8.96* have been combined into a single worst-case activity for assessment purposes. For example the scenario that has been assessed for loss of well control/well blowout during both the construction and production phases is a continuous 90 day release of 6,720 bbls/day.

A summary of potential Project-related hazards, contributing causes, and consequences for the Project workforce, nearby communities and/or surrounding environment are summarised in *Table 8.97*. This table also provides a risk ranking for each potential impact pre-implementation of Project embedded controls.

Table 8.97 Potential Impacts from Unplanned Events and Pre-Mitigation Risk Ranking

No.	Hazard	Cause	Consequence[1]	Risk Ranking Pre-mitigation
1a	Small scale spill from onshore construction activities	Corrosion, dropped objects, overpressure, over temperature or other damage to storage vessels; failure to secure valves.	**Communities** –Based on the liquid fuel storage volumes the potential exists for exposure to contaminated water or soil and resulting in long term effects on surrounding communities utilising groundwater resources if a spill is not contained.	3C (Moderate)
1b			**Environment** - Based on the liquid fuel storage volumes potential for loss of containment of oil/chemicals into ground of surrounding area, including nearby surface water resources resulting in localised, potentially long term, degradation.	3C (Moderate)
2a	Damage to other onshore gas pipelines	Corrosion or damage to pipeline resulting from construction activities	**Communities -** Unignited gas release leading to risk of suffocation to nearby community receptors and leading to potential fatalities or ignited gas release leading to jet/flash fires or explosions.	2D (Moderate)
2b			**Environment –** Release of natural gas to atmosphere	2B (Minor)
3a	Damage to onshore telecommunication cables	Corrosion or damage to telecommunication cables resulting from construction activities	**Communities –** Loss of telecommunications networks..	2A (Negligible)
4a	Road traffic transporting personnel or materials involved in a collision	Wet / dark conditions, driver distraction, fatigue, other dangerous drivers, variable road conditions; rural areas with pedestrian road users	**Communities** – Traffic accidents that involve community members, resulting in injury or fatality. Accidents may require use of local medical emergency services in the Project area and could temporarily decrease access to these services for local residents.	2E (Major)
4b		As 4a above with livestock in the road	**Community** - Traffic accident with livestock leading to death of livestock and loss/reduction in community member's livelihood.	2B (Minor)
5a	Offshore vessel fuel tank ruptures from collision	Multiple causes possible e.g. adverse weather conditions leading to loss of vessel control resulting in collision with another vessel.	**Environment –** Release of oil affects fisheries, marine mammals and protected areas.	2D (Moderate)
5b			**Communities –** Release of oil reaches shoreline and affects recreation and tourist facilities. Fishery resources are affected resulting in reduced catch for fishermen.	2D (Moderate)
6a	Loss of well control/well blowout during construction	Multiple causes possible e.g. excessive pressure in well, damage to well head and/or riser during installation.	**Environment –** Release of oil affects fisheries, marine mammals and protected areas.	2D (Moderate)
6b			**Communities –** Release of oil reaches shoreline and affects recreation and tourist facilities. Fishery resources are affected resulting in reduced catch for fishermen.	2D (Moderate)
7	Damage to other offshore gas pipelines during construction		**Environment –** Release of natural gas to marine environment and atmosphere	2B (Minor)

No.	Hazard	Cause	Consequence[1]	Risk Ranking
8a	Leak from onshore gas pipeline during production	Corrosion or damage to pipeline resulting from poor installation/maintenance.	**Communities -** Unignited gas release leading to risk of suffocation to nearby community receptors and leading to potential fatalities or ignited gas release leading to jet/flash fires or explosions.	2D (Moderate)
8b			**Environment –** Release of natural gas to atmosphere	2A (Negligible)
9	Leak from offshore gas pipeline during production	Corrosion or damage to pipeline resulting from poor installation/maintenance, damage caused by vessel keels and/or anchor drag.	**Environment –** Release of natural gas to marine environment and atmosphere	2C (Moderate)
10a	Offshore supply vessel fuel tank rupture from collision	Multiple causes possible e.g. adverse weather conditions leading to loss of vessel control leading to collision with another vessel. The weather conditions then allow a mass of oil to disperse from the source and reach the shoreline.	**Environment –** Release of oil affects fisheries, marine mammals and protected areas.	2D (Moderate)
10b			**Communities –** Release of oil reaches shoreline and affects recreation and tourist facilities. Fishery resources are affected resulting in reduced catch for fishermen.	2D (Moderate)
11a	Offshore spill resulting from collision between supply tanker and FPSO	Multiple causes possible e.g. adverse weather conditions leading to loss of vessel control resulting in collision with another vessel.	**Environment –** Release of oil affects fisheries, marine mammals and protected areas.	2D (Moderate)
11b			**Communities –** Release of oil reaches shoreline and affects recreation and tourist facilities. Fishery resources are affected resulting in reduced catch for fishermen.	2D (Moderate)
12	Non routine flaring of natural gas during production		**Environment –** Release of combustion pollutants to atmosphere	4B (Minor)
13a	Loss of well control/well blowout during production	Multiple causes possible e.g. excessive pressure in well, damage to well head and/or riser during installation.	**Environment –** Release of oil affects fisheries, marine mammals and protected areas.	2D (Moderate)
13b			**Communities –** Release of oil reaches shoreline and affects recreation and tourist facilities. Fishery resources are affected resulting in reduced catch for fishermen.	2D (Moderate)
14	Offshore vessel traffic transporting personnel or materials involved in a collision.	Dark/poor visibility conditions, driver distraction, fatigue, other dangerous drivers, poor sea conditions; fishing areas with small fishing vessels.	**Communities** – Traffic accidents that involve community members, resulting in injury or fatality. Accidents may require use of local medical emergency services in the Project area and could temporarily decrease access to these services for local residents.	2D (Moderate)

No.	Hazard	Cause	Consequence[1]	Risk Ranking
15	Accident and resulting injury from unsafe conditions at construction sites	Inadequate H&S standards or implementation; movement of heavy machinery; inadequate signage and fencing and unsecured sites (where community members could access)	**Communities –** Construction site accidents involving community members could occur if sites are unsecured. Accidents may require use of local medical emergency services in the Project area and could temporarily decrease access to these services for local residents.	4C (Moderate)

Notes:

(1) 'Communities' refers to all individuals not directly or indirectly employed by the Project but living and/or working in proximity to Project infrastructure or areas of Project activity such that they are at risk of potential impacts from a Project-related unplanned event

In order to reduce Project risk from the key potential unplanned events, the standard mitigation hierarchy should be applied. For the purposes of this assessment mitigation measures are discussed in the following sections where the pre-mitigation significance of the unplanned event is greater than ***Minor***.

Unlike impacts from planned activities, mitigation of unplanned events should consider both pre-event preventative actions (that reduce the likelihood of the cause of the potential impact) and post-event mitigation that reduces the magnitude of the consequence.

8.12.2 *Potential Impacts from Unplanned Events 1a, 1b, 2a, 8a, 4a, 14, and 15)*

Impact Significance

The likely significance of the identified unplanned events is provided in *Table 8.97*.

Mitigation and Monitoring

All preventative and mitigation measures proposed to reduce the likelihood and severity of accidental onshore spills are summarised in *Table 8.98*.

Table 8.98 Preventative and Mitigation Measures for Accidental Onshore Spills (1a and 1b)

Management Control	**Responsibility - Organisation**	**Timing**
Design the site to include good site management practices to ensure that the products are properly stored on site (e.g. secondary containment, double walled tanks, over filling alarm system, etc.).	EPC	Embedded Mitigation
Develop Emergency Response Plan for construction activities.	EPC	Prior to pipeline construction and drilling
Review EPC Emergency Response Plan for construction activities.	Energean	
Implement EPC Emergency Response Plan. Maintain internal audit records of how the Plan is being implemented.	EPC	During pipeline construction and drilling

All preventative and mitigation measures proposed to prevent an accident from occurring and to protect community safety and the environment from pipeline ruptures are provided in *Table 8.99.*

Table 8.99 Preventative and Mitigation Measures for Pipeline Rupture *(2a and 8a)*

Management Control	**Responsibility - Organisation**	**Timing**
Ensure the buried pipeline is indicated on site with marks or plots and that people working nearby are aware of the pipeline route	EPC	Embedded Mitigation
For aboveground section of the pipeline, ensure access to the pipeline is restricted (e.g. barriers, plots)	EPC	Embedded Mitigation

Management Control	Responsibility - Organisation	Timing
Implement EPC Emergency Response Plan. Maintain internal audit records of how the Plan is being implemented.	EPC and Energean	During pipeline construction, drilling, commissioning and production
Monitor and supervise the EPC contractor to ensure that the Emergency Response Plan is implemented in line with the Project's requirements. It is recommended to formalise and centralise communication through a local Community Liaison Officer to ensure that key stakeholders (including affected communities but also relevant authorities) will be provided with appropriate information communicating the nature and extent of any potential incidents that could arise and procedures to be followed in the case of an unplanned accident or emergency.	Energean	During pipeline construction, drilling, commissioning

All preventative and mitigation measures proposed to reduce the likelihood and severity of traffic accidents are summarised in *Table 8.100.*

Table 8.100 Preventative and Mitigation Measures for Traffic Accidents *(4a and 14)*

Management Control	Responsibility - Organisation	Timing
Develop a Traffic Management Plan for construction that includes: x an Emergency Procedure, taking into account potential impacts on local communities and measures needed to ensure the safety and security of individuals in this regard; x provision of a traffic plan for heavy equipment/major items during construction by the EPC contractor to be made available to concerned stakeholders; x provision of a traffic access map to send to all contractors and suppliers involved in the construction phase; x restricting the speed of construction vehicles; x consideration of the reduction of heavy goods vehicles during the morning, afternoon and evening peak/rush hour times; x provision of sufficient advanced notice of all traffic diversions and road closures, together with details of whom to contact at the construction site in the case of complaints; x clear signing of all diversions; x requirements for driver behaviours, competency and training (i.e. they don't just have to have a drivers licence); x vehicle specifications to include safety controls such as reversing alarms and use of a spotter when reversing a heavy vehicle with large blind spots; x regular vehicle maintenance; and x If the transportation of material will be by boat the Traffic Management Plan should include avoidance measures for fishing areas.	EPC	Prior to pipeline construction

Management Control	Responsibility - Organisation	Timing
Prior to onshore construction, review the EPC Traffic Management Plan to ensure that requirements and procedures are adequately addressed by the EPC contractor. Integrate the Traffic Management Plan related activities as part of the Project's Stakeholder Engagement Plan (SEP) to ensure that relevant stakeholders are adequately engaged. It is recommended to formalise and centralise communication through a Community Liaison Officer. As part of the Project SEP implement a grievance mechanism that will be communicated to relevant stakeholders so that to collect and address as required grievances in line with IFC PS and with Israeli law.	Energean	
Implement the Traffic Management Plan. Maintain internal audit records of how the Plan is being implemented.	EPC	During pipeline construction
Monitor and supervise the EPC contractor to ensure that the Traffic Management Plan is implemented in line with the Project's requirements. It is recommended to formalise and centralise communication through a local Community Liaison Officer to ensure that key stakeholder (including affected communities but also relevant authorities) will be provided with appropriate information communicating the nature and extent of any potential incidents that could arise and procedures to be followed in the case of an unplanned accident or emergency.	Energean	

Measures to protect worker safety are managed outside the scope of the ESIA; however there is a risk that if community members gain access to Project areas, accidents could result in injury to community members.

The most effective way to manage these potential impacts is to restrict access to the Project sites. All preventative and mitigation measures proposed to prevent accidents from occurring and to protect community safety from such accidents are provided in *Table 8.101.*

Table 8.101 Preventative and Mitigation Measures for On-site Accidents (15)

Management Control	Responsibility - Organisation	Timing
Develop Site Security Plan	EPC	Prior to pipeline construction
Review Site Security Plan	Energean	
If existing port facilities will be used, review the port's security access measures and confirm that access is restricted.	Energean	

Management Control	Responsibility - Organisation	Timing
Implement Site Security Plan. This should include measures such as: x secure the Project site, including the lay-down area, with a permanent fence at an early stage of construction; x employ security guards to patrol the site and control access on a 24 hour/7 day basis to restrict access to community members. Security will serve to prevent theft and damage of equipment on-site and to avoid potential injury to community members; and x require all personnel to display personal identification and all visitors will be required to sign in to prevent unauthorised access.	EPC	During pipeline construction
Monitor and supervise EPC contractor's security measures (implementation of Site Security Plan)	Energean	
Maintain internal audit records of how the Plan is being implemented.	Energean	During production

In the event of an accident at a Project site resulting in a community member(s) being injured, the Project will contact local emergency services to provide medical support.

Residual Impacts

Because the majority of the mitigation presented is preventative, the primary goal of these measures is to reduce the likelihood of the unplanned event from occurring. However, if these unplanned events occur, ***Moderate*** and ***Major*** impacts could still occur. In these cases, the post-event measures described in the previous section would apply to minimise impacts. See *Table 8.97* for the pre- and post-mitigation ratings of the specific unplanned events.

8.12.3 *Potential Impacts from Offshore Vessel Fuel Tank Rupture, FPSO Rupture and Well Blowout (5a, 5b, 6a, 6b, 10a, 10b, 11a, 11b, 13a and 13b, 15)*

Impact Significance

To characterise the potential impacts, oil spill modelling was conducted for a number of potential spill scenarios:

- ***Scenario 1.*** Continuous 90 day release of 6,700 bbls/day as a result of Karish Well blowout for winter, spring, summer and autumn.
- ***Scenario 2.*** Phased release of 500,000 bbls because of a FPSO tank rupture for winter, spring, summer and autumn.
- ***Scenario 3.*** Instantaneous release (5 hours) of 25,000 bbls because of a FPSO tank rupture for summer only.

The detailed Oil Spill Modelling Report is included in *Annex F*, and the predicted impacts on the shoreline and sea surface are summarised below. It should be noted that the results of the oil spill modelling to not predict likely oil spills, but rather the worst case scenarios that could occur. The model results do not take credit for any mitigation (e.g. spill intervention or application of dispersants).

Shoreline impact: Light shoreline oiling along the coastline of Israel and Lebanon could occur following a well blowout from the Karish Tanin Well. Oil released during the larger FPSO rupture is most likely to result in shoreline oiling, and this oiling will be heaviest during the summer season. Lebanon is the country most likely to be affected by shoreline oiling, although Israel receives some heavy oiling during the tank rupture and Cyprus is impacted by light oiling.

Oil is likely to reach the shoreline quicker during the Tank Rupture than the Well Blowout. The coastline of Lebanon could see shoreline oiling within 5 days because of the larger Tank Rupture scenario; within 8 days because of the smaller Tank Rupture scenario, and within 9 days because of the Well Blowout scenario.

Only the larger FPSO Tank Rupture scenario resulted in heavy shoreline oiling (using ITOPF's recognition of shoreline oiling). This was recorded in Spring (6%), Summer (20%) and Autumn (16%). Most of the simulations resulted in no significant impact for both the Well Blowout scenario; with the highest percentage of oiling being light oiling which accounted for 177 out of 303 (58%) of simulations during the Well Blowout summer scenario, and the smaller Tank Rupture scenario. In this scenario, the highest percentage of oiling was light oiling (68 of 303 scenarios or 22%) although most of the scenarios results in no significant impact.

Surface impact: During the Well Blowout, metallic oil is likely to reach~64 km north of the well, with sheen oil reaching up to ~330 km north. During the larger FPSO Tank Rupture, metallic oil could reach ~280km north east, with sheen oil reaching ~184 km north east. The smaller FPSO Tank Rupture shows sheen oil reaching ~393 km north of the FPSO and metallic oil reaching ~200 km north east of the FPSO. Oil of a discontinuous true colour thickness (50-200ìm) is unlikely to reach the shore in any of the scenarios.

The waters of several countries are potentially affected by both scenarios, although the two that are impacted by every scenario are Lebanon and Cyprus.

It should be noted that Scenario 1 (Well Blowout), and scenario 2 (500,000 bbls released from an FPSO tank rupture) represent highly unlikely worst-case scenarios. Whereas scenario 3 (25,000 bbls released from an FPSO tank rupture) is more indicative of a reasonable worst-case. Furthermore, the oil spill modelling in this report does not include any response techniques. When used appropriately, response techniques would reduce the scale and severity of the impact to the environment.

Because of both the worst-case nature of the scenarios and the fact that no response techniques are simulated, the actual impact to surface waters and shoreline is almost certainly going to be less severe than that identified through modelling. These modelling scenarios have been devised with the intent of providing information so that that the merits of different response techniques and strategies can be assessed. Determining the most appropriate response strategy is a complex decision-making process. The advantages and disadvantages of each response strategy should be considered in relation to not responding [1]. Considerations must be made for the type of oil spilled, the prevailing environmental conditions and the location of the spill.

To demonstrate the effectiveness of a response technique, a response simulation has been undertaken. The chosen scenario is the summer scenario from the FPSO tanker spill. The worst-case scenario that resulted in 4,700 MT of oil reaching the shoreline was re-run, and this became the benchmark for the response strategy modelling.

The model then simulated how effective a vessel equipped with a dispersant system would be and used shoreline impact as a measure of success.

This simulation has been carried out for guidance purposes only, and is not intended for use in planning a response. For example, the modelling has assumed that this oil is amenable to dispersant application, which would need to be checked before considering a dispersant strategy. The model has also not restricted where dispersant can be applied whereas dispersant is unlikely to be a viable strategy as the oil slick approaches the shore.

The figure below shows an idealised result of a response vessel armed with a dispersant spray system. It shows that the impact to the shore could be reduced by approximately 15% if a dispersant system is mobilised.

This is just one example of the effectiveness of a response strategy. Whilst response strategies will not be 100% effective, regardless of the number of assets, they do reduce the impact of a spill on the local environment.

Mitigation and Monitoring

Oil Spill Prevention: Energean has designed the project facilities with a range of inherent measures designed to minimise the risk of potential of oil spills. Oil spill prevention measures that will be implemented, as part of the Project design, will include the measures presented in *Table 8.102*.

Table 8.102 Embedded Mitigation Measures for all Offshore Oil Spill Scenarios

Management Control	Responsibility - Organisation	Timing
Blow-Out Preventers (BOPs) will be permanently installed on the subsea wells during well completions, and a double mechanical barrier system will be used during production and injection operations using the subsea 'Christmas trees' and other barriers.	EPC	Embedded Mitigation
A system of wells, subsea flowlines, risers, emergency shutdown systems and FPSO topsides will be designed and operated to international process codes and with alarm and shutdown systems to maintain the system within its design criteria at all times. The system will be tested, inspected and maintained to meet performance standards.	EPC	Embedded Mitigation
The FPSO deck and drainage system will be designed to contain spills (as well as leaks and contaminated wash-down water) to minimise the potential for overboard release.	EPC	Embedded Mitigation

(1) http://www.oilspillresponseproject.org

Management Control	Responsibility - Organisation	Timing
Specific procedures will be developed for offloading crude onto the export tankers. These will include vetting of tankers involved in offloading, management of offloading activities by trained and experienced personnel, the use of a quality marine fleet to undertake the operation of hose handling and tanker movements (including contingencies for any engine failures), and the continuous monitoring and actions to be taken in the event of any non-routine events or equipment failures.	Energean	Embedded Mitigation

Spill Preparedness and Response: Despite the prevention measures and management procedures built into the design of the Project there is always a risk that an oil spill can occur. In response to such as event Energean will put in place the fundamental components of preparedness and response, including an Oil Spill Contingency Plan (OSCP), which will set out the strategy and procedures that will be taken in the event of an oil spill.

The OSCP is based on a tiered response approach. The approach involves categorising potential oil spills as Tier 1, 2 or 3 incidents in terms of their potential severity and the capabilities that need to be in place to respond. This approach is aligned with the International Petroleum Industry Environmental Conservation Association (IPIECA) guidance, which advocates a response to oil spills such that the planned response engages resources commensurate with the severity of the spill, with the higher the Tier, the higher the collateral response required. *Figure 8.7* provides indicative conditions for the establishment of different tiers of response. *Figure 8.8* illustrates the full definition of tiered preparedness and response showing the influence of factors.

Figure 8.7 Conditions for the Establishment of a Tiered Response

CHARACTERISTICS OF A TIER 1 OIL SPILL
x The spill is less than 100 bbls
x The spill does not affect sensitive areas
x There is no threat to the coastal ecosystem
x The response will be immediate
x There is no danger of an oil slick crossing maritime boundaries
x The response is monitoring

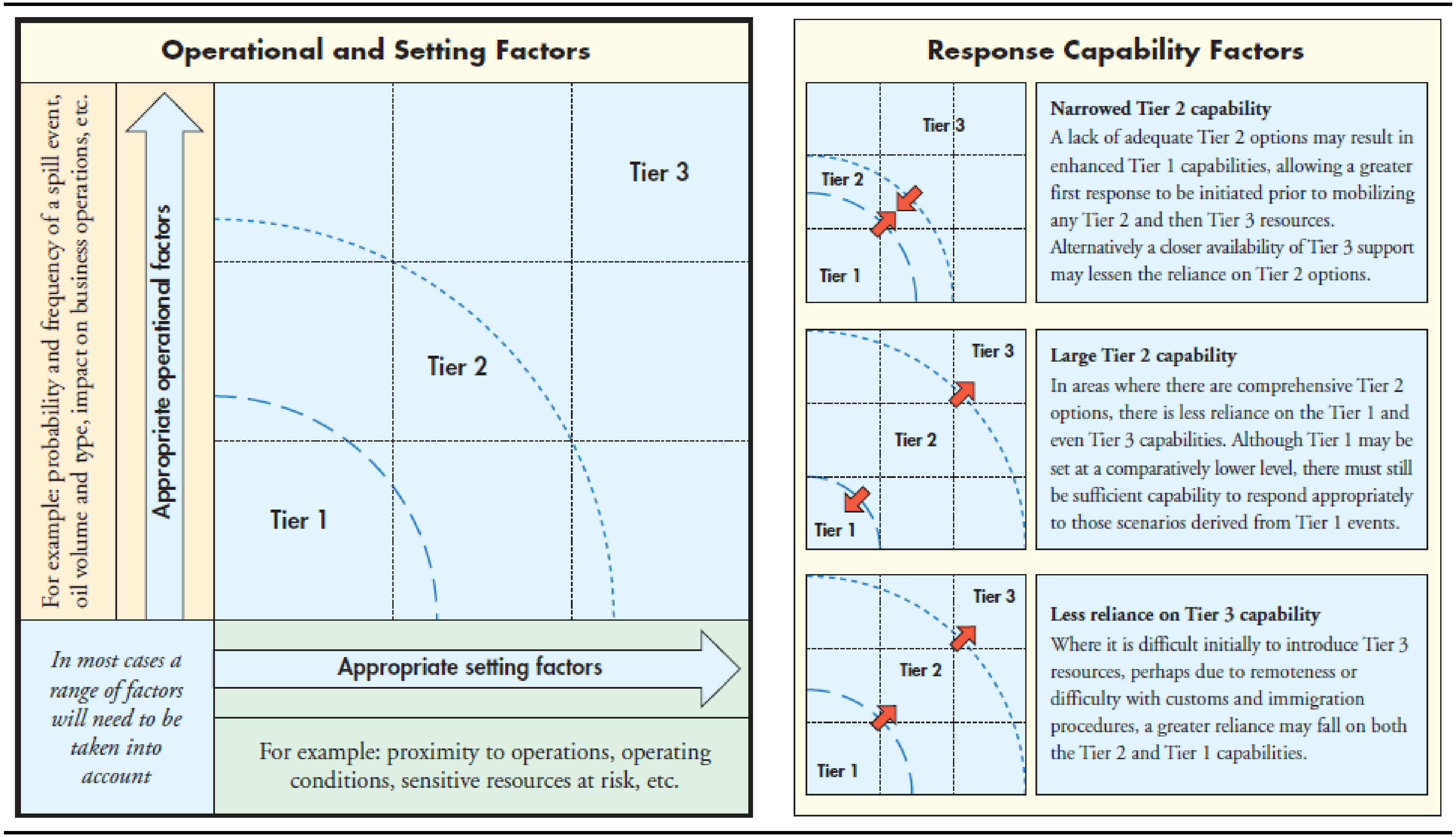
CHARACTERISTICS OF A TIER 2 OIL SPILL
x The spill is between 100 and 1,000 bbl
x There is a possibility of significant pollution
x Tier 1 resources are insufficient
x Alterations are expected to normal operations
x There is continued leakage
x The oil is migrating across maritime boundaries
x Active response strategies are needed
x The oil needs to be isolated

CHARACTERISTICS OF A TIER 3 OIL SPILL
x The spill is more than 1,000 bbl
x There is coastal impact or is imminent
x The incident involved a catastrophic spill
x Tier 2 resources are insufficient
x Sensitive area were affected or are about to be
x The oil is migrating across maritime boundaries
x Intervention is necessary

To provide context, all three oil spill scenarios modelled for the Project would be characterised as Tier 3 oil spills.

The definition of oil spills are based on operational factors (e.g. probability and frequency of a spill event, oil volume and type), setting factors (e.g. proximity to operations, sensitive resources) and response capability factors (i.e. adequate resources/capacity to respond).

Figure 8.8 Definition of Tiered Preparedness and Response



Source: IPIECA 2007

Oil Spill Preparedness: Energean's oil spill preparedness is based on a number of key elements that are consistent across all tiers of capability and includes the measures in *Table 8.103*.

Table 8.103 Preparedness and Response Mitigation Measures for all Offshore Oil Spill Scenarios

Management Control	Responsibility - Organisation	Timing
Energean shall develop an Oil Spill Contingency Plan (OSCP) that covers its current offshore and onshore operations using the three tiers described previously. The OSCP will define the following components: x key personnel, roles and responsibilities; x internal and external notification procedures; x the processes for managing the integration of local, regional, national and international resources; x response strategies and control procedures; and x internal and external resources.	Energean	Before drilling and pipeline construction
On-site oil spill response equipment for small to medium sized spills will be available at the FPSO and at the onshore construction areas at all times.	Energean	Before drilling and pipeline construction
Staff trained staff in oil spill response measures for Tier 1 - 3 will be present on-site (offshore and onshore).	Energean	Before drilling and pipeline construction
Implement a programme of simulation exercises to test the different aspects of oil spill response preparedness to build familiarity and promote competence.	Energean	Before drilling and pipeline construction

The OSCP will comprise a number of sub-plans including action plans for offshore and onshore spills, a WMP, response resources, and a risk and regulatory review. The OSCP may be complemented by Site Specific Mobilisation Plans that provide guidance for the deployment of shore protection resources if there is a probability of shoreline oiling.

Energean will establish and maintain an on-going programme to train relevant personnel in oil spill response. The programme will include training on oil spill preparedness and response and periodic oil spill preparedness exercises.

The oil spill preparedness and response training will include:

- x oil spill monitoring;
- x notification procedures;
- x strategic solutions;
- x safe and effective use of dispersants;
- x safe and effective use of offshore booms and ancillaries;
- x mobilisation and deployment of onshore booms and ancillaries;
- x onshore site management; and
- x waste management.

Energean will conduct oil spill response exercises and drills on a regular basis to improve and maintain the skills of staff. The different types of exercise that will be undertaken include:

- x OSCP orientation workshops;

communications drills;
- desktop exercises;
- equipment deployment drills; and
- full-scale incident management exercises.

Response Resources: Response resources will depend on the tier level of the spill. Spill response resources are outlined below.

- **Tier 1 Resources.** Energean has access to a range of spill response equipment to respond to oil spill incidents. In addition, Energean will employ the services of an in country oil spill response contractor. Offshore resources are located mainly on the support vessels and include oil containment and recovery equipment as well as dispersant spraying systems. Additional dispersant spraying systems are located on other vessels supporting the FPSO. Onshore resources include containment and recovery equipment, ground clearing equipment and additional stock of dispersant.

- **Tier 2 Resources.** In addition to Tier 1 resources, Energean, through its membership of Oil Spill Response Limited (OSRL), has access to resources that are capable of responding to a Tier 2 spill. OSRL is an oil spill response contractor based in Southampton, UK. A Tier 2 response service can be delivered from any of one, or a combination of, three OSRL response bases in the UK, Bahrain or Singapore.

- **Tier 3 Resources.** A Tier 3 response service can be delivered from any of one, or a combination of, three OSRL response bases in the UK, Bahrain or Singapore. Singapore and the UK have dedicated aircraft and hold equipment in commercial aircraft compatible pallets. OSRL will provide technical advice to Energean on the most appropriate spill response equipment for the specific incident. This equipment would be transported by cargo aircraft to Israel and then to the site. The Israeli national statutory agency would have overall responsibility for formulating the response strategies to combat a Tier 3 incident. To support response and clean-up of wildlife, Energean would mobilise the oiled wildlife response group, Sea Alarm, through its membership with OSRL.

Residual Impacts

Because the majority of the mitigation presented is preventative, the primary goal of these measures is to reduce the likelihood of the unplanned event from occurring. However, if these unplanned events occur, ***Moderate*** impacts could still occur. In these cases, the post-event measures described in the previous section would apply to minimise impacts. See *Table 8.97* for the pre- and post-mitigation ratings of the specific unplanned events.

8.13 CUMULATIVE EFFECTS

8.13.1 ***Overview***

Cumulative impacts are those that arise as a result of an impact of the Project when added to impacts from other projects or developments. Cumulative impacts may have the potential to arise during any stage of the Project.

The Area of Influence as regards cumulative impacts as defined under IFC PS 1 encompasses:

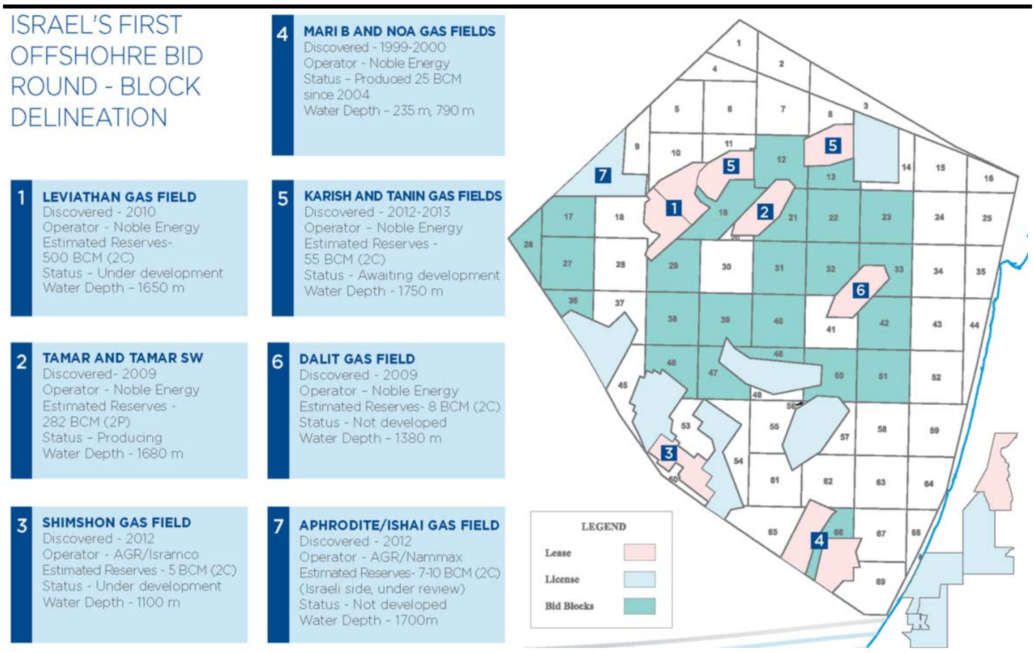
> *"…cumulative impacts that result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted. Cumulative impacts are limited to those impacts generally recognized as important on the basis of scientific concerns and/or concerns from Affected Communities"*.

The process for assessing how cumulative impacts from other projects have been assessed as part of this ESIA is provided in *Annex A.*

This section defines the planned and reasonably defined developments in the vicinity of the Project. If the Project is able to interact with these developments, either temporally and/or spatially, there is the potential for a cumulative impact to occur. Information has been obtained from the Project studies and environmental and social assessment, and from a desktop review of published Israeli Government documentation, and open literature.

The primary types of activities with which the project could have cumulative effects would be from other oil and gas activities in the region (i.e. within the Levant Basin). The Israeli government has produced a summary of the status of oil and gas exploration and development in Israeli waters, including the EEZ, as shown in *Figure 8.9*. There are ten production leases and several active exploration licences offshore Israel. Further details of these licence areas are provided in *Table 8.104*.

Figure 8.9 Status of Exploration and Development in Israel's First Offshore Bid Round



Source: http://energy.gov.il/subjects/oilsearch/documents/israeli%20gas%20opportunitties.pdf

Table 8.104 Summary of Offshore Developments in the Levant Basin

Development Name	Developer or Operator	Description	Development Phase
Tamar Field (and Tamar SW)	Noble Energy with Delek, Avner, Isramco and Alon	x Discovered in January 2009 and online in 2013. x 10Tcf and deliverability of over 1.1 Bcf/d onshore. Includes a 150km tieback to Tamar Platform located on Mari-B. x Generates more than half of Israel's electricity.	Operational
Mari-B and Noa	Noble Energy and partners (Delek)	x Discovered field in 2000 and contains about 2Tcf gas. x Gas to mainland Israel (Ashdod) from 2004	Operational
Hadera Deepwater LNG Terminal	IEC	x LNG buoy located 6km offshore Israel and capable of accepting up to 600MMcf/day LNG, to supply LNG to Israel.	Developed
Aphrodite Block 12	Noble Energy, BG (with Avner Oil Exploration and Delek Drilling)	x 4Tcf gas field. x Noble Energy has filed a preliminary field development plan in Cyprus for the Aphrodite field located in Block 12, in the EEZ of Cyprus, west of Leviathan. x The Leviathan Development Plan includes a potential tieback of wells. The production flowline, MEG flowline, and umbilical lengths would be approximately 45km long. Such connection would be designated for export capacities only.	In Development
Dalit	Noble Energy	x Discovered 2009	Not developed
Leviathan	Noble Energy	x Discovered 2010 x Planned development during 2018/2019.	In Development

Development Name	Developer or Operator	Description	Development Phase
Tanin	Energean	Discovered 2012 Planned development 10 to 15 years after Karish (2029 to 2034)	Not developed
Shimshon Gas Field (License 332)	AGR/Isramco	x First exploration well in 2012 with commercial discovery of natural gas. A detailed development plan was submitted in 2015. Estimated reserves 5BCM.	Development
Aphrodite/Ishai	AGR/Nammax	x In Israeli EEZ and under review. Adjacent to Leviathan.	Development
Daniel East and Daniel West licence areas	Isramco and partners Modiin, IOC, ATP Oil & Gas, Petroleum Services Holdings)	x The Og Prospect located within the Daniel East licence, is estimated at 1.1Tcf (prospective resources). x Daniel West is estimated to contain 7.9Tcf.	Not developed

As well as offshore developments that may interact with the offshore components of the Project, nearshore and onshore developments in the vicinity of the nearshore and onshore Project components have also been identified. These nearshore and onshore developments are described in *Table 8.105*.

Table 8.105 Nearshore and Onshore Developments

Developer and Project Name	Description of Development	Interaction with Karish Gas Pipeline		
		Spatial	**Temporal**	**Scoped in/out of CIA**
TAMA 37 is the "National Outline Plan for the Natural Gas Transmission System in Israel."	TAMA 37 was created in 2001 and is the "master plan" for promoting Israel's natural gas infrastructure, mainly the transmission system. Under TAMA 37, several additional detailed TAMAs were approved, covering separate geographic regions of the country related to different purposes. Within TAMA 37 is TAMA 37/H which includes the onshore infrastructure for Leviathan and Karish fields namely: x CVS; x Two onshore pipelines (2km long); x DVS next to the INGL station;	The Leviathan onshore pipeline CVS and DVS are either spatially adjacent or utilising the same infrastructure as Karish.	The onshore infrastructure is unlikely to be constructed at the same time, but could be programmed as little as 12 months apart.	Scoped in
IEC owns and operates 17 power station sites including the 1.4MW power station at Hagit.	A draft recommendation of the Yogev Committee (proposing electricity reform) is "IEC will sell certain power stations and in parallel construct and/or convert existing power stations". It is unknown which power stations will be sold, converted to gas or constructed.	Conversion of coal plants to gas not defined. No plan for Hagit power plant upgrades or major project work.	Timing of major project work defined for Q1 2016 in Israel does intersect with Project construction.	Scoped out
Edeltech Group and Zorlu Enerji power plant	Leviathan Partners have agreed with Edeltech the sale of 16Bcm of Leviathan gas, for 18 years, to power plants they plan to build in Israel.	Location of future power plants is not defined; unclear if will interact.	Expect construction timing in line with receiving Leviathan gas, which is likely to occur before the construction of Karish onshore pipeline.	Scoped out
Be'er Tuvia 413MW Independent Power Plant (IPP)	Leviathan signed deal to supply up to 473 Bcf gas for 18 years. IPM in advanced process to build a power plant at the Be'er Tuvia industrial zone. The plant will supply electricity and energy consumption of different consumers at the Be'er Tuvia industrial zone.	South Israel, approx. 60km West of Jerusalem and about 20km East of Ashdod. Will not interact spatially.	Construction potentially in line with Karish onshore gas pipeline.	Scoped out

The main development that may interact with onshore Project activities, is the Leviathan field onshore infrastructure identified in TAMA 37/H. This infrastructure includes the CVS; two onshore pipelines; and the DVS. Pipeline construction and connection activities may intersect spatially with the Karish Project works and indeed presents opportunities for synergies to reduce some potential impacts.

The following social and environmental resources have been identified as having potential for cumulative impacts to arise from the offshore and onshore components of the projects and their related activities:

- offshore fishing (deep water);
- nearshore and onshore fishing;
- onshore employment and economy;
- tourism; and
- turtle nesting.

The potential cumulative impacts on these resource and receptor groups are assessed in the following sections.

8.13.2 *Potential Cumulative Impacts on Offshore Fishing (Deep Water)*

Impact Description

Oil and gas offshore infrastructure has been observed to attract significant levels of marine species (including fish) from surrounding habitats. This 'attraction' hypothesis can be considered detrimental to fishers, as sparsely distributed resources can become concentrated in the area of the infrastructure. The Karish field is one of a number that have been developed or are in development within the offshore Israel licence blocks. This cluster of developments is likely to exacerbate the concentration of fish around multiple items of infrastructure. Where an exclusion zone exists around this infrastructure, this can make the marine resources inaccessible to fishers.

Security management plans indicate that an exclusion zone of up to 1.5km around key infrastructure will be in place and therefore closed to fishery activities.

A 500m radius exclusion zone will exist for Project offshore pipelines and Field infrastructure and around the pipelay vessel and the Offshore Construction Vehicle (OCV) while it is operating; it is assumed this will also be the case for future Developments.

Noise from construction and/or pipelaying activities was estimated as being **Not Significant**, but as possibly causing temporary disturbance to trawler fishing. It can be expected the same level of noise would arise from future offshore development activities. It is, however, unlikely that construction and pipelaying activities from the multiple offshore field developments would occur at the same time.

Receptor Sensitivity

The assessment of the drilling activities has determined that drill sites in the Project area are not located in known fishing areas. This means that it is unlikely that the cluster of known offshore developments will attract large numbers of marine resources and that they would become in accessible to fishers as a result of the exclusion zones. It is therefore unlikely that offshore fishing activities would be impacted by drilling activities or from the presence of exclusion zones. It is also understood that mariculture and fish farming activities do not take place in the deep water areas in and around the Project.

Offshore marine fishing is described as relatively sparse as a result of water depths and the relatively low nutrient levels of the marine environment in this area. This is reflected in the fact that marine fishing contributed only 10% towards the total domestic fish production in Israel in 2005.

While the stakeholder group that could be adversely affected by offshore activities is deep sea fishers (with an adverse effect on their livelihoods), the number of fishers relying on fishing in these areas is small. The receptor sensitivity of offshore fishers is therefore assessed as Low.

Impact Significance

The potential cumulative impacts arising from the Project and the developments within the offshore Israel licence blocks on offshore fishing, relate to the attraction of marine species to the infrastructure, and to their inaccessibility due to the presence of multiple exclusion zones. The identified impacts are summarised in *Table 8.106*.

Table 8.106 Impact Assessment: Impacts on Offshore Fishing (Deep Water)

Nature and Type: Direct negative **Receptor Sensitivity:** Low **Impact Magnitude:** Negligible **Impact Significance (pre-mitigation):** Not Significant

The main environmental assessment indicates the potential impacts on deep sea fishers will be Negligible and offshore fishers could likely adapt to the exclusion zones and trawling does not typically occur in deep waters (e.g. where the FPSO is located).

In considering the number of future developments and likely associated permanent infrastructure with exclusion zones in the range of 500m to 1.5km, the ability of deep sea fishers to adapt is reduced. The combination of the current exclusion zone, increasing number of offshore activities with exclusion zones possibly in areas of greater fish concentration, additional pipeline construction activities, and increased vessel movements, there will be reduced availability of waters to deep sea fishers.

In addition, future offshore infrastructure may attract significant levels of marine species (including fish) from surrounding habitats. This has the potential to impinge on the catch of fishers in surrounding regions. The (up to) 1.5km exclusion zones around offshore infrastructure may exacerbate this issue. While this is a technically unproven environmental impact, the perception of a cumulative impact arising from multiple offshore platforms is likely to raise concerns amongst stakeholder groups.

The Project has been assessed as having a Negligible contribution to this potential cumulative impact. This is because the development of the Karish field comprises seabed wells and an FPSO vessel, rather than offshore platforms, which limits the 'attraction' of the infrastructure to marine species. This contribution, combined with the Project being located in a low value area, not known for commercial fishing, means that cumulative impacts are assessed as ***Not Significant***.

Mitigation and Monitoring

The Project will be a minor contributor to the potential cumulative impacts on offshore fishing. Notwithstanding, as a proactive step Energean's grievance mechanism will provide potentially affected communities with a means to express their concerns and voice their opinions during the construction phase. Energean will also notify communities of buffer zones and other Project-related information, which could affect the livelihoods of sea users nearshore, in advance of construction and/or operational activities.

Residual Impact

As no additional mitigation measures are recommended, the residual impacts will therefore remain ***Not Significant*** (see *Table 8.107)*.

Table 8.107 Residual Impact Significance

	Impact Significance
Pre-mitigation: offshore fishing (deep water)	*Not Significant*
Post-mitigation: offshore fishing (deep water)	*Not Significant*

8.13.3 *Potential Cumulative Impacts on Nearshore and Onshore Fishing*

Impact Description

The onshore pipeline route has been defined by TAMA/37/H, is shown in *Figure 2.14*, and allows for the construction of the pipelines from the Karish and Leviathan offshore fields. Both of these pipeline routes will cross shoreline areas that are used for fishing by both commercial and recreational fishers. The staging areas for carrying out the drilling will be located within the area of the fish ponds. The mud of the horizontal drilling will be treated and re-used, with the cuttings collected and transported to a licensed disposal site. The TAMA 37/H allows for additional staging and construction in the fish pond area. The land that will be crossed by the remainder of the onshore pipelines, allowed for in TAMA 37/H, has been previously disturbed by either existing agricultural or former fish farming activities.

The potential magnitude of cumulative impact arising from the Karish pipeline with additional; future pipelines, is considered Negligible, given that the amount of coastline intersected by the pipeline is small in relation to the overall length of coastline. Additionally, the land adjacent to the onshore pipeline route has previously been disturbed during the construction of a gas distribution pipeline routed to the existing DVS facility.

The construction of the offshore and nearshore pipeline will not require excavation of the seabed. A pipelay vessel will place the pipeline on the seabed, and the pipeline will not be buried. The rock placement activities will involve only minor intervention on the seabed.

The TAMA EIA [1] discussed that bottom trawlers usually fish at depths down to 400m, but trawl fleets are prohibited from fishing at depths shallower than 15m. Fishing is concentrated along the narrow continental shelf offshore Israel and narrows to 10km in the north (Haifa–Carmel Mountains).

It also is understood that the Government of Israel has now made trawling illegal. This will impact the economic livelihoods of trawl fishers; however, as it is an illegal activity, it is not assessed further.

Receptor Sensitivity

Commercial, subsistence and recreational fishers operate in the nearshore area of the Project and along the shorelines of Israel. The TAMA EIA indicated that there are approximately 1,000 kayak owners who fish along the Israeli coast, approximately 1,000 free divers engaged in the sport of spear-fishing, and on a sunny day up to 20,000 Israelis fish with rods from beaches, and several hundred small boats engage in fishing along the coast – although how many fish in the area that will be impacted by the Project is unknown.

It is unknown how many of those fishing in coastal waters using spears, rods, and boats are doing so for subsistence or for recreation, although the assumption made is it is for recreation.

The stakeholder groups, which could be adversely affected by offshore activities, are nearshore and onshore fishers (with an adverse effect on their livelihoods). Although the number of fishers relying on fishing for their livelihood in these areas is small, this group has a Medium sensitivity to impacts.

Impact Significance

The potential cumulative impacts arising from the Project, and the pipelines allowed for in the TAMA 37/H corridor, on nearshore and onshore fishing, relate to the presence of the new project infrastructure and the exclusion zones, and from the disturbance created by the horizontal drilling worksite. The identified impacts are summarised in *Table 8.108*.

Table 8.108 Impact Assessment: Impacts on Nearshore and Onshore Fishing

Nature and Type: Direct negative **Receptor Sensitivity:** Medium **Impact Magnitude:** Negligible **Impact Significance (pre-mitigation):** Not Significant

Fishers could be adversely affected by nearshore activities, as it is expected the future development in the Dor Beach area will be similarly located and include similar activities, such as pipelaying and drilling, restricting fishing.

(1) National Outline Plan (NOP) 37/H for Natural Gas Treatment Facilities from Natural Gas Discoveries prepared by Lerman Architects and Urban Planning Ltd. ("TAMA EIA")

It is likely that exclusion zones may be in place for up to 2 years during Project construction, the 500m exclusion zone will be in place permanently, and similarly for future nearshore and onshore activities through the TAMA 37/H process at the same nearshore and onshore sites. Whilst the extent of nearshore fishing remains unclear, and there is an assumption the majority of fishing is for recreation and not for subsistence, for fishers in this area the Project activities (e.g. pipelaying and microtunnelling activities) represent an additive cumulative effect and the fishers may be vulnerable to the reduction of available area for nearshore fishing if they are unable to relocate to other coastal areas. It is understood kayakers do not venture beyond about 5km from shore and therefore will not be impacted by an exclusion zone offshore infrastructure placed at the same distance.

In consideration of the planned additional nearshore and onshore development in the area and the impact on nearshore fishers at Dor Beach cumulative mitigation measures are warranted.

Mitigation and Monitoring

Table 8.109 Additional Mitigation to Mitigate Potential Cumulative Impacts on Nearshore Fishing

Management Control	**Responsibility - Organisation**	**Timing**
Coordinate with Noble Energy about the construction schedule for the Leviathan pipeline compared to the schedule for the Energean pipeline. Energean should verify that at no time will significant construction activities for both projects be occurring at the same time within the same offshore area (e.g. within 1 km). This is to avoid duplicate simultaneous impacts. Conversely, Energean and Noble Energy could also adopt a combined construction programme (e.g. using the same vessels) if this meant that magnitude of the predicted impacts would not increase.	Energean	Before pipeline construction

Residual Impact

The implementation of the identified mitigation measures will result in residual impacts that are Negligible in magnitude. The residual impacts will therefore remain ***Not Significant*** (see *Table 8.110*).

Table 8.110 Residual Impact Significance

	Impact Significance
Pre-mitigation: nearshore and onshore fishing	*Not Significant*
Post-mitigation: nearshore and onshore fishing	*Not Significant*

8.13.4 *Potential Cumulative Impacts on Onshore Employment and Economy*

Impact Description

Energean's onshore construction and commissioning activities will take approximately 12 months to complete. Within this period there will be two months during which the directional drilling of the pipeline under the nearshore and beach will take place. The remainder of the onshore pipeline will take six months to construct. Whilst the timing of the Leviathan project's onshore activities is unconfirmed, there is a possibility that they will overlap with Energean's schedule.

There is one local community is in the vicinity of the nearshore and onshore Project components, which may be impacted by Project activities (Dor), and one community outside the area (Kibbutz Ma'ayan Tzvi) with rights to use land in the onshore Project area. There may be some positive economic impact to these communities during the Project construction phase as an average of 100 workers (and peak of 250 workers) will be in the onshore area buying goods and services, and contractors may recruit workers from neighbouring communities.

Receptor Sensitivity

The vulnerability of business receptors in Dor is considered Medium.

Impact Significance

It is assumed that Leviathan's traffic flows and onshore construction impacts will be similar to Energean's based on the similarities in activities. As such, it is assumed that the magnitude of socio-economic impacts will be Small, and any negative economic impacts from disruption would be offset by positive economic impacts associated with locally sources goods and services during construction.

Mitigation and Monitoring

The mitigation and monitoring measures required for the management of the potential cumulative impacts on nearshore and onshore fishing are similar to those identified in *Section 8.13.2* for the management of the potential impacts on offshore fishing.

Residual Impact

The implementation of the identified mitigation measures will result in residual impacts that are Negligible in magnitude. The residual impacts will therefore remain ***Not Significant*** (see *Table 8.111*).

Table 8.111 Residual Impact Significance

	Impact Significance
Pre-mitigation: onshore employment and economy	*Not Significant*
Post-mitigation: onshore employment and economy	*Not Significant*

8.13.5 *Potential Cumulative Impacts on Tourism*

Impact Description

The nearshore and onshore Dor Beach site will be impacted by Project and future development site works and civil construction activities. During construction period there will be noise, dust, and traffic impacts.

The TAMA 37/H makes land available for future developers to connect with the INGL transmission line and/or build a valve station to connect to the Israeli power infrastructure, alongside the DVS. This development may occur in parallel, or soon before the Project construction activities.

Traffic congestion/delays and additional accidents due to increased vehicle traffic on community roadways around Dor may impact on tourism in the area. Construction activities adjacent to the beach (although microtunnelling but still visible onshore and offshore) could impact the number of tourists and visitors who come to enjoy the beach.

The potential impacts on tourism that could arise from the combined pipeline construction activities in the onshore pipeline corridor are described in *Table 8.112*.

Table 8.112 Sources of Potential Impacts on Tourism

Receptor Group	Potential Impacts
Dor Beach Island Reserve	May have restricted access to Dor Beach during construction or be impacted by noise.
Wildlife and Nature Tours (www.northern-wind.com)	This is the primary tour operator in the area and partnered with the Nahsholim Resort. May perceive loss of customers as a result of construction.
Nahsholim Seaside Resort (www.nahsholm.co.il) Sells tourism options that utilize the beach for wildlife viewing and sports activities	May perceive a loss of customers during construction activities as a result of reduced access, noise, visual impact.
Kayaking clubs. Kayakers launch from Dor Beach and travel up to 5 km offshore. Clubs frequent Dor Beach and camp on the adjacent rock islands, and wildlife area. The nearest club is based at Hadera Power Plant.	May have reduced access to Dor Beach and to near shore kayaking areas. Construction noise may impact their enjoyment of kayaking, fishing and camping on the nearby islands.
Dor Ranch (Horseback Riding located east of Dor Mushav). Horses are rented from a ranch on the road leading to Dor, the beach and the hotel. Guided horseback riding takes place on the shoreline, up to the ridge, and to the fish pond.	Will lose access to riding areas during construction, and possibly during operations (fish pond area).
Recreational fishers, Dor Beach	May lose access to Dor Beach area during construction due to restricted areas; noise impacts will reduce fishing enjoyment and catch.
Birdwatchers (Dor)	May perceive impact to bird nesting or visiting due to construction impacts (e.g. noise).

Receptor Sensitivity

The Dor Beach is a highly used area for multiple tourism users. These tourists use the beach area and engage in activities that draw upon businesses and resources of the area. Tourism receptor sensitivity is assessed as Moderate.

Impact Significance

Cumulative construction activities as a result of this Project and future similar developments like the Leviathan development could reduce the attractiveness of the area to tourists due to the likely impacts to be experienced during construction, particularly traffic movements. Construction during this project will be for 1-2 years in total, and it is likely future construction for a second natural gas connection at Dor Beach will also be of a similar duration. If this second development takes place in parallel or at a later date, the impact of the construction activities could reduce tourism in the area and cumulatively impact businesses that benefit from tourism. As the businesses are relatively small in scale and rely on this local tourism trade, there will be a potentially negative cumulative impact.

Mitigation and Monitoring

Energean has already sought to minimise impacts and disruption as much as possible through its construction selection methods such as the use of horizontal directional drilling to construct infrastructure under the beach area.

Energean will also provide advanced notification to tourism businesses and users during construction to ensure impacts are minimised. If future construction activities are proposed in the Dor Beach area by Energean and/or other developers, the proponents should seek to coordinate and plan together to organise parallel or concurrent activities to minimise impacts.

Residual Impact

The implementation of the identified mitigation measures will result in residual impacts that are Minor in magnitude. The residual impacts will therefore be ***Not Significant*** (see *Table 8.113*).

Table 8.113 Residual Impact Significance

	Impact Significance
Pre-mitigation: onshore employment and economy	*Moderate*
Post-mitigation: onshore employment and economy	*Not Significant*

8.13.6 *Potential Cumulative Impacts on Turtle Nesting*

Impact Description

Sea turtle species (i.e. the loggerhead turtle, green turtle and leatherback turtle) are known to be present in the Project's area of influence and in the Eastern Mediterranean. These species are very sensitive to beach disturbances during nesting and egg hatching season.

Receptor Sensitivity

The receptor sensitivity is variable depending on seasonality. During nesting and egg hatching, these species are considered as High sensitivity at the beach only; however, in the offshore environment and during other seasons, the sensitivity is Low.

Impact Significance

According to the Ministry of Environmental Protection, projects utilising the TAMA 37/H corridor will be expected to utilise horizontal directional drilling for any beach crossings. This approach is already confirmed for the Energean pipeline. This embedded mitigation should mitigate any cumulative impacts to a Negligible magnitude, resulting in the overall potential impact being classified as ***Not Significant***.

Mitigation and Monitoring

Energean and other projects using the TAMA 37/H corridor will utilise horizontal directional drilling for any beach crossings as an embedded mitigation.

Residual Impact

No additional mitigation measures beyond the embedded mitigation are proposed. The residual impacts will therefore be ***Not Significant*** (see *Table 8.114*).

Table 8.114 Residual Impact Significance

	Impact Significance
Pre-mitigation: onshore employment and economy	*Not Significant*
Post-mitigation: onshore employment and economy	*Not Significant*

9 ENVIRONMENTAL AND SOCIAL MANAGEMENT

9.1 INTRODUCTION

This *Section* introduces the framework Environmental and Social Management Plan (ESMP) for the Karish Development. The purpose of the framework ESMP is to ensure that these recommendations are translated into practical management actions which can be adequately resourced, monitored and reported against through the phases of the Project.

The ESMP has been developed to demonstrate how Energean intends to fulfil the requirements presented in the International Finance Corporation (IFC) Performance Standard 1 (PS 1), Assessment and Management of Environmental and Social Risks and Impacts.

In addition to the requirements of PS 1, the ESMP content has taken into account the IFC General Environmental, Health, and Safety Guidelines, the IFC Technical Guidelines for Offshore Oil and Gas Development, Onshore Oil and Gas Development and Gas Distribution Systems, and other relevant IFC Performance Standards.

The ESMP includes a series of tables that set out the embedded mitigation measures, long-lead mitigation measures, construction mitigation measures, and production phase mitigation measures. These tables are provided in *Annex E*.

9.2 PURPOSE OF THE ESMP

The purpose of the ESMP is to provide the framework to enable environmental and social (including health and safety) risks to be identified and assessed throughout construction and operations, and mitigation measures to be developed, implemented and appropriately managed. The ESMP will therefore assist Energean to comply with relevant authorizations, legal requirements, and IFC Standards in a systematic and structured way. The purpose of the ESMP is to:

- provide an institutional mechanism with well-defined roles and responsibilities for ensuring that measures identified in ESIA designed to mitigate potentially adverse impacts, are implemented;

- list all suggested mitigation measures and control technologies, safeguards identified through the ESIA process;

- provide Project monitoring program for effective implementation of the mitigation measures and ascertain efficacy of the environmental management and risk control systems in place; and

- assist in ensuring compliance with all relevant legislations at local, state and national level for the Project.

The ESMP is a dynamic document, and will therefore be reviewed and updated from time to time to continually improve the management of environmental and social impacts. Changes may be based on the Project phase, the environmental and social performance of the Project, or updated to reflect changes in operations, the receiving environment, legislation, stakeholders, and personnel.

The objectives of the ESMP are:

- clearly identify and define the ESMP scope applicable to the Project;
- identify and outline the policies, procedures and management plans for the identified ESMP scope as per the IFC standard requirements;
- guide management in assessing and evaluating the effectiveness, suitability and adequacy of the ESMP and conformance to the IFC standard requirements and other identified requirements to which Energean subscribes; and
- provide the framework that enables a dynamic ESMP to be implemented and easily revised and improved throughout the Project life cycle.

9.3 SCOPE OF THE ESMP

The ESMP covers those Project components and activities described in *Section 2* of this ESIA report during construction and operation. This will be subject to thorough reviews prior to the commencement of each stage of Project activity to ensure completeness and will be updated as necessary.

The ESMP provides for the management of significant environmental and social risks, incorporating the community as well as the health and safety of EMP personnel, contractors and visitors.

The ESMP details the mitigation and enhancement measures the Project has committed to implement (also summarised in *Section 8*) and includes desired outcomes; performance indicators; targets or acceptance criteria; costs and timing for actions and responsibilities. The Project will have principal responsibility for all measures outlined in the ESMP, but may delegate responsibility to its contractors, where appropriate. In cases where other individuals or organisations will be delegated to, the responsibility for mitigation measures is clearly indicated in the ESMP tables at *Annex D*.

Capacity building and environmental and social training requirements are also described in this *Section*, where these relate to specific skills required to deliver the ESMP action in question. General staff training, including health and safety, is not included in the ESMP.

9.4 PROJECT ESMP FRAMEWORK

9.4.1 *Roles and Responsibilities*

The effective implementation of the ESMP is dependent on established and clear roles, responsibilities and reporting lines within the Energean institutional framework. The organisational structure for environmental and social management for the Project is defined below. The structure will be maintained throughout the construction, operation and decommissioning phases, while being reviewed on a regular basis to adapt the structure as necessary. The key roles and responsibilities are outlined in *Table 9.1*.

Table 9.1 Key Roles and Responsibilities

Role	Responsibilities
Project Manager	The Project Manager is the senior representative for the Site and, as such, is the ultimate authority on all matters including environmental and social management. The objective is to actively work towards the elimination of Company and Sub-contractor environmental damage. The Project Manager is responsible for providing the human and financial resources necessary for ensuring compliance to the ESMP. The Project Manager must be fully conversant with the conditions of the environmental approval and ensure that all stipulations within the ESMP are communicated and adhered to by the construction team (and any subcontractors).
Site Manager	The Site Manager shall be responsible for the day-to-day operations of the Contract and may deputise for the Project Manager if required. The Site Manager's responsibilities include: • To ensure that all Supervisors and employees are familiar with the contents of the ESMP. • Advise or instruct any person on site in matters related to Environmental Management. • To attend Environmental Meetings when required. • To ensure that all Statutory Acts, Regulations and Codes of Practice are adhered to. • To ensure that all aspects of the ESMP are carried out to the standards and performance expectation the Client and Company requires. • Report to the Client and Project Manager on all accidents and incidents and corrective and preventative measures. • Report to the Project Manager and Client any public grievances or concerns raised by the local communities with respect to the project. • Project related Health and Safety.
HSE Manager	The HSE Manager will be appointed by Energean and will be responsible for the day to day environmental and social management. The HSE Manager is responsible for implementing the monitoring programmes and maintaining the monitoring databases as well as the reporting of the results. Key responsibilities of the HSE Manager include: • Maintenance of the EMS, and EMS training. • GRI reporting on environmental statistics. • Undertake internal environmental compliance audits. • Coordinate external compliance audits. • Draft and implement action plans following audits. • Obtains all company EHS permits and approvals. • Ensures that all documentation and records required comply with procedures that are current, available and auditable, and are properly executed in accordance with project quality assurance requirements. • Reviews and recommends approval status of subcontractors EHS documents that are intended to be incorporated on the project. • Keeps abreast of applicable national and international requirements as per the projects tracking process. • Develop environmental training and awareness programmes. • Work with managers to ensure appropriate actions/management programs are built into the annual action/business plans to achieve community related objectives and targets, and review (and as necessary revise) these actions/management programs annually to ensure progress toward meeting the objectives and targets. • Determine whether new or modification of current internal documents

Role	Responsibilities
	based on significant aspects and impacts, job experiences, corrective action reports, audit findings, legal requirements, new or modified operations, and/or any other activities is required, and assign personnel to do this where necessary. • Prepare a document that provides a list of which roles hold responsibility for controlling different types of records related to community issues. • Maintain an ESMP Document Register and a Record Register. • Review community-related documents and records annually to determine archiving requirements.
Employees	Key responsibilities of the Employees include: Reads and understands the requirements contained in this ESMMP Framework. • Attends EHS training as required. • Responsible for observing measures for their own safety and for others who may be affected by their acts or omissions. • Co-operates with EMP management on health and safety related measures. • Adheres to safety rules at all times. • Specific responsibilities as defined by the ESMMP. • Seeks out hazards and reports them for correction. • Intervenes when they come across unsafe work/conditions and shall use right/obligation to stop work, unless act/condition is safe. • Adheres to EHS rules at all times.

9.4.2 *Inspection, Monitoring and Audit*

Inspection and monitoring of the environmental impacts of the Project activities will increase the effectiveness of ESMP. Through the process of inspection and auditing, Energean will ensure that the conditions stipulated in various permits are complied. The inspection and audits will be done by the project identified HSE staff in coordination with EPC contractors and any other external agencies identified. The entire process of inspections and audits should being documented. The inspection and audit findings are to be implemented by the 'person-in-charge' in the respective Project area and phase.

9.4.3 *Reporting and Review*

Energean will develop and implement a programme of reporting through all stages of the project cycle. Delegated personnel shall be required to fully comply with the reporting programme in terms of both timely submissions of reports as per an appropriate level of detail. Reporting will be carried out through a variety of different forms, such as environmental check list, incident record register, environmental and social performance reports (e.g. weekly, monthly, quarterly, half yearly, yearly).

9.4.4 *Documentation and Record Keeping*

Documentation is an important step in implementing ESMP. Energean will establish a documentation and record keeping system to ensure recording and updating of documents per the requirements specified in ESMP. The documents should be kept as hardcopies as well as in electronic format. Responsibilities have to be assigned to relevant personnel for ensuring that the ESMP documentation system is maintained and that document control is ensured through access by and distribution to, identified personnel in form of the following:

- Environment and Social Management System documentation;
- legal register;
- operational control procedures;
- work instructions;
- incident reports;
- emergency preparedness and response procedures;
- training records;
- monitoring reports;
- auditing reports; and
- grievance register and issues attended/closed.

9.4.5 *External Reporting and Communication*

HSE head is the responsible person for ensuring that communication with regulatory agencies and stakeholders are maintained as per requirements. All grievances and enquiries are to be appropriately dealt with and records be maintained in a Grievance/Enquiry Register by the delegated HSE staff. All communications made to regulatory agencies should also be reported to Energean's corporate HSE Head.

9.4.6 *Internal Reporting and Communication*

Inspection and audit findings along with their respective improvement program are to be regularly reported to the senior management for their consideration. The same are also to be communicated within the staff working on the project. To maintain an open communication between the staff and management on HSE and social issues the following should be used:

- team briefings;
- on-site work group meetings;
- work specific Instructions; and
- engagement and meetings with stakeholders.

9.4.7 *ESMP Review and Amendment*

The ESMP acts as an environment and social management tool that needs to be reviewed periodically to address changes in the organisation, process or regulatory requirements. Following review, the Energean HSE Head will be responsible for making the amendments in the ESMP and seeking approval from the senior management. The amended ESMP will be communicated to all the staff.

9.4.8 *Management of Change*

Energean will maintain procedures to identify and control risk associated with change, and to maintain the accuracy and safety of environmental information. Changes will be managed to review risk associated with change actions associated with:

The organisation	Permitting	Products
Personnel	Procedures	Materials
Systems	Equipment	Chemicals

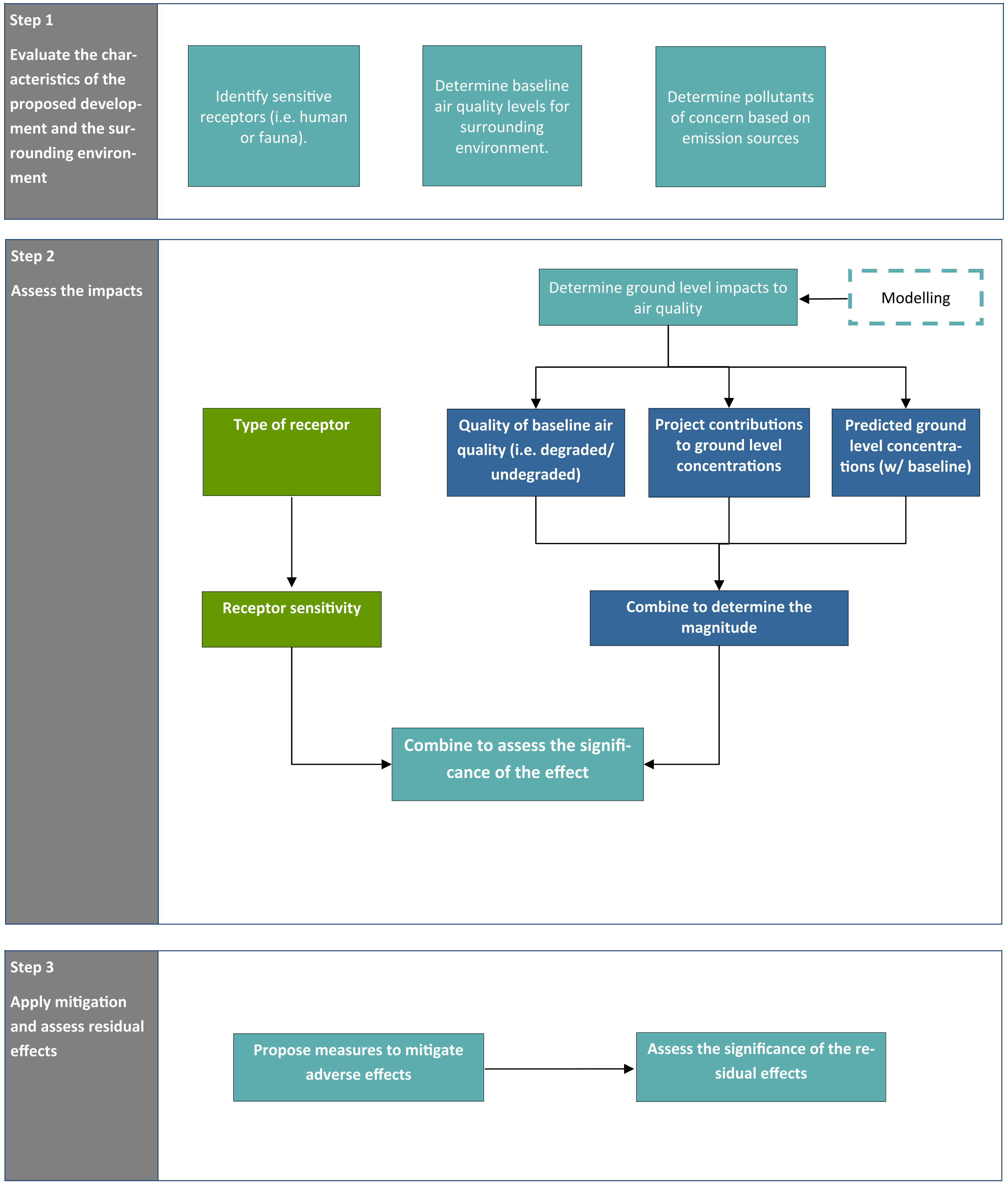
9.4.9 *Additional Documentation*

The ESMP Framework has identified some additional plans (and policy) that will be prepared by Energean and its chosen EPC contractor (Technip) prior to the commencement of construction:

- Oil Spill Contingency Plan;
- Emergency Preparedness and Response Plan;
- Chemical Use Plan;
- Offshore Discharge Program;
- Waste Management Plan;
- Chance Finds Procedure;
- Biodiversity Action Plan;
- Workers Grievance Mechanism;
- Stakeholder Engagement Plan;
- Local Labour Policy; and
- Community Grievance Mechanism.

Annex A:

Topic Specific Methodologies



Receptor Sensitivity

The sensitivity of ecological receptors is defined on the basis of their designated importance as an ecological resource. Any significant ecology impacts from air quality on non-designated sites will be assessed qualitatively as part of the Ecology assessment. This is typically determined on the basis of the statutory protection conferred on a receptor (for example, under the Ramsar convention). The table below provides receptor sensitivity with respects to human health. Sensitivity criteria for ecological receptors is as defined in the biodiversity methodology.

Sensitivity	Human	Ecology
Negligible	N/A	Non-designated habitats
Low	N/A	Locally designated sites
Medium	General population	Nationally designated sites
High	Particularly vulnerable individuals, e.g. a hospital with intensive care ward	Internationally designated sites

Magnitude of Change

The results of the air dispersion modelling are compared to the relevant air quality standards or guidelines (either for human health or ecology). Different standards/ guidelines will apply depending on the pollutant of concern and the averaging period. To determine magnitude, the Project's Contributions (PCs) to ground level pollutant concentrations are assessed in tandem with the total Predicted Environmental Contributions (PECs), where the PEC is the sum of the baseline concentration and the PC for a particular pollutant. The criteria used is presented below. Where national guidance exists for impact magnitude levels, this should take precedent to the value provided below.

PC as % of AQS	Magnitude
Undegraded Airsheds Where PEC < Air Quality Standards/Guidelines	
<10%	***Negligible***
10-25%	***Small***
25-75%	***Medium***
>75%	***Large***
Degraded Airsheds, i.e. Where PEC > Air Quality Standards/Guidelines	
<5%	***Negligible***
5-10%	***Small***
10-25%	***Medium***
>25%	***Large***

Note that in some countries a site-specific methodology is required to assess ecology impacts from air emissions (e.g. acid deposition and eutrophication). In such cases, an additional assessment would be required using site-specific ecology criteria.

Step 1

Evaluate the characteristics of the proposed development and the surrounding environment

Define the preliminary scope of the biodiversity impact assessment and determine the study area. Both direct and indirect impacts should be considered.

Identify ecological resources and receptors

Establish the existing baseline conditions with particular reference to distribution of habitats and species, their uniqueness in the affected area, and their value / importance

Step 2

For each impact...

Identify the interactions between the proposed development and identified resources / receptors

Identify and describe the likely impacts and for each quantify and/or judge the...

Scale of the impact

Duration of the impact

Frequency of impact

Extent of Impact

Sensitivity of the resource / receptor to the impact

Value or importance of the resource / receptor

Assessment of impact magnitude

Assessment of sensitivity to impact / importance / value

Combine to assess the significance of the effect

Step 3

Apply mitigation and assess residual effects

Propose measures to mitigate adverse effects

Assess the significance of the residual effect

Critical, Natural and Modified Habitat Assessment

Identify presence of Natural Habitat or Modified Habitat (IFC PS6)

Define Discrete Management Unit (DMU) within Study Area

Assess DMU for presence of...

Criterion 1—globally, regionally or nationally important populations of CR or EN species

Criterion 2—globally, regionally or national important populations of endemic or restricted range species

Criterion 3—internationally or regionally important populations of regularly occurring migratory or congregatory species

Criterion 4—threatened or unique ecosystems or those of high conservation value

Criterion 5—landscape features that have influenced (or may influence) key evolutionary behaviours

If Critical Habitat is identified...

Cross reference to IA and apply mitigation hierarchy (defined in PS6). Determine significant residual effects on Critical Habitat trigger features

Produce Biodiversity Action Plan (BAP) that identifies measures designed to deliver net biodiversity gain for Critical Habitat features

If Natural Habitat or Modified Habitat with significant biodiversity interest is identified...

Cross reference to IA and apply mitigation hierarchy (defined in PS6). Where necessary develop offsets to deliver no net loss of biodiversity

Capture biodiversity commitments made in IA in Biodiversity Management Plan (BMP)

Magnitude of Change

Ranking	Habitat	Environmental factors e.g. presence, ambient air quality, noise
Negligible	Immeasurable, undetectable or within the range of normal natural variation change to the extend and condition of a habitat.	Change is within the normal range of natural variation.
Small	Minimal disturbance and/or loss of habitat, such that there is no loss of viability or function of the habitat.	Slight change expected over a limited area and returning to background levels within a few metres or tens of metres. No exceedances of benchmark limits. A temporary and localised physical change / source of disturbance.
Medium	Localised disturbance and/or loss of a habitat that does not threaten the long term viability or function of the habitat	Temporary or localised change and/or occasional exceedance of benchmark limits. A physical change in the medium term over a relatively large area.
Large	Widespread and/or permeant disturbance or loss of a habitat, threatening the long term viability or function of the habitat.	Change over a large area that lasts over the medium to long term, likely to cause secondary effects on ecology and/or routine exceedance of benchmark limits. A long term physical change that affects a large area or introduces a permanent physical barrier to migration

Sensitivity

Sensitivity is not an inherent characteristic of a receptor or resource. Receptor or resource sensitivity is the degree to which it is tolerant of, adaptable to and able to recover from a change in its environment. Therefore in addition to considering the importance/quality/value of the affected receptor or resource, its response (or sensitivity) to a particular impact is also considered. This is typically informed by literature review and the evidence base.

Ranking	Tolerance	Adaptability	Recoverability
High	Receptor unable to tolerate effect resulting in permanent change in its abundance or quality.	Receptor unable to avoid impact.	Receptor unable to recover resulting in permanent or long term change (e.g. >10 years).
Medium	Receptor has some ability to tolerate this effect but a detectable change (e.g. a change in distribution) will occur.	Receptor has some ability to avoid the most negative consequences of the impact or can partially adapt to it (e.g. by moving to other suitable areas).	Receptor recovers to an acceptable status over the short term to medium term (e.g. 1-10 years).
Low	receptor unaffected or positively affected.	Receptor can completely avoid the impact or adapt to it with no detectable changes.	Receptor recovers fully within e.g. 1 year.

Value / Importance

Ranking	Habitats	Species
Low	Habitats with no, or only a local designation / recognition. Habitats of significance for species listed as of Least Concern (LC) on IUCN Red List. Marine habitats which are common and widespread within the region, or with low conservation interest.	Species that are abundant, common or widely distributed and are generally adaptable to changing environments. Species are not endangered or protected, but may be listed as LC.
Medium	Habitats within nationally designated or recognised areas. Habitats of importance to globally Vulnerable (VU), Near Threatened (NT) or Data Deficient (DD) species, and species with nationally restricted ranges. Habitats supporting nationally significant concentrations of migratory species (more than 1% of national population) and / or congregatory species, and habitats used by species of medium value.	Species listed as VU, NT or DD. Species that have low abundance, restricted ranges, are currently under pressure or are slow to adapt to changing environments. Species are valued locally / regionally and may be endemic, endangered or protected. Species that do not meet criteria for High Value linked to IFC critical habitats.
High	Habitats within internationally designated or recognised areas. Habitats of importance to globally Critically Endangered (CR) or Endangered (EN) species, endemic and/or globally restricted-range. Habitats supporting globally significant concentrations of migratory species and / or congregatory species, highly threatened and/or unique ecosystems, areas associated with key evolutionary species, and low or medium value habitats used by high value species.	Species listed as CR or EN. Range restricted or endemic as defined in IFC criteria for Tier 1 or Tier 2 assessment (Guidance notes 81-83) Species that are valued nationally /globally and are listed as endangered or protected.

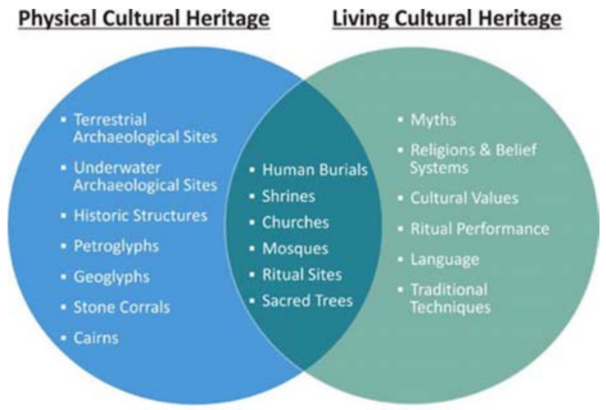
(1) The integrity of a site is assessed in terms of: the extent and distribution of the habitats of the qualifying features; the structure and function of the habitats of the qualifying features; the supporting processes on which the habitats of the qualifying features rely; the population of each of the qualifying features, and the distribution of the qualifying features within the site.

Cultural Heritage

Definitions—what does it involve?

Cultural Heritage - the tangible and intangible legacy we inherit from previous generations and comes in a vast array of concepts and terminology.

It includes buried assets (such as archaeology and unmarked human burials), above ground assets (such as buildings and monuments), marine sites and assets, landscapes and Intangible heritage (such as language, belief systems and folklore).



Step 1

Evaluate the characteristics of the proposed development and the surrounding environment

Collect and collate a baseline of heritage to understand the existing situation

Define the preliminary scope of the cultural heritage impact assessment and determine the study area:

- Review potential presence of known/likely cultural heritage resources.
- Identify sources of existing information.
- Take account of degree of previous research – absence of known cultural heritage does not necessarily mean that none exists.
- Assess which techniques are likely to be needed in order to identify the presence of cultural heritage.
- Depending on which standards apply (national legislation or international standards) assess level of effort required.

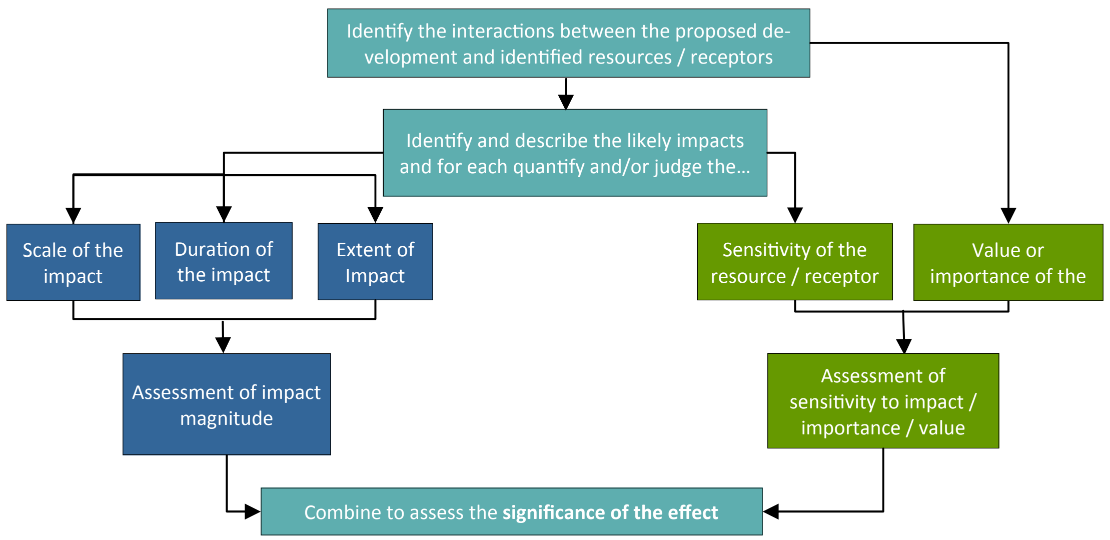
Identify cultural heritage resources and receptors. Establish the existing baseline conditions with particular reference to distribution of tangible and intangible heritage resources, their uniqueness in the affected area, and their value / importance.

The known information about an affected area represents a starting point. Addition data collection allows a fuller picture of the potential presence of unidentified remains to be developed. Additional information is gathered through:

- site reconnaissance;
- intrusive fieldwork ;
- non-intrusive fieldwork; and
- stakeholder consultation.

Step 2

For each impact...



Step 4 - Mitigation

Apply mitigation and assess residual effects

Propose measures to mitigate adverse effects of identified impacts on cultural heritage. These measures can be included within a combined Environmental and Social Management Plan (ESMP) or within a stand alone management plan .

Assess the significance of the residual effect.

Magnitude of Change

Ranking	Tangible/Intangible Cultural Heritage	Relevant factors (e.g. presence)
Negligible	No discernible change in the physical condition, archaeological potential, setting or accessibility and enjoyment of the site/ feature. No perceived change to an intangible resource/asset.	Change is insufficient to affect the value of the site or resource.
Small	Small part of the site is lost or damaged resulting in a loss of scientific or cultural value or archaeological potential: the setting undergoes a temporary or permanent change that has a limited effect on the site's perceived value to stakeholders. Public and expert access to the site/resource may be temporarily restricted.	Slight change expected over a limited area and duration. A temporary and localised physical change / source of disturbance not leading to a permanent reduction in value/importance to stakeholders.
Medium	A majority of the site is damaged or lost resulting in a loss of scientific or cultural value and perceived/actual value to stakeholders. The setting undergoes permanent change that diminishes the site's value. Access to the site is permanently reduced or restricted.	A physical and/or perceived change that alters the physical ,scientific and community value of a site or resource.
Large	The entire site or resource is damaged or lost resulting in a loss of all scientific or cultural value or archaeological potential. The setting of the site or resource is impacted to such a degree as to cause almost complete loss of value to stakeholders and loss of access to the site or resource.	A long term physical or cultural change that affects the value of a site or resource on a permanent basis.

Sensitivity

Sensitivity is not an inherent characteristic of a receptor or resource. Receptor or resource sensitivity is the degree to which it is tolerant of, adaptable to and able to recover from a change in its environment. Therefore in addition to considering the importance/ quality/value of the affected receptor or resource, its response (or sensitivity) to a particular impact is also considered. This is typically informed by literature review and the evidence base.

Ranking	Characteristics
High	A site is considered to be of high sensitivity if: • it is protected by local, national, and international laws or treaties; • the site cannot be moved or replaced without major loss of cultural value; • the legal status specifically prohibits direct impacts or encroachment on site and/or protection zone; • the site has substantial value to local, national, and international stakeholders; and/or • the site has exceptional scientific value and similar site types are rare or non-existent (equivalent of IFC Performance Standard (PS) 8 Critical Cultural Heritage).
Medium	A site is considered to be of medium sensitivity if: • it is specifically or generically protected by local or national laws but laws allow for mitigated impacts; • the site can be moved or replaced, or data and artefacts recovered in consultation with stakeholders; • The site has considerable cultural value for local and/or national stakeholders; and/or • the site has substantial scientific value but similar information can be obtained at a limited number of other sites (equivalent of IFC PS8 Non-Replicable Cultural Heritage).
Low	A site is considered to be of low sensitivity if: • it is not specifically protected under local, national, or international laws or treaties; • the site can be moved to another location or replaced by a similar site, or is of a type that is common in surrounding region; • the site has limited or no cultural value to local, national, or international stakeholders; and/or • the site has limited scientific value or similar information can be obtained at numerous sites (equivalent of IFC PS8 Replicable Cultural Heritage).

Introduction

When evaluating climate change effects, there are two aspects to consider:

- what are the potential effects on receptors/resources ***FROM*** the Project, i.e. from greenhouse gas (GHG) emissions; and
- what are the climate change risks ***TO*** the Project (e.g. flooding, increase heat fatigue to staff)?

This methodology addresses only the former, with climate risks being assessed through a separate Climate Risk Assessment process.

Step 1

Quantify the greenhouse gas emissions, both direct and indirect.

Obtain GHG emissions data from Project

For each phase of the Project, quantify the annual Scope 1 and Scope 2 GHG emissions using the GHG Protocol.

Step 2

Assess the impacts

Are the annual GHG emissions greater than 25 000 tCO_2e for any year?

Yes → GHG emissions are considered ***Significant***

No → GHG emissions are considered ***Not Significant***

Step 3

Apply mitigation and assess residual effects

Can GHG emissions be reduced to below the significance threshold?

If not, basic mitigation measures that will apply for ***Significant*** impacts are: as follows

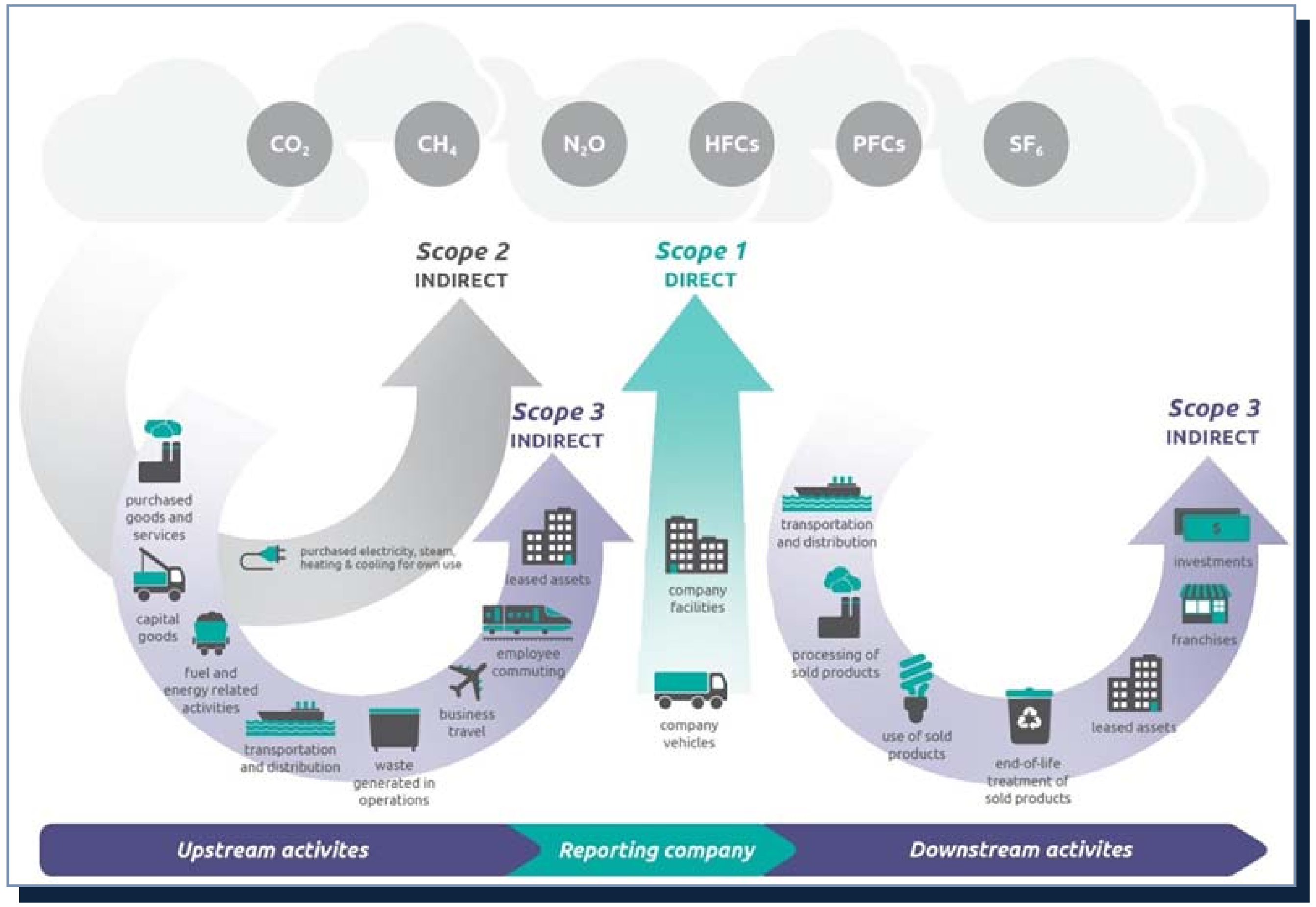
- Quantify GHG emissions annually in accordance with internationally recognised methodologies and good practice.
- The Project shall have a system in place to periodically review annual GHG performance and evaluate options for improving energy efficiency over the life of the Project.
- The Project will develop and implement a routine maintenance plan for all key GHG emission sources.

The GHG Inventory

The most internationally accepted guidance for estimating GHG emissions for this purpose is 'The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard', published by the World Resources Institute. This protocol was prepared through a partnership between the World Resources Institute and the World Business Council for Sustainable Development.

GHGs included in the GHG assessment methodology are the gases under the UNFCCC/Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbon (PFC), sulfur hexafluoride (SF_6) and nitrogen triflouride (NF_3). GHG emissions are expressed in tonnes CO_2 equivalents (tCO_2e). Emissions are estimated by multiplying activity data (e.g. fuel consumption) with the corresponding emission factor. All emissions are then converted into CO_2 equivalents by multiplying emissions by the global warming potential factor of the specific GHG.

The GHG Protocol defines three emissions 'scopes' for GHG accounting and reporting purposes: Scope 1, Scope 2 and Scope 3. These scopes are illustrated in the figure below from the GHG Protocol. According to the GHG Protocol requirements, organisations must separately account for and report Scope 1 and Scope 2 emissions at minimum.



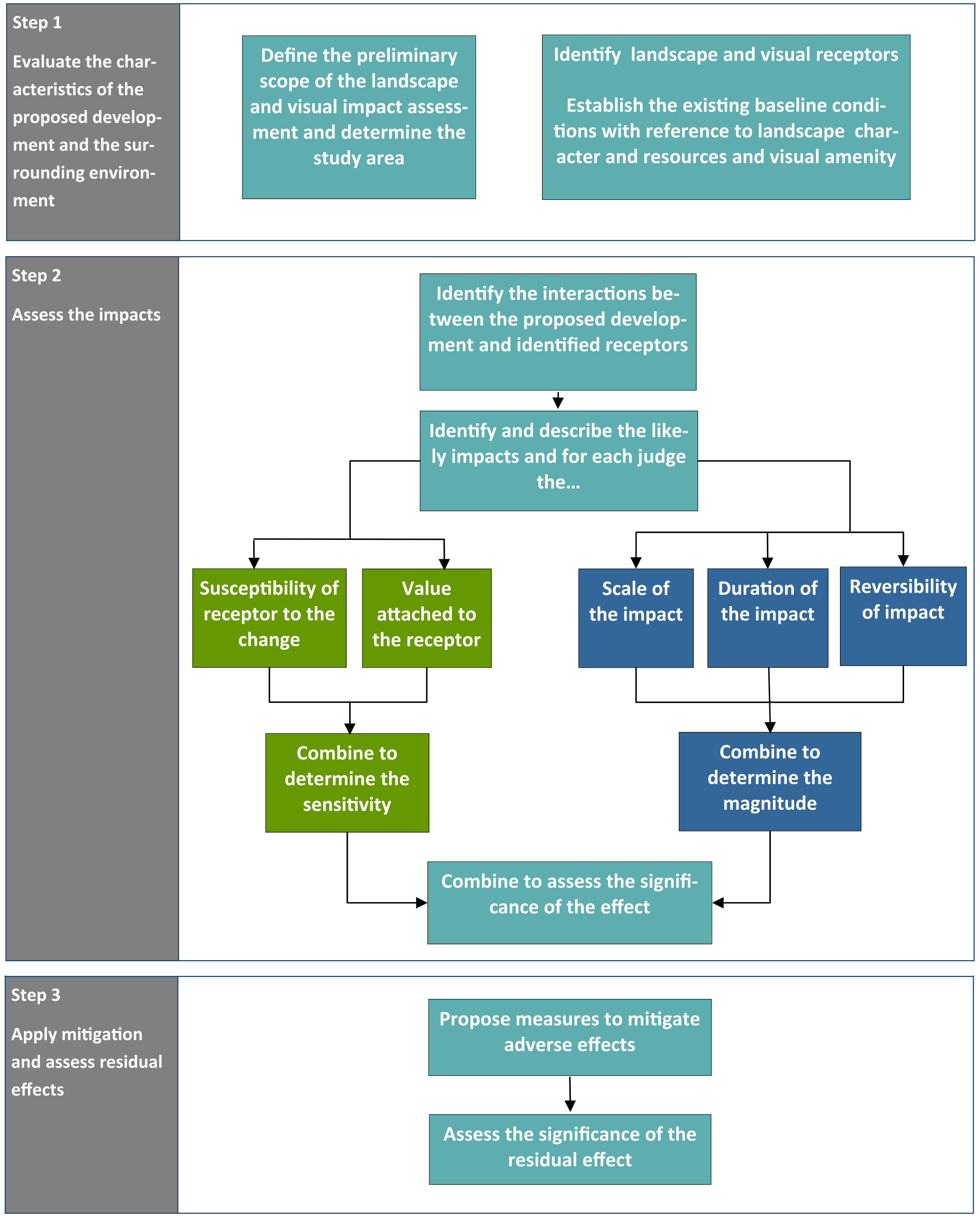
Scope 1 - Direct GHG emissions from the Project

Scope 2 - Indirect GHG emissions associated with consumption of energy produced off-site (i.e. electricity from the grid).

Scope 3 - All other indirect emissions, such as (but not limited to) contracted and other associated activities. *For this initial GHG inventory, no Scope 3 emissions associated with the Project have been included.*

Significance

Because the potential impacts covered in this assessment are global in nature, impact significance cannot be determined in the same way that other topic areas are (i.e. by evaluating receptor sensitivity and magnitude). Climate change effects do vary in significance according to magnitude and local sensitivities, but this is determined by geography and does not necessarily correlate to the source location of the GHG emissions contributing to climate change effects. For this reason, the assessment does not try to assign significance in the traditional way (i.e. Negligible, Minor, Moderate, or Major), but rather only assigns overall significance based on the threshold of 25 000 tCO_2e set out in the IFC's Performance Standard 3.



Receptor Sensitivity

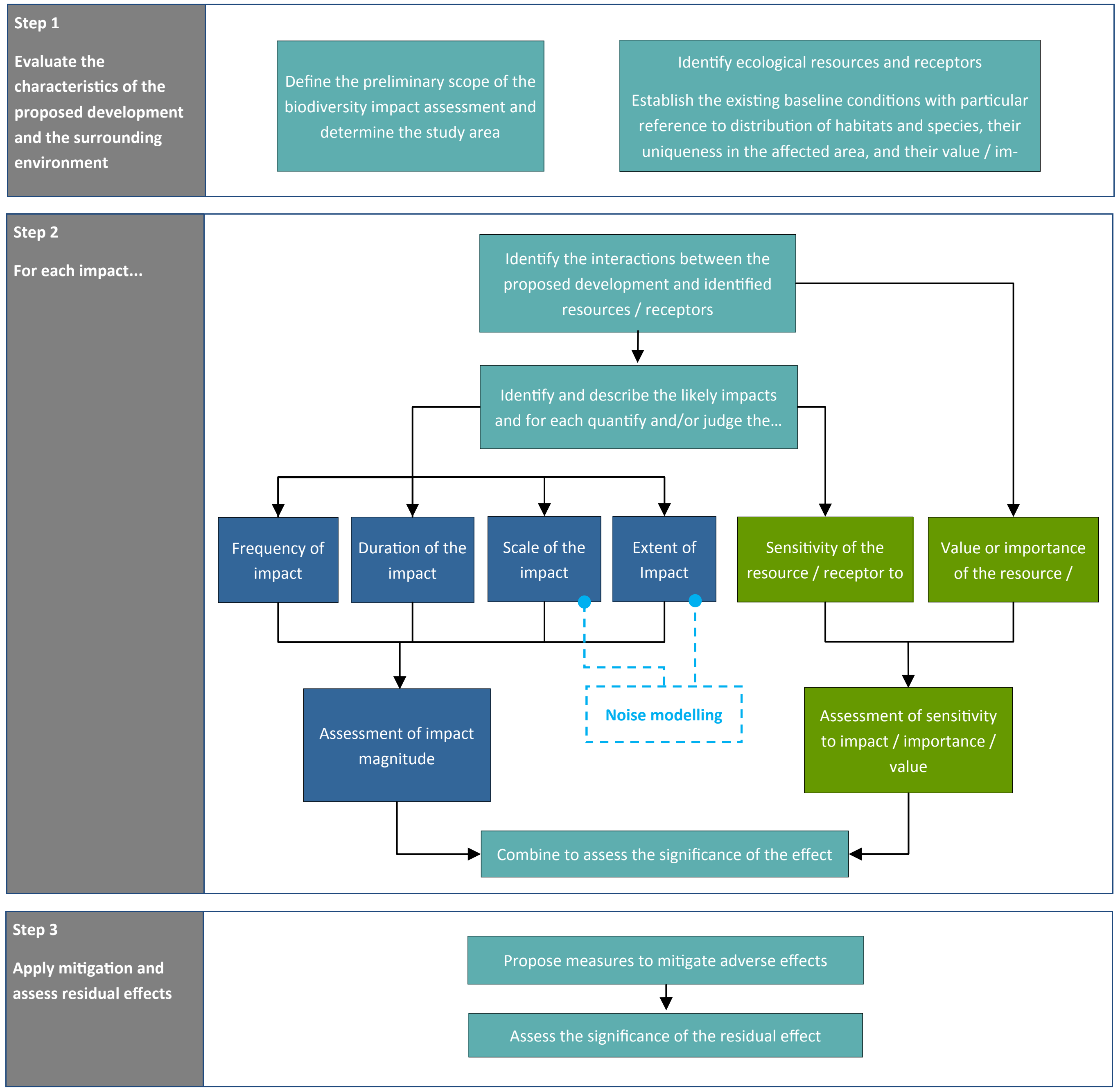
Judgement based on the extent to which the receptor can accept change of a particular type and scale without adverse effects on its character, and the value attached to it. Viewpoint sensitivity depends on a number of factors including: context of the viewpoint, viewer occupation, viewing opportunities, number of people affected, and extent to which the viewers are affected by changes in their view together with the quality of the existing view.

Sensitivity	Landscape	Visual
Low	A moderately valued landscape, perhaps a locally important landscape, or where its character, land use, pattern and scale may have the capacity to accommodate a degree of the type of change envisaged.	Small numbers of visitors with interest in their surroundings. Viewers with a passing interest not specifically focussed on the landscape e.g. workers, commuters. The quality of the existing view, as likely to be perceived by the viewer, is assessed as being low.
Medium	A landscape protected by a structure plan or national policy designation and/ or widely acknowledged for its quality and value; a landscape with distinctive character and low capacity to accommodate the type of change envisaged.	Small numbers of residents and moderate numbers of visitors with an interest in their environment. Larger numbers of recreational road users. The quality of the existing view, as likely to be perceived by the viewer, is assessed as being medium.
High	A landscape protected by a regional (structure plan) or national designation and/ or widely acknowledged for its quality and value; a landscape with distinctive character and low capacity to accommodate the type of change envisaged.	Larger numbers of viewers and/or those with proprietary interest and prolonged viewing opportunities such as residents and users of attractive and well-used recreational facilities. The quality of the existing view, as likely to be perceived by the viewer, is assessed as being high.

Magnitude of Change

Judgement based on the nature, scale and duration of the change that is envisaged in the landscape and the overall impact on a particular view.

Magnitude of change	Landscape	Visual
Negligible	An imperceptible, barely or rarely perceptible change in landscape characteristics.	A change which is barely visible, at very long distances, or visible for a very short duration, perhaps at an oblique angle, or which blends with the existing view.
Small	A small change in landscape characteristics over a wide area or a moderate change either over a restricted area or infrequently perceived.	Minor changes in views, at long distances, or visible for a short duration, perhaps at an oblique angle, or which blends to an extent with the existing view.
Medium	A moderate change in landscape characteristics, frequent or continuous, and over a wide area, or a clearly evident change either over a restricted area or infrequently perceived.	Clearly perceptible changes in views at intermediate distances, resulting in either a distinct new element in a significant part of the view, or a more wide ranging, less concentrated change across a wider area.
Large	A clearly evident and frequent /continuous change in landscape characteristics affecting an extensive area.	Major changes in view at close distances, affecting a substantial part of the view, continuously visible for a long duration, or obstructing a substantial part or important elements of the view.



Assessing Underwater Noise Impacts

Underwater noise can be assessed qualitatively or quantitatively. A qualitative approach will approximate the likelihood of a sensitive species being present in the vicinity of a sound source and make an assessment of significance based on professional judgement. A quantitative approach uses modelling to predict the propagation of sound through the water column from the sound source. For either approach, the assessment follows a similar process to that described above, where modelling is used to determine the extent and scale of the impact magnitude.

Modelling can be used to determine the extent over which behavioural responses and auditory injury may occur. This usually requires separate modelling runs for each type of marine mammal (high-, mid- and low-frequency cetaceans and pinnipeds) as the frequency at which they perceive sound and the sound levels that they are affected by will differ. These extents can then be represented as a proportion of the overall range of a species or as a proportion of an affected population (based on the recorded density in the affected area).

Magnitude of Change

Ranking	Seabed	Water column
Negligible	Immeasurable, undetectable or within the range of normal natural variation.	Immeasurable, undetectable or within the range of normal natural variation.
Small	Minimal seabed disturbance or change to its physical and chemical composition.	Slight change in water quality expected over a limited area with water quality returning to background levels within a few metres to tens of metres. Discharges do not exceed effluent discharge limits. A temporary and localised physical change / source of disturbance e.g. presence or occasional presence of a vessel or small number of vessels.
Medium	Localised and/or short term disturbance of seabed, and/or change to its physical and chemical composition.	Temporary or localised change in water quality (e.g. from a long term effluent discharge) and / or occasional exceedance of effluent discharge limits. A physical change in the medium term over a relatively large area (eg multiple vessel movements within and to and from a marine construction area).
Large	Widespread and/or long term disturbance or permanent change to its physical and chemical composition.	Change in water quality over a large area that lasts over the medium to long term, likely to cause secondary effects on marine ecology and / or routine exceedance of benchmark effluent discharge limits. A long term change that affects a large area (e.g. a new commercial shipping route or port access) or introduces a permanent physical barrier to migration (eg between sea and rivers).

Sensitivity

Sensitivity is not an inherent characteristic of a receptor or resource. Receptor or resource sensitivity is the degree to which it is tolerant of, adaptable to and able to recover from a change in its environment. Therefore in addition to considering the importance/quality/value of the affected receptor or resource, its response (or sensitivity) to a particular impact is also considered. This is typically informed by literature review and the evidence base.

Ranking	Tolerance	Adaptability	Recoverability
High	Receptor unable to tolerate effect resulting in permanent change in its abundance or quality.	Receptor unable to avoid impact.	Receptor unable to recover resulting in permanent or long term change (e.g. >10 years).
Medium	Receptor has some ability to tolerate this effect but a detectable change (e.g. a change in distribution) will occur.	Receptor has some ability to avoid the most negative consequences of the impact or can partially adapt to it (e.g. by moving to other suitable areas).	Receptor recovers to an acceptable status over the short term to medium term (e.g. 1-10 years).
Low	receptor unaffected or positively affected.	Receptor can completely avoid the impact or adapt to it with no detectable changes.	Receptor recovers fully within e.g. 1 year.

Value / Importance

Ranking	Habitats	Species
Low	Marine habitats with no, or only a local designation / recognition. Marine habitats of significance for species listed as of Least Concern (LC) on IUCN Red List. Marine habitats which are common and widespread within the region, or with low conservation interest.	Species that are abundant, common or widely distributed and are generally adaptable to changing environments. Species are not endangered or protected, but may be listed as LC.
Medium	Habitats within nationally designated or recognised areas. Habitats of importance to globally Vulnerable (VU), Near Threatened (NT) or Data Deficient (DD) species, and species with nationally restricted ranges. Habitats supporting nationally significant concentrations of migratory species (more than 1% of national population) and / or congregatory species, and habitats used by species of medium value.	Species listed as VU, NT or DD. Species that have low abundance, restricted ranges, are currently under pressure or are slow to adapt to changing environments. Species are valued locally / regionally and may be endemic, endangered or protected. Species that do not meet criteria for High Value linked to IFC critical habitats.
High	Habitats within internationally designated or recognised areas. Habitats of importance to globally Critically Endangered (CR) or Endangered (EN) species, endemic and/or globally restricted-range. Habitats supporting globally significant concentrations of migratory species and / or congregatory species, highly threatened and/or unique ecosystems, areas associated with key evolutionary species, and low or medium value habitats used by high value species.	Species listed as CR or EN. Range restricted or endemic as defined in IFC criteria for Tier 1 or Tier 2 assessment (Guidance notes 81-83) Species that are valued nationally /globally and are listed as endangered or protected.

Overview

When assessing effects on humans from noise impacts, impact significance is not determined in the same way that it is for most other technical disciplines, i.e. using a matrix of impact magnitude and receptor sensitivity. Consideration of receptor sensitivity is instead made at the start of the assessment, and impacts are only assessed where sensitive receptors are identified. Receptor sensitivity is represented by impact thresholds/ criteria determined by reference to appropriate standards or guidelines. Impact significance is determined by comparing the acceptable receptor thresholds/ criteria with project noise emissions. The process followed to assess noise impacts on humans is presented below.

IFC Performance Standard 1 (Assessment and Management of Environmental and Social Risks and Impacts) includes objectives which are key to this Project, including to avoid, minimise, mitigate or compensate adverse impacts.

The IFC/World Bank EHS Guidelines describe assessing project noise levels against two metrics: allowable noise level criteria at the nearest noise receptors (noise impact thresholds) **or**, where pre-existing background noise levels exceed these noise impact thresholds, to not increase background noise levels by more than 3 dB.

Hence, there are two types of noise impacts that should be considered:

Step 1

Evaluate the characteristics of the surrounding environment and determine the assess-

Identify noise sensitive receptors (i.e. human or fauna) and their type (e.g. residential, school, medical, commercial)

Determine baseline noise levels for surrounding environment

Evaluate regulatory requirements for noise and applicable international guidance

Evaluate any stakeholder concerns or cultural sensitivities around noise

Step 2

Assess potential for noise emissions from the development (predictive modelling)

Modelling or measurement

Equipment noise level

Site geometry (topography, buildings, equipment location)

Noise characteristics (duration, tonal, intermittent, impulsive)

Weather conditions (Prevailing winds or temperature inversions)

Project noise levels (PNL) (day)

Project noise levels (PNL) (night)

Step 3

Assess the preliminary impacts

Disturbance Impacts

Difference between PNL and Criteria (PNL – Criteria)

Duration and frequency

Receptor Type

Period

Amenity Impacts

Difference between PNL and baseline ($PNL\ L_{Aeq,1hr} - L_{A90,1hr}$) or ($\Delta\ L_{A90,1hr}$)

See impact significance tables

Step 4

Apply mitigation and assess residual effects

Propose measures to mitigate adverse effects

Assess the significance of the residual effects

Disturbance impacts: for example sleep disturbance or annoyance, are possible when PNL are above noise impact threshold levels or, where pre-existing background noise levels exceed these noise impact thresholds, when PNL increase background noise levels by more than 3 dB.

Amenity impacts are more likely when existing noise levels (baseline) are relatively low, typically when background levels are less than 35 dB $L_{A90,1hr}$.

Determining Noise Impact Significance

Project Noise Levels (PNL) are compared to criteria to determine and evaluate impact magnitudes. The tables below present the impact significance fro both disturbance and amenity impacts.

Construction Phase: Noise impacts are usually determined by evaluating the likelihood of disturbance impacts, recognising that the IFC Guidance does not specifically give guidance on this.

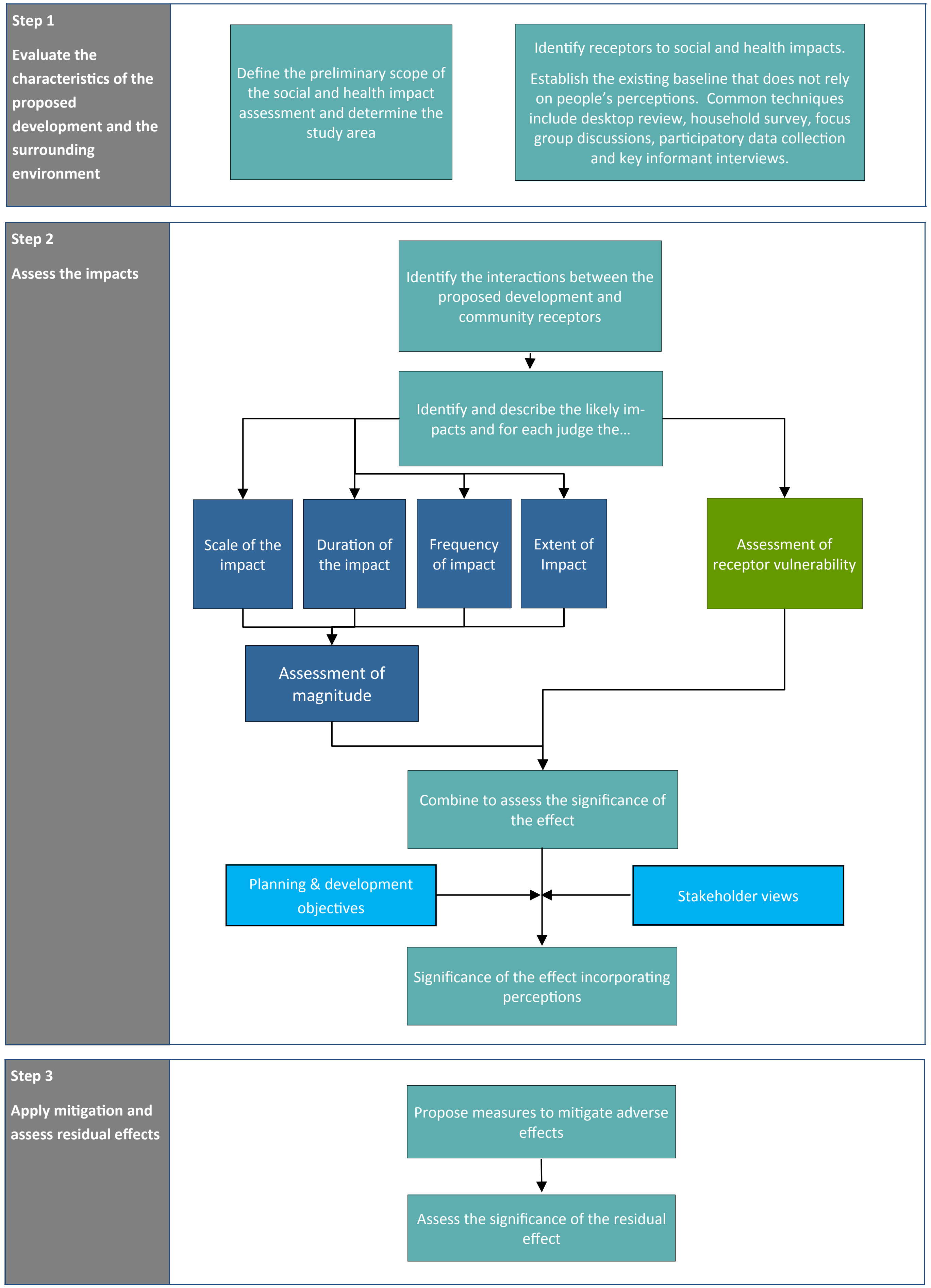
Operational Phase: Noise impacts are usually determined by evaluating the likelihood of disturbance impacts and amenity Impacts. Where there is a difference in impact significance between the two types, the higher rating should be taken.

Impact Significance—Disturbance Impacts

Duration / Frequency	Noise Receptor Type	Period	Project Noise Level (dBA)			
			Negligible	Minor	Moderate	Major
Permanent / Constant	Residential, institutional, educational	Daytime	<50	50-55	55-60	>60
		Night time	<40	40-45	45-50	>50
	Industrial, commercial	Daytime & Night time	<65	65-70	70-75	>75
Temporary, long-term / Often	Residential, institutional, educational	Daytime	<55	55-60	60-65	>65
		Night time	<45	45-50	50-55	>55
	Industrial, commercial	Daytime & Night time	<70	70-75	75-80	>80
Temporary, medium-term / Occasional	Residential, institutional, educational	Daytime	<65	65-70	70-75	>75
		Night time	<50	50-55	55-60	>60
	Industrial, commercial	Daytime & Night time	<70	70-75	75-80	>80
Temporary, short-term / Rare	Residential, institutional, educational	Daytime	<70	70-75	75-80	>80
		Night time	<55	55-60	60-65	>65
	Industrial, commercial	Daytime & Night time	<70	70-75	75-80	>80

Impact Significance—Amenity Impacts

Duration / Frequency	Noise Receptor Type	Period	PNL L_{Aeq1hr} - $L_{A90,1hr}$ (for background noise above L_{A90} 30 dB)			
			Negligible	Minor	Moderate	Major
Permanent / Constant	Residential	All	<5	5-10	10-15	>15



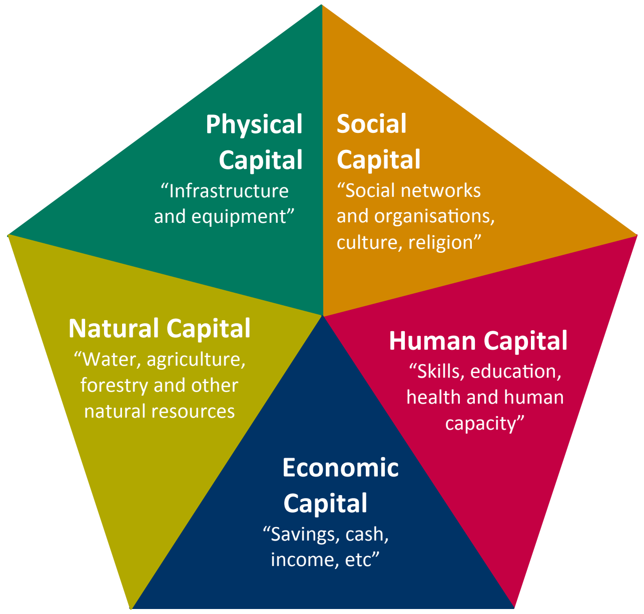
Magnitude of Change

The approach for designating magnitude for social or community health impacts takes a "best fit" approach whereby the various characteristics contributing to magnitude (scale, duration, extent, frequency) are considered in together, and the appropriate description is selected based on the overall combination of characteristic values using the judgement of the practitioner.

Magnitude	Community Receptors
Negligible	Change remains within the range commonly experienced within the household or community.
Small	Perceptible difference from baseline conditions. Tendency is that impact is local, rare and affects a small proportion of receptors and is of a short duration.
Medium	Clearly evident difference from baseline conditions. Tendency is that impact affects a substantial area or number of people and/or is of medium duration. Frequency may be occasional and impact may potentially be regional in scale.
Large	Change dominates over baseline conditions. Affects the majority of the area or population in the area of influence and/or persists over many years. The impact may beexperienced over a regional or national area.
Positive	In the case of positive impacts, it is generally recommended that no magnitude be assigned, unless there is ample data to support a more robust characterisation. It is usually sufficient to indicate that there will be a positive impact, without characterising the exact degree of positive change likely to occur.

Determining Vulnerability

Vulnerability describes the sensitivity of the receiving environment (i.e. societies, communities and households) that will experience impacts. A vulnerable individual or group is one that could experience adverse impacts more severely than others, based on his/her vulnerable or disadvantaged status. Vulnerability is a pre-existing status that is independent of the project under consideration. It is important to understand the vulnerability context as it will affect the ability of social receptors to adapt to socio-economic/cultural or bio-physical changes. A higher level of vulnerability can result in increased susceptibility to negative impacts or a limited ability to take advantage of positive impacts. More vulnerable receptors will tend to lack one or more livelihoods assets that could help them to respond to, or manage, change (see figure—right). The characteristics that underpin vulnerability will be specific to each social setting, however, the following general definitions can apply.

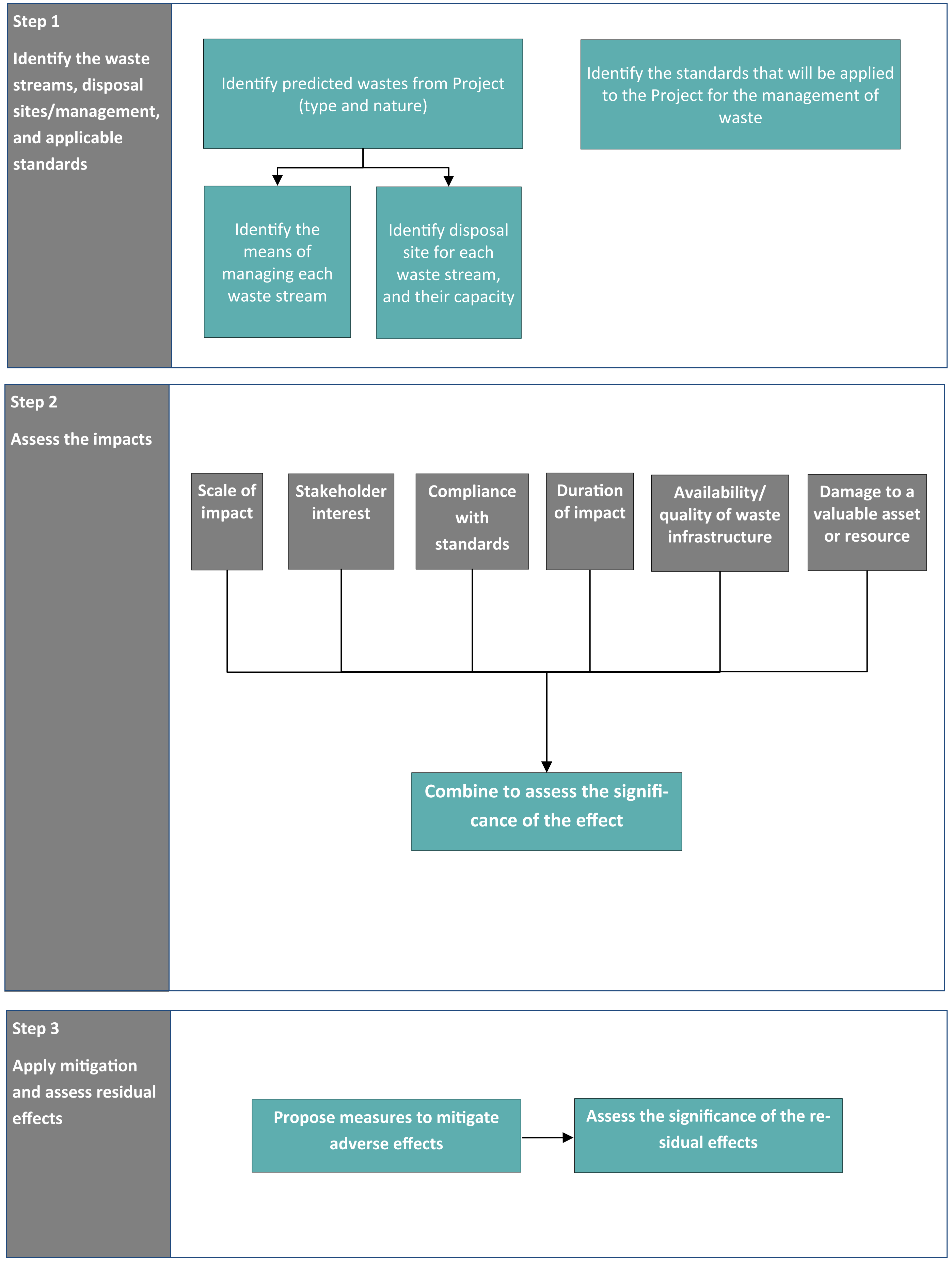


Vulnerability	Community Receptors
Low	Minimal areas of vulnerabilities; consequently with a high ability to adapt to changes brought by the Project
Medium	Some but few areas of vulnerability; but still retaining an ability to at least in part adapt to change brought by the Project
High	Profound or multiple levels of vulnerability that undermine the ability to adapt to changes brought by the Project

Integrating Stakeholders, Policy and Planning Perceptions

Impacts should be considered within the context of the local setting as set out in policy or development objectives and / or the view and perceptions of the local people. These priorities and views should be integrated into the assessment when evaluating the effect significance, ideally after an initial significance has been rated.

It is possible that the community will have a different perception of an impact than that expected; this is commonly referred to as a perceived impact. The effects of a perceived impact can be just as 'real' as those from other impacts and should be captured, but should be clearly differentiated. Failure to adequately address perceived impacts and the effects they cause is just as likely to result in project delays as other impacts assessed.



Introduction

The potential for impacts relating to waste management are assessed based on the following key considerations:

- anticipated waste arising from the Project;
- the proposed means of managing/disposing of the different wastes generated by the Project; and
- The standards to be employed by the Project for waste management.

Waste management standards apply to the following activities:

- handling and storing of waste prior to treatment or disposal;
- transport of waste from the point of arising to final treatment or disposal (including measures taken to track the waste);
- any landfill sites to be used;
- any incinerators to be used;
- any wastewater facilities to be used; and
- any recycling facilities (assuming information is available).

In the case of waste management, a discrete quantification of the impact magnitude and receptor sensitivity is not carried out. Rather the assessment is focused on the quantification of potential waste arising, the availability of suitable treatment and disposal facilities and the potential need to store wastes for which no treatment and/or disposal capacity exists in the region. As such the overall impact significant is determined following the considerations listed below. Note, in situations where stakeholder interest is high, it may be appropriate to increase the impact significance by one level higher than otherwise predicted to account for these concerns.

Impact Significance	Description
Negligible	The effect is temporary, of low scale/ magnitude, within accepted standards etc., and of little concern to stakeholders. For example: The waste can be managed at approved/licensed facilities which meet international standards with little or no impact on the capacity for wastes from other local sources to be managed appropriately.
Minor	The waste causes an adverse effect on a sensitive receptor although the effect is either temporary or mainly within currently accepted standards. The impact should be mitigated where cost effective measures are available. For example: The waste can be managed at locally approved/licensed facilities although the facilities may not fully align with international standards and/or the management of the project's wastes will adversely impact on the local waste management capacity.
Moderate	The effect on a sensitive receptor must be mitigated (either because it breaches relevant standards, norms, guidelines or policy, or causes long–lasting damage to a valuable or scarce resource). For example: The waste can be managed at a locally licensed/permitted site although the performance standards of the site are well below international standards and/or the management of the project's wastes will have a serious impact on the local waste management capacity.
Major	The waste causes an unacceptable effect on a sensitive receptor (either because it breaches standards or norms relating to human health and livelihood, or causes irreversible damage to a valuable asset or resource). For example: Dumping of waste at unlicensed sites or which is likely to cause pollution of drinking water resources or uncontrolled burning of the waste resulting in smoke which may impact health of nearby residents.

Overview

To evaluate potential impacts from unplanned events, a risk-based approach is used to define: 1) the most likely unplanned events leading to environmental, social and/or community health impacts; and 2) those unplanned events with the most significant potential environmental, social and/or community health impacts overall. Impact significance for unplanned events is therefore determined by evaluating the combination of likelihood and consequence.

Step 1

Assess the Scale of Consequence

Indicative levels of consequence for potential impacts from unplanned events can be defined for the physical, biological, and social environment as provided below.

	Incidental	Minor	Moderate	Major	Severe
Physical Environment	Impacts such as localised or short term effects or environmental media, meeting all environmental standards	Impacts such as widespread, short-term impacts to environmental media, meeting all environmental standards	Impacts such as widespread, long-term effects on environmental media, meeting all environmental standards	Impacts such as significant, widespread and persistent changes in environmental media OR Exceedance of environmental standards	Exceedance of environmental standards and fine/ prosecution
Biological Environment	Impacts such as localised or short term effects on habitat or species	Impacts such as localised, long term degradation of sensitive habitat or widespread, short-term impacts to habitat or species	Impacts such as localised but irreversible habitat loss or widespread, long-term effects on habitat or species	Impacts such as significant, widespread and persistent changes in habitat or species	Impacts such as persistent reduction in ecosystem function on a landscape scale or significant disruption of a sensitive species.
Social Environment	Slight, temporary, adverse impact on a few individuals	Temporary (<1 year), adverse impacts on community which are within international health standards	Adverse specific impacts on multiple individuals that can be restored in <1 year OR One or more injuries, not lost-work injuries.	Adverse long-term, multiple impacts at a community level, but restoration possible. OR One or more lost-work injuries to a member of the public including permanently disabling injuries.	Adverse long-term, varied and diverse impacts at a community level or higher – restoration unlikely. OR Fatalities of public.

Step 2

Assess the Likelihood

For the purposes of assessment, the likelihood of an unplanned event occurring can be classified as follows:

1 - Very unlikely, not known in the industry

2 - Unlikely to occur but known of in the industry

3 - Likely to occur once or more in life of the Project

4 - Likely to occur once or twice per year

5 - Will likely occurs more than twice per year, or is continuous or certain to occur

Step 3

Assess the Significance

The consequences and likelihood of potential unplanned events are combined to determine the overall impact significance using the risk matrix shown here.

For potential impacts that are determined to have an impact significance of Moderate or Major, mitigation measures are identified. Note that mitigation can include measures that reduce the likelihood of the event from occurring (i.e. barriers) and those that reduce the consequences on sensitive receptors/resources if the event were to occur.

			Likelihood of Occurrence				
			1	2	3	4	5
Consequence	Incidental	A	Negligible	Negligible	Negligible	Negligible	Negligible
	Minor	B	Negligible	Minor	Minor	Minor	Moderate
	Moderate	C	Minor	Minor	Moderate	Moderate	Major
	Major	D	Moderate	Moderate	Major	Major	Major
	Severe	E	Major	Major	Major	Major	Major

Annex B:
Alternatives Assessment

1.1 INTRODUCTION

The *Planning & Building Regulations (Environmental Impact Statements) 5763-2003* require that the Environmental Impact Statement (EIS) describe the alternatives considered. This Annex describes the work carried out to select the design concept and the process that will be followed for assessing design options.

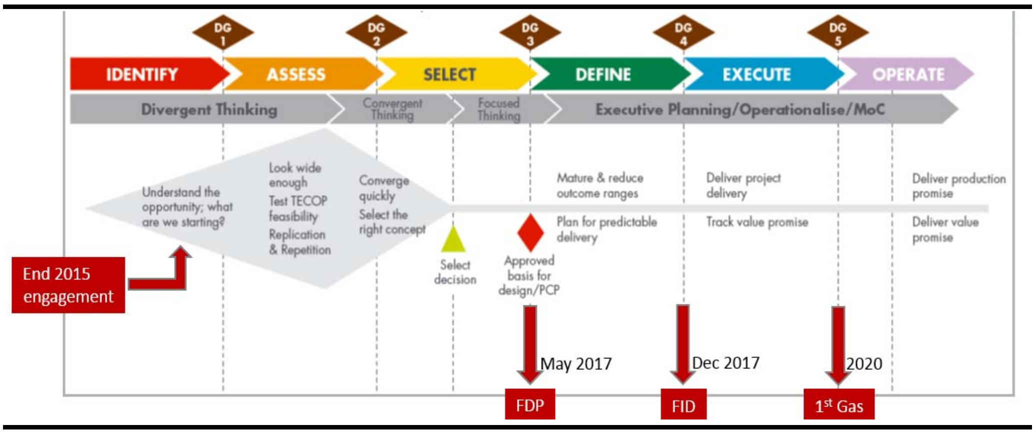
The aim of considering alternatives is to evaluate reasonable options which could be pursued that meet the Project's objectives with less impact on the environment.

For the Project the main alternatives considered to date include the overall design concept, the location of onshore facilities, and the pipeline landfall construction method. A 'no development' option was also considered. In addition to the overall design concept, an evaluation of some of the key detailed technical design measures that have significant environmental implications has also been provided.

1.2 DESIGN PROCESS AND TIMELINE

Energean uses a stage-gate process (illustrated in *Figure 1.1*) for planning the Karish and Tanin development. The process is based on passing a series of decision gates (DGs) at the end of a number of development stages, namely Identify, Assess, Select, Define and Execute. Specific conditions must be met before development can continue past a DG. Alongside the stages are several phases of 'thinking', which broadly define whether the process is generating more options or discounting / refining existing ones.

Figure 1.1 Energean Stage-Gate Process (Karish and Tanin)



Planning for the development started in early 2015 and is ongoing. The progress to date is summarised below.

- The *Identify* stage was carried out in mid-2015 and the initial development ideas were presented to the Israeli authorities in late 2015. This stage demonstrated that the development was commercially viable meaning that the project passed DG1 into the Assess stage.

- The *Assess* stage, which looked at the different ways of developing the Karish and Tanin fields, was completed by August 2016. A *Select* decision was taken early December 2016.

- The project is currently in the *focused thinking* phase of the *Select* stage. Energean is being supported by Genesis (a UK based specialist FEED company) for the remaining elements of the Select stage as well as to steer the project through DG3 and into the *Define* stage. The Field Development Plan (FDP), which this Scoping Report is included within, marks DG3.

1.3 NO DEVELOPMENT OPTION

The decision on whether to proceed with the development is made during the *Identify* step based on its commercial viability.

A decision not to proceed with the development would result in a reduction of potential gas revenues to Israel and loss of any associated benefits to the national economy. Proceeding with the project establishes an additional fuel supply that provides greater redundancy of gas supply, which would allow Israel to switch over more power generation facilities from higher polluting fuels (coal, heavy fuel oil) to cleaner burning fuel (gas). The Project will also result in increased domestic gas supply and provides potential for future oil and gas exports beyond Israel, as well as employment creation.

The option of not proceeding with the development was therefore disregarded when considered against the socio-economic benefits.

1.4 ASSESSMENT OF DEVELOPMENT OPTIONS

1.4.1 Overview

Following the decision discount of the no development option, the overall concept of the development was considered (i.e. the different ways to develop the fields). A wide number of options were identified and evaluated during the *Assess* step based on two concepts.

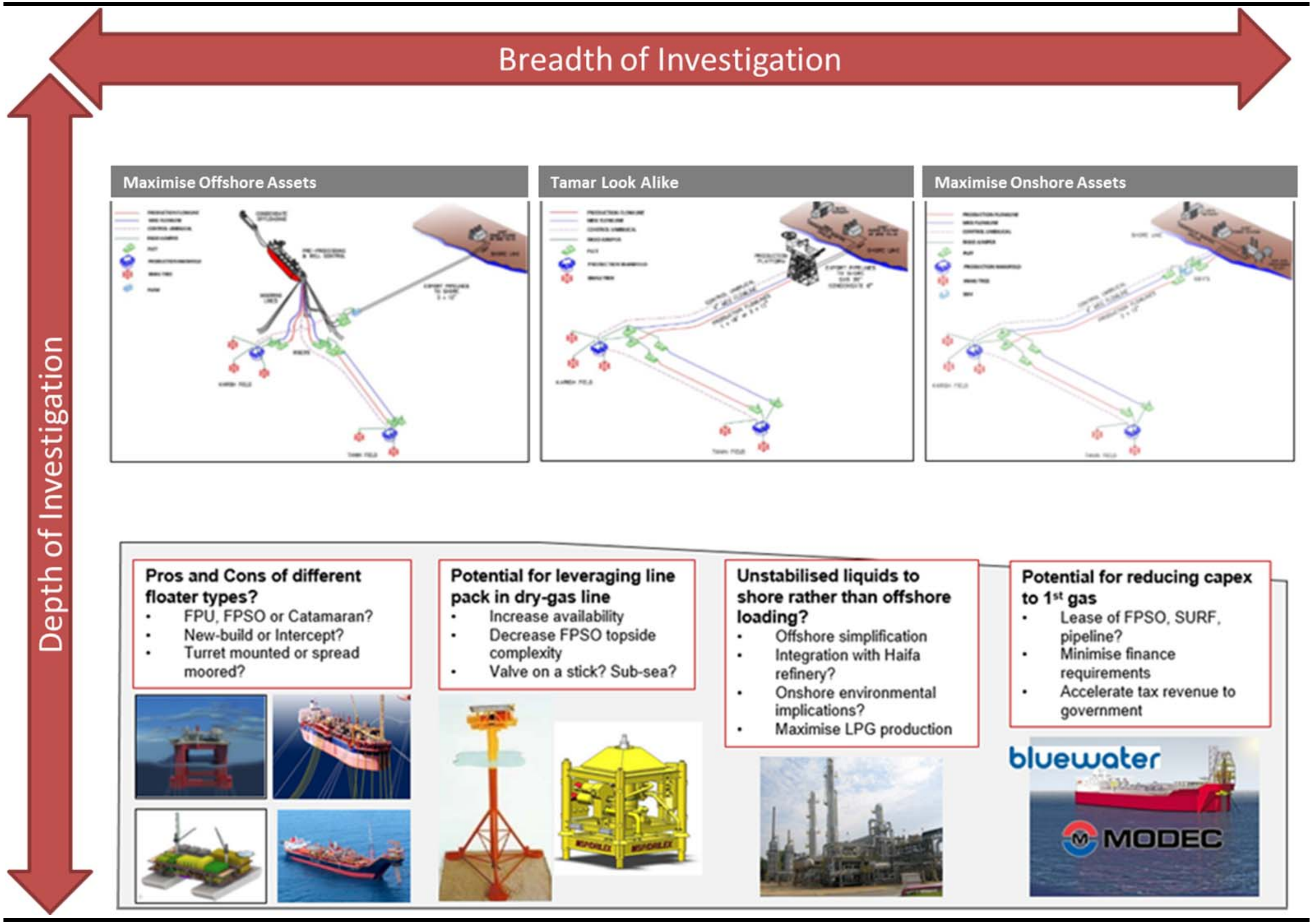
- **Maximise offshore assets.** All separation and processing facilities would be located offshore at the Karish field. The only onshore element of this concept would be a short length of the dry-gas pipeline (plus metering facility) required to connect with the INGL system at the extended Dor Valve Station (DVS).

- **Maximise onshore assets.** All separation and processing facilities would be located onshore in an area adjacent to the existing power station at Hagit. Using this location would require pipelines and umbilical cables to be routed along a defined corridor between Dor and Hagit. It would also necessitate a pressure reduction facility offshore to ensure fluid pressure would not exceed 110 bar (the limited imposed by Israeli legislation).

These concepts were used as a starting point to optimise existing options (by changing specific elements and assumptions) and define additional hybrid concepts by combining elements the different concepts. Initial work focused on identifying a broad range of development approaches based upon the geographic location of the facilities required to process the produced fluids.

Figure 1.2 provides an overview of the initial development options.

Figure 1.2 Overview of Development Options

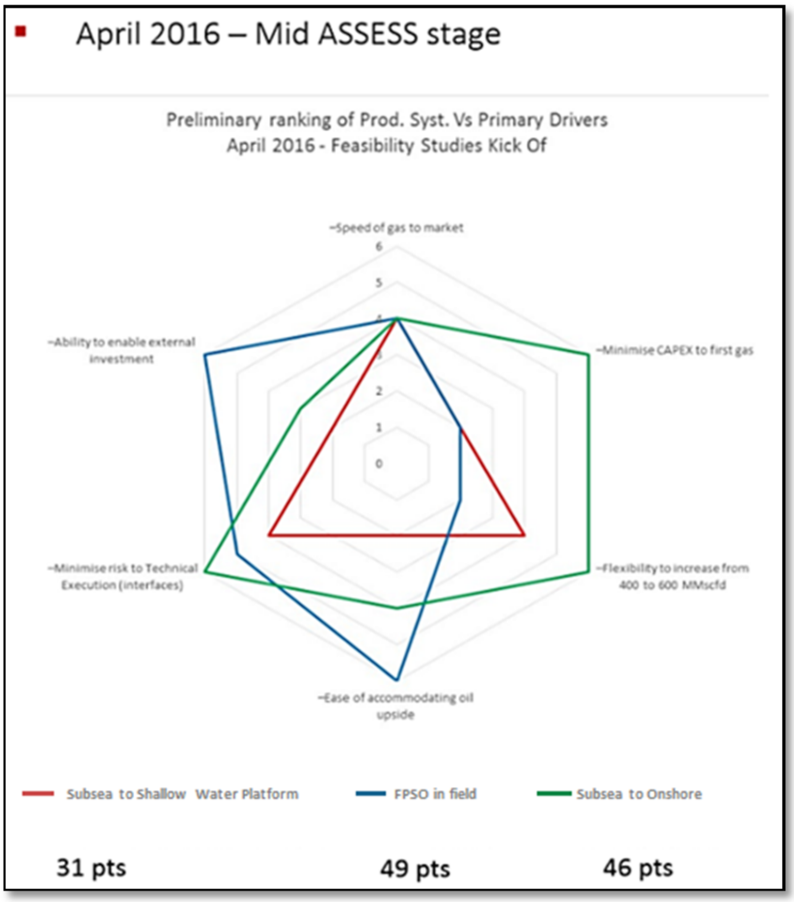


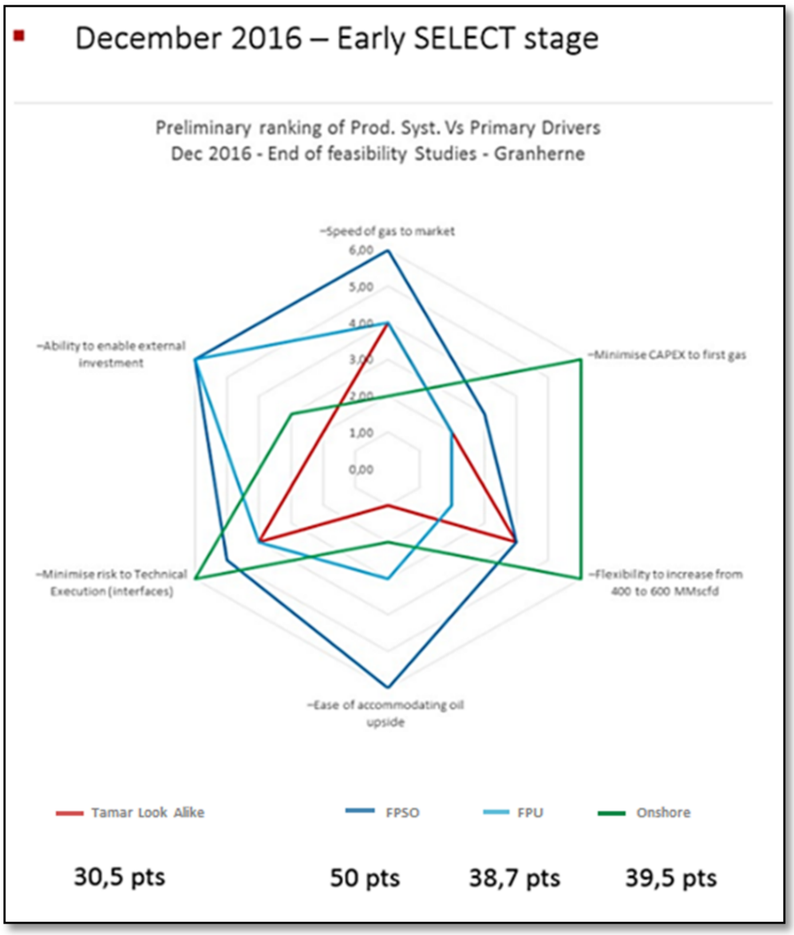
Energean assessed the concept options based on a number of value drivers, rather than simply on the basis of cost. These value drivers were:

- delivery of gas to the Israeli gas market as early as possible;
- minimised capex to first gas;
- flexibility to increase production capacity as market demand grows;
- ease of accommodating additional oil production from a deeper horizon;
- ability to allow 3rd party access;
- minimised project execution risk;
- ability to attract external investments;
- **minimised environmental footprint**; and
- the ability to accelerate and maximise the government revenue stream.

Error! Not a valid bookmark self-reference. illustrates how the three concepts were initially ranked against the primary value drivers.

Figure 1.3 Ranking during Assess and Select Against Primary Drivers Only





As *Figure 1.3* excludes consideration of environmental and social impacts, the following sections present a high level evaluation of the environmental and social implications of each option.

1.4.2 Environmental and Social Considerations

Offshore Development Option

An offshore processing option is preferred by the National Outline Plan 37/H for Natural Gas Treatment facilities and has been selected by Energean for more detailed design in the Define step.

The disadvantages from an environmental perspective is that the offshore concept will have a larger seabed footprint compared to the other concept options from the wells, mooring anchors, manifolds, flowlines and pipeline. However, this footprint is expected to small when compared to the total available space in Israeli waters. The subsea equipment will be located away from any potentially sensitive areas of the seabed (to be confirmed during the Environmental Baseline Survey, EBS) and assessed fully in the ESIA. Suitable mitigation measures will be utilised so that any potential impacts to the marine environment will be minor or negligible.

This increased seabed footprint offshore is considered highly favourable when compared with the disturbance that would be caused by having the processing facilities either onshore or in shallower waters, which are more sensitive from an environmental perspective. More critically, a development nearshore onshore would have significantly more social impacts, especially as the area near Dor is a popular destination for tourists and recreational users.

Being located further from shore is also considered advantageous from a safety and security perspective. The TAMA/37/H prefers that all offshore gas processing facilities are located as far from shore as reasonably possible.

In addition, any emissions and discharges, from both planned and unplanned events, will be located further from shore in conditions that are more favourable to dilution and dispersion.

From an environmental and social perspective, this is the preferred development option.

Onshore Development Option

The benefits of an onshore development option are a smaller offshore footprint and reduction in the complexity associated with offshore construction, installation and operation. However, with the exception of the small footprint, there are no environmental and social considerations that would make an onshore option advantageous. The component of the Project that will cause the most disturbance, namely the pipeline landfall crossing Dor beach, is still required to receive gas from the offshore fields.

Hybrid Development Option

One hybrid alternative investigated involved the removal of the liquid stabilisation equipment from the FPSO and locating this either adjacent to the Hagit power station or at the refinery in Haifa. This option would simplify offshore processing complexity, introduce the option of using a Floating Production Unit (FPU) rather than an FPSO and allow heavy, LPG rich flash gas and heavier ends to be liquefied and routed to the Haifa refinery via pipeline rather than being recovered and exported offshore. However, the hybrid alternative increases the projects onshore footprint and potential to impact on other nearby enterprises and residents. It is the recommendation of TAMA/37/H that all onshore aspects of gas processing onshore be minimised.

Summary

As the case taken forward, the Offshore Development Option, is the preferred option from an environmental and social perspective, no further assessment of the environmental and social performance of the potential options has been conducted.

1.5 ASSESSMENT OF ONSHORE LOCATION OPTIONS

The Project will be using the same landfall and gas receiving facilities as the proposed Leviathan development. This includes a landfall south of Dor and connection to coastal valve station (CVS) and Dor Valve Station (DVS). This location was originally identified based on the recommendations included in TAMA/37/H. As part of the impact assessment process for Leviathan, a location for the landfall and CVS has been selected and agreed with the Israeli authorities. By using this same landfall location and pipeline corridor, impacts associated with land take can be minimised across these different projects. Because Energean is restricted to using this landfall location no further alternatives have been considered.

1.6 ASSESSMENT OF LANDFALL CONSTRUCTION OPTIONS

Two landfall construction options were considered, namely an open trench and microtunnelling.

The open trench would have required the beach landing area to be cleared and levelled and a cofferdam constructed. A cofferdam of this nature would likely have significant impact on coastal processes in an area with potential turtle nesting activity. Moreover, a cofferdam would likely impact beach users (both local recreational users and tourists) in the short to medium term.

The microtunnel option was selected because it minimises disturbance at the Dor beach area. The Leviathan development, with which the Project will share the landfall and gas connections to CVS and DVS, has selected to use horizontal directional drilling (HDD). Energean will investigate potential construction synergies with Leviathan to further reduce disturbance to the beach area.

1.7 *ASSESSMENT OF ONSHORE PIPELINE CONSTRUCTION OPTIONS*

The base case is the onshore pipeline to be trenched between the Coastal Valve Station (CVS) and the Dor Valve Station (DVS). As best practice, microtunneling will be used to cross the Haifa – Tel Aviv railway and Coastal Highway 2 to avoid impacts to major public infrastructure. Energean considered using microtunneling for the entire route rather than just the crossings. This would reduce the impacts associated with trenching and reinstating the pipeline route. However, given that the land is already modified and there is no evidence of recent use, it was judged the additional cost was not justifiable given the temporary nature of trenching impacts.

1.8 *ASSESSMENT OF KEY TECHNICAL MEASURES*

Because the project is still in the design phase, a detailed evaluation of all technical design measures cannot be conducted yet. However, to verify that international best practice is used, the project has conducted a review of the applicable Best Available Techniques (BAT) measures. This assessment has evaluated what measures would be considered best practice according to guidance from the European Union. These measures will be applied and verified by the project once the design phase is completed.

Whilst the full, detailed evaluation of the technical design options cannot be done at this stage, a review of some of the key design decisions that have the potential to affect environmental performance is provided below.

1.8.1 *FPSO Power Generation*

The FPSO central power plant (CCP) will include three gas driven turbogenerators that will have Dry Low Emissions (DLE) technology installed to minimise NO_x emissions. Using DLE technology means that the turbogenerators will be compliant with the latest NO_x emissions limits set out in the EU BAT reference document (BREF) for large combustions plants. The technology is not widely used for offshore installations and the decision has been made to reduce the overall pollutant emissions profile of the project.

1.8.2 *FPSO Storage Capacities*

The FPSO will have oversized storage capacities relative to the expected production levels of oil and produced water from the Karish Main field. The alternative was to have storage capacities more in-line with the expected production of just the Karish Main field. By having a larger storage capacity, Energean has the flexibility to only offload oil to sales tankers during optimum weather conditions. This reduces the likelihood of a collision occurring between a tanker and the FPSO that could result in an environmentally damaging oil spill.

Similarly, having an over-sized produced water storage capacity provides Energean with the flexibility to increase the residence time in the storage tanks. This will allow Energean extra control to verify that the water quality meets discharge specifications agreed with the Israeli MOEP prior to any discharge.

1.8.3 Production Hub

The FPSO will have sufficient deck space so that the processing facilities can be expanded to accommodate tie-in of future fields or export systems. By using the Karish FPSO as a production hub, the environmental and social impacts associated with any new developments will be prevented or reduced.

1.8.4 Drilling Fluid

Drilling fluids can either be water-based or non-aqueous. Energean has committed to only water-based drilling fluids (or 'muds') for the development. These are primarily (approximately 75%) water and are essentially non-toxic. The majority of spent WBM are classified under Annex 6 of the OSPAR Convention as substances which are considered to 'Pose Little Or No Risk' to the environment (PLONOR chemicals). The alternative to this design would be to utilise non-aqueous drilling fluids (NADFs) comprised of either oil based muds or synthetic oil based muds. NADFs include constituents that have a toxic effect on marine life, thereby making them more harmful to the environment. The use of NADFs is sometimes required for technical and safety reasons when drilling through particular subsurface formations; however, the subsurface conditions in the Karish Main field are such that Energean can use exclusively water-based muds, thereby reducing the impacts associated with drilling discharges.

Annex C:

Supporting Information on the Air Dispersion Modelling Conducted

1.1 INTRODUCTION

Air dispersion modelling was used to estimate potential impacts from offshore and onshore Project emissions. The model predicts the ground level/sea level increases in pollution concentrations attributable to the project's emissions, and these concentrations are then assessed against the applicable air quality standards and guidelines.

1.2 DISPERSION MODEL

The impacts from the combustion processes both offshore and onshore were assessed using the USEPA AERMOD model. AERMOD is one of a 'new generation' of dispersion models which describe the atmospheric boundary layer properties. AERMOD allows for the modelling of dispersion under convective meteorological conditions using a skewed Gaussian concentration distribution. It is able to simulate the effects of terrain and building downwash simultaneously. It can also calculate concentrations for direct comparison with air quality standards or guidelines.

AERMOD is internationally recognised for the assessment of near-field impacts (<20km from source). Other models, for example Calpuff, are designed for longer range assessments (>20km from source to receptor), or where there are particular issues to be dealt with including terrain and coastal fumigation. Whilst the onshore element of this project is located on the coast, fumigation is only an issue for taller stacks where the plume transition between stable air arriving from over the sea to more turbulent conditions over land. In this case, as the stacks are short, the plume is directly emitted into the more turbulent over land conditions. Additionally, for the offshore emission sources, the most significant concentrations are expected to be within the immediate vicinity of the FPSO (e.g. <20 km). For these reasons, AERMOD is considered the most appropriate model to assess impacts from this project.

1.3 BASIS OF DESIGN AND ASSUMPTIONS

1.3.1 Onshore Pipeline Commissioning

It was assumed that all the modelled compressors, pumps and generators will be operating 8760 hours per year and all at the same time. No consideration of different emissions during start-up and shutdown has been made. *Table 2.5* in the main report shows the emission parameters as used in the model for the onshore activities. At the time of this assessment, the final engine models and characteristics had not been agreed. As such, data from potential vendors was used to determine representative information for the engine size, emission volume flow rate, exhaust temperature, stack height and diameter.

Energean confirmed that the project will be compliant with the stage IIIB NO_x and PM_{10} emission limits as set out in the European Directive 97/68/EC[(1)] (as amended) on non-road mobile machinery emissions.

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(1) Directive 97/68/EC of the European Parliament and of the Council of 16 December 1997 on the approximation of the laws of the Member States relating to measures against the emission of gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machinery, as amended.

The final location of the engines in the staging areas was also unconfirmed at the time of the assessment. It has been assumed that these are in the most north east corner of the staging area, which is the most conservative location as it is the closest to the sensitive human receptors in the settlements. The layout of the engine compound was supplied by Energean.

1.3.2 *Offshore FPSO Operations*

It was assumed that all the modelled turbines and flare will be operating 8,760 hours per year. No consideration of different emissions during start-up and shutdown has been made. *Table 2.4* in the main report shows the emission parameters as used in the model for the offshore activities. The turbines' characteristics were provided by Energean and are representative of the most probable system to be installed. The flare emissions parameters have been estimated from the gas composition and physical parameters provided by Enegean using the Alberta modelling method for flaring[(1)].

1.4 MODELLING DOMAIN

The study area for the onshore assessment was taken as a 5 km radius from the Project's eastern staging area. The impact at all sensitive human receptors in the northern and eastern settlements within the study area have been considered. The maximum off-site impact was also included as the nearby beach is used for recreation. This modelling domain also includes the sensitive ecological receptors in the area of influence.

The study area for the offshore assessment was taken as a 15 km radius from the Project's FPSO. There are no nearby permanent sensitive receptors within this area as it is an open sea. However, occasionally vessels may approach, including fishing boats. As no precise location can be determined for those boats, the whole area within 15 km from the FPSO was assessed. The nearest onshore receptors are approximately 70km distant. At this distance the magnitude of impact from the FPSO's emissions will be negligible. Onshore receptors have therefore not been included in the assessment of offshore operations' impact.

1.5 METEOROLOGICAL DATA SELECTION

The meteorological data used in the model must be reflective of the local conditions. There are only a limited number of meteorological stations in Israel which measure all of the parameters required by the model. A review of available meteorological sites was undertaken, which focussed on the surrounding land use, the surrounding terrain and relative proximity to the coast. As the offshore FPSO operations were modelled, no onshore meteorological stations could be representative of those conditions. On this basis, meteorological data was bought from Lakes Environmental. WRF model based data was purchased, centred on the FPSO's location.

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(2) Alberta Environmental Sustainable Resource Development (ESRD) (2017) https://www.aer.ca/rules-and-regulations/directives/directive-060

Five years of hourly meteorological data were used, so that inter-annual variability is incorporated in the model. The results of the assessment are based upon the worst case result for any of the five meteorological years used. The wind roses for 2012 – 2016 are presented in *Figure 6.9* of the main report and show that the prevailing wind direction is mainly from the west.

1.6 CONSIDERATION OF TERRAIN EFFECTS

Changes in terrain elevations (i.e. hills or mountains) can have a significant impact on dispersion of emissions, in terms of funnelling of plumes and changing local wind flows. Terrain effects are typically considered important where there are sustained gradients of 1:10 or greater.

Both study areas are situated flat areas. In the case of the FPSO, open water and in the case of the staging area, a flat coastal plain. On this basis, terrain was not included in the model for both offshore and onshore areas.

1.7 CONSIDERATION OF LAND USE

The surrounding land uses determine the disruption of airflow close to the ground due to obstructions and protuberances, such as buildings, trees and hedges. The open water surrounding the FPSO has been reflected in the case of the offshore model. A mix of open water and agricultural land has been used to represent the shore to the west and the grasslands to the west of the onshore staging areas.

1.8 CONSIDERATION OF BUILDING DOWNWASH

When air flow passes over buildings, a phenomenon known as building downwash occurs where the air is entrained in the lee of the building and drawn down to ground level. This phenomenon can bring the plume from the stack down to ground level more quickly than would otherwise be the case, and therefore increase the ground level concentration relative to a case where there are no buildings.

For the onshore location, the engines are principally contained within shipping containers. Due to the low stack heights, downwash effects will be minimal and these were not included. The FPSO vessel was included as a 250m by 45m by 20m rectangular building as it is the most probable dimension of the ship.

1.9 GRIDDED RECEPTORS

No specific receptors were entered directly in the model. Nested receptor grids centred on the FPSO for the offshore model and on the engines on the staging area for the onshore model, covering their respective study areas. The impacts at receptors were then identified from the results at these receptors. *Table Error***! No text of specified style in document.**.1 presents the grid resolution used. A fine grid was used close to source to capture the maximum impacts; a coarser grid was used further afield as emissions become more dispersed, in order to limit the number of receptors and therefore model run-time.

Table** Error! No text of specified style in document.**.1 ***Nested Grids Resolution***

Distance from the Centre of the Grid (km)	Resolution (m)
Offshore Model – Centred on the FPSO	
0 – 1	50
1 – 5	250
5 – 15	500
Onshore Model – Centred on the Engines for Pipeline Commissioning	
0 – 0.5	50
0.5 – 2	150
2 – 5	350

1.10 CONVERSION OF NO_x TO NO_2

Emissions from the assets contain NO_x. These occur as both nitric oxide (NO) and NO_2. The ratio of these two gases in the exhaust gases from combustion processes varies, but is typically in the ratio of 90-95% NO to 5 – 10% NO_2. With regard to the assessment of impact on human health NO_2 is the pollutant of interest as NO has little effect on human health at concentrations typically encountered in ambient air.

Within the atmosphere various processes oxidise NO to create NO_2 but this process will not occur quickly or completely before the plume reaches ground level. Therefore it is overly pessimistic to assume 100% conversion from NO_x to NO_2, and it is necessary to use a factor to estimate ground level concentrations of NO_2 based upon total NO_x emitted.

A number of international agencies have developed guidelines for including in assessments the conversion of NO_x to NO_2. A summary of selected guidelines are set out below in *Table Error***! No text of specified style in document.**.2 which indicates that a wide range of ratios to convert NO_x to NO_2 recommended by a variety of agencies.

Table** Error! No text of specified style in document.**.2 ***Recommended NOx to NO2 Conversion Ratio***

Country	Averaging Period	Recommended NO_x to NO_2 Conversion Ratio
United States	1 hour	80%
	Annual	75%
Germany	24 hour	60%
	Annual	60%
United Kingdom	Short term (1 hour)	35%
	Annual	70%
Hong Kong	24 hour	20%
	Annual	20%
Ontario, Canada	24 hour	52%
	Annual	68%

The conversion rates from the USEPA are for the purposes of screening, and are conservative. Those from the UK are intentionally more pragmatic, and in the interests of not over-engineering the project due to over-estimation of impacts, these have been used. A 70% conversion rate for long term and a 35% conversion rate for short term were used in this assessment to convert the modelled NO_x concentrations.

Annex D:
Environmental and Social Management Plan (ESMP)

Ref No	Aspect	Potential Impact Managed	Priority	Management Control	Responsibility - Organisation	Responsibility - Individual	How has implementation been documented?
E1	Air quality, Community health	Reduced air quality impacting local community health	High	All non-road engines rated at greater than 300 kW that are used onshore will comply with the European Union's Stage IIIB NO_x emission standards for non-road engines.	Energean and Technip	Design team (TBC)	Include name of design document following completion of detailed design
E2	Air quality, Community health	Reduced air quality impacting local community health	High	Only use low sulphur diesel fuel (i.e.10 ppm or less) for the onshore non-road engines.	Energean and Technip	Design team	Include name of design document following completion of detailed design
E3	Noise and vibration	Impacts on noise sensitive receptors	High	Verify that equipment suppliers undertake measurements to certify that construction equipment to be mobilised on site are compliant with the applicable Israeli guidance: Abatement of Nuisances Regulations (Unreasonable Noise from Construction Equipment), 1979.	Energean and Technip	Design team	Include name of design document following completion of detailed design
E4	Terrestrial biodiversity	Degradation and loss of habitat, Loss of sensitive fauna (e.g. turtles)	High	Conduct microtunnelling for the pipeline landfall to avoid conducting open trenching within the beach habitat.	Energean and Technip	Design team	Include name of design document following completion of detailed design
E5	Unplanned events	Environmental impacts from an unplanned release of chemicals/oil to water	High	Design the site to include good site management practices to ensure that the products are properly stored on site (e.g. secondary containment, double walled tanks, over filling alarm system, etc.).	Energean and Technip	Design team	Include name of design document following completion of detailed design
E6	Unplanned events	Environmental and social impacts associated with an accidental pipeline rupture	High	Ensure the buried pipeline is indicated on site with marks or plots and that people working nearby are aware of the pipeline route	Energean and Technip	Design team	Include name of design document following completion of detailed design
E7	Unplanned events	Environmental and social impacts associated with an accidental pipeline rupture	High	For aboveground section of the pipeline, ensure access to the pipeline is restricted (e.g. barriers, plots)	Energean and Technip	Design team	Include name of design document following completion of detailed design
E8	Unplanned events	Environmental and social impacts associated with an accidental pipeline rupture	High	Blow-Out Preventers (BOPs) will be permanently installed on the subsea wells during well completions, and a double mechanical barrier system will be used during production and injection operations using the subsea 'Christmas trees' and other barriers.	Energean and Technip	Design team	Include name of design document following completion of detailed design
E9	Unplanned events	Environmental and social impacts associated with an accidental pipeline rupture	High	A system of wells, subsea flowlines, risers, emergency shutdown systems and FPSO topsides will be designed and operated to international process codes and with alarm and shutdown systems to maintain the system within its design criteria at all times. The system will be tested, inspected and maintained to meet performance standards	Energean and Technip	Design team	Include name of design document following completion of detailed design
E10	Unplanned events	Environmental impacts from an unplanned release of chemicals/oil to water	High	The FPSO deck and drainage system will be designed to contain spills (as well as leaks and contaminated wash-down water) to minimise the potential for overboard release.	Energean and Technip	Design team	Include name of design document following completion of detailed design
E11	Unplanned events	Environmental and social impacts associated with an accidental oil spill	High	Specific procedures will be developed for offloading crude onto the export tankers. These will include vetting of tankers involved in offloading, management of offloading activities by trained and experienced personnel, the use of a quality marine fleet to undertake the operation of hose handling and tanker movements (including contingencies for any engine failures), and the continuous monitoring and actions to be taken in the event of any non-routine events or equipment failures.	Energean and Technip	Design team	Include name of design document following completion of detailed design

E12	Ballast water	Reduced water quality, leading to adverse impacts on marine organisms	Medium	The FPSO will have segregated ballast tanks from other process systems. Visiting export tankers and other vessels discharging ballast water will be required to undertake ballast water management measures in accordance with the International Convention for the Control and Management of Ships Ballast Water & Sediments. This includes requirements for a ballast water management plan on each vessel and ballast water exchange at least 200 nmi from the nearest land and in water at least 200 m deep to minimise the transfer of organisms. Exceptionally, discharges are permitted 50 nmi from land in water depths of less than 200 m. All visiting vessels and tankers (including the FPSO) shall comply with the letter sent by MOE on 16th October 2017 entitled "Principles for the Prevention of Entry of Invasive Species".	Energean and Technip	Design team	Include name of design document following completion of detailed design
E13	Visual amenity	Loss of visual amenity for sensitive visual receptors	Medium	During the engineering design process for the onshore installations (i.e. Staging Area 1, Staging Area 2, CVS, and DVS) the site elevation should be designed either at the same grade as the surrounding area or lower, to minimise to visual impacts to the surrounding communities.	Energean and Technip	Design team	Include name of design document following completion of detailed design
E14	Visual amenity	Loss of visual amenity for sensitive visual receptors	Medium	For onshore construction activities and for the long-term operation of the CVS and DVS, all external lighting should be low level, and/or directed downwards. For the CVS and DVS, the design should ensure that the external facility walls facing the coast (whether parallel or diagonally) are not illuminated directly, except for flashing collision-avoidance lights for air and sea craft.	Energean and Technip	Design team	Include name of design document following completion of detailed design
E15	Wastes	Adverse environmental or health impacts associated with poor waste management	Medium	On-board the drillship, waste materials that can be incinerated on board will be kept separate from wastes that need to be returned to shore for recycling, treatment or disposal. To comply with Israeli law and to maximise the potential for reuse and recycling of waste materials, and to ensure proper disposal of other wastes, strict segregation of different waste materials will be practised.	Energean and Technip	Design team	Include name of design document following completion of detailed design
E16	Wastes	Adverse environmental or health impacts associated with poor waste management	Medium	Waste storage areas will be designated on the drillship in areas isolated from other operations. Waste containers will be stored in these areas prior to processing or shipment to the contract waste management vendor.	Drillship operator	Design team	Include name of design document following completion of detailed design
E17	Wastes	Adverse environmental or health impacts associated with poor waste management	Medium	Waste collection points will be provided on board the drill ship, other project vessels and at the onshore construction worksites, and these will be clearly marked to ensure segregation of different types of waste. Waste will be removed from work areas at regular intervals and will not be allowed to accumulate in undesignated areas.	Drillship operator	Design team	Include name of design document following completion of detailed design
E18	Wastes	Adverse environmental or health impacts associated with poor waste management	Medium	A dedicated area will be created at the supply base and onshore construction areas for the storage of segregated wastes prior to their transfer to recycling, incineration or landfill facilities.	Drillship operator	Design team	Include name of design document following completion of detailed design
E19	Air quality, Community health	Reduced offshore air quality	Low	Flaring will only be used for emergency/upset conditions (e.g. depressurisation of the FPSO topsides hydrocarbon inventory and the pipeline and flowline depressurisation).	Energean and Technip	Design team	Include name of design document following completion of detailed design
E20	Air quality, Community health	Reduced offshore air quality	Low	All gas-fired turbines used on the FPSO will not emit more than 50 mg/Nm3 of oxides of nitrogen on average over a year, which corresponds to the European limits given in best available techniques conclusions for large combustion plants	Energean and Technip	Design team	Include name of design document following completion of detailed design
E21	Cooling water	Reduced water quality, leading to adverse impacts on marine organisms	Low	FPSO cooling water will be compliant with the good industry practice guideline (2) that the temperature rise be less than 3°C within 100 m of the discharge structure	Energean and Technip	Design team	Include name of design document following completion of detailed design

E22	Deck drainage and bilge water	Reduced water quality, leading to adverse impacts on marine organisms	Low	The FPSO and drillship deck and drainage system will contain leaks, spills and contaminated wash-down water to minimise the potential for uncontrolled overboard release. The open drain system will collect oily rainwater drainage. A closed drain system will collect hazardous fluids from service areas. The FPSO, drillship and vessels will treat oily water (e.g. from open and closed drain systems, bilges and slop tank water) in accordance with the MARPOL Annex I requirements (15 parts per million (ppm) oil and grease as a maximum limit) and discharge to sea. Oil discharge monitors are used to prevent oil in water content targets being exceeded. Records will be maintained of all discharges and oil content to verify controls in place are working effectively.	Energean and Technip	Design team	Include name of design document following completion of detailed design
E23	Drilling waste discharges	Reduced water quality, leading to adverse impacts on marine organisms	Low	Only Water Based Muds will be used. The mud programme will be designed to take into account the concentration, toxicity, bioavailability and bioaccumulation potential of its components. MSDS will be submitted to the Israeli authorities as part of a Pollution Permit before drilling commences.	Energean and Technip	Design team	Include name of design document following completion of detailed design
E24	Drilling waste discharges	Reduced water quality, leading to adverse impacts on marine organisms	Low	High-efficiency solids control equipment (shale shakers) will be used to reduce the need for fluid change out and amount of residual fluid adhered in drilled cuttings.	Energean and Technip	Design team	Include name of design document following completion of detailed design
E25	Drilling waste discharges	Reduced water quality, leading to adverse impacts on marine organisms	Low	Drilling fluids to be discharged to sea (including as residual material on drilled cuttings) will be subject to tests for toxicity, barite contamination, and oil content. Barite contamination by mercury (Hg) and cadmium (Cd) will be checked to ensure compliance with IFC requirements (See Table 1, in the World Bank's EHS Guidelines for Offshore Oil and Gas Development) and Israeli discharge limits defined in the approved discharge permit.	Energean and Technip	Design team	Include name of design document following completion of detailed design
E26	Drilling waste discharges	Reduced water quality, leading to adverse impacts on marine organisms	Low	WBM and treated drilled cuttings will be discharged via a caisson submerged below the sea surface for suitable dispersion.	Energean and Technip	Design team	Include name of design document following completion of detailed design
E27	Hydraulic fluid	Reduced water quality, leading to adverse impacts on marine organisms	Low	The hydraulic fluids used will be water-based glycol control fluids with low toxicity and bioaccumulation potential that are readily biodegradable.	Energean and Technip	Design team	Include name of design document following completion of detailed design
E28	Operational Discharges - Black Water	Reduced water quality, leading to adverse impacts on marine organisms	Low	Blackwater will be treated prior to discharge. Approved sanitation units will achieve discharge standards of no floating solids, no discolouration and a residual chlorine content of <3 mg ł1. No discharge within 12 nmi of land.	Energean and Technip	Design team	Include name of design document following completion of detailed design
E29	Operational Discharges - Grey Water (including macerated food waste)	Reduced water quality, leading to adverse impacts on marine organisms	Low	Organic food wastes generated will be macerated to pass through a 25 mm mesh and discharged more than 12 nmi from land with no floating solids or foam.	Energean and Technip	Design team	Include name of design document following completion of detailed design
E30	Pre-commissioning and line flushing fluids	Reduced water quality, leading to adverse impacts on marine organisms	Low	A pre-commissioning disposal plan will be developed to control the rate of discharge, chemical use and dispersion. Dispersion will be improved by optimising the discharge rate, pressure and direction of the discharge at the release point. The volume of pre-commissioning water discharged to sea will be reduced by testing equipment onshore where possible, before it is loaded for offshore installation. All discharges resulting from commissioning activities shall be included in a Discharge Permit issued by the Israeli MOE/MOEP.	Energean and Technip	Design team	Include name of design document following completion of detailed design

E31	Produced water	Reduced water quality, leading to adverse impacts on marine organisms	Low	The FPSO will have a produced water separation / treatment system and storage in a dedicated gravity settling tank. Residence times within the tank will be adequate to meet minimum discharge requirements i.e. concentration of dissolved oil to at or below 21 mgl-1 maximum and 15 mgl-1 maximum daily average oil content and no visible sheen on the sea surface.	Energean and Technip	Design team	Include name of design document following completion of detailed design
E32	Operational Discharges	Reduced water quality, leading to adverse impacts on marine organisms	Low	All vessels used by the project will be fully MARPOL compliant with regards to water and waste discharges.	Vessel operators	Design team	Include name of design document following completion of detailed design

Ref No	Aspect	Potential Impact Managed	Priority of Impact Managed	Management Control	Responsibility - Organisation	Responsibility - Individual	Completion Indicator	Type of Action (e.g. management action, monitoring, meetings, training)	Timeframe for Completion
P1	Cumulative impacts	Exacerbation of predicted environmental and social impacts due to cumulative effects from Energean and Noble activities	High	Coordinate with Noble Energy about the construction schedule for the Leviathan pipeline compared to the schedule for the Energean pipeline. Energean should verify that at no time will significant construction activities for both projects be occurring at the same time within the same offshore area (e.g. within 1 km). This is to avoid duplicate simultaneous impacts. Conversely, Energean and Noble Energy could also adopt a combined construction programme (e.g. using the same vessels) if this meant that magnitude of the predicted impacts would not increase.	Energean	HSE Manager	Meeting minutes	Meeting	Prior to any project activities
P2	Marine Biodiversity	Disturbance/destruction of high sensitivity/value marine habitats	High	Energean has commissioned an Environmental Baseline Survey (EBS) for the offshore project area. If the EBS identifies any high value and/or high sensitivity habitats along the proposed pipeline route, then the pipeline route will be modified to avoid these areas by 150 m.	Energean	HSE Manager	EBS survey report and final pipeline route drawings	Survey	Mar-18
P3	Marine Biodiversity	Disturbance/destruction of high sensitivity/value marine habitats	High	If re-routing of the offshore pipeline is required beyond the area covered in the EBS, conduct a pre-lay survey to confirm that the modified route is clear of any high value and / or high sensitivity habitats.	Energean	HSE Manager	Pre-lay survey report	Survey	May-18
P4	Terrestrial ecology	Destruction of sensitive flora from site clearance	High	If medium or high sensitivity flora is identified during the onshore flora check survey that cannot be avoided during vegetation clearance and construction, then the plants will be translocated to suitable nearby habitat to avoid their destruction.	Energean	HSE Manager	Survey report, Restoration and Monitoring Plan records	Management action	If required (based on survey results)
P5	Terrestrial ecology	Destruction of sensitive flora from site clearance	High	If medium or high sensitivity flora is identified during the onshore ecological survey, a Restoration and Monitoring Plan will be developed with the objective of restoring populations of these species following construction. Energean will consult a trained ecologist to support on the development and implementation of this Plan.	Energean	HSE Manager	Restoration and Monitoring Plan	Management action	If required (based on survey results)
P6	Terrestrial ecology	Disturbance to sensitive bird species in project area	High	If the breeding season (March – August) cannot be avoided for vegetation clearance, then a qualified ornithologist will undertake pre-vegetation clearance surveys of areas to be cleared. Identify and cordon off any nests identified with a 25 m buffer until chicks have fledged from the nest or it is abandoned. Energean will engage a trained ecologist to oversee the management measures for any nesting birds identified.	Energean	HSE Manager	Survey report	Survey	If required (based on schedule)
P7	Terrestrial ecology	Disturbance to sensitive reptiles in project area (i.e. Schreiber's fringe-fingered lizard)	High	If Schreiber's fringe-fingered lizard is identified during the check survey, vegetation clearance in the suitable areas for the Schreiber's fringe-fingered lizard will be done by hand. Artificial reptiles' refuges would be placed in the proximity of the clearing areas, to facilitate the movement of the reptiles out of the clearing areas.	Energean	HSE Manager	Survey report, Restoration Plan records	Management action	If required (based on survey results)
P8	Terrestrial ecology	Disturbance to sensitive reptiles in project area (i.e. Schreiber's fringe-fingered lizard)	High	If Schreiber's fringe-fingered lizard is identified during the check survey, a Restoration Plan will be developed by a trained ecologist with the objective of restore the habitat increasing its suitability to host populations of the Schreiber's fringe-fingered lizard. Energean will engage a trained ecologist to support the implementation of this Plan.	Energean	HSE Manager	Restoration Plan	Management action	If required (based on survey results)
P9	Unplanned events	Environmental and social impacts associated with an accidental pipeline rupture or other unplanned release	High	Develop Emergency Response Plan.	Technip	HSE Manager	Emergency Response Plan	Management action	Prior to any project activities
P10	Unplanned events	Environmental and social impacts associated with an accidental pipeline rupture or other unplanned release	High	Review Emergency Response Plan.	Energean	HSE Manager	Emergency Response Plan	Management action	Prior to any project activities
P11	Unplanned events	Environmental and social impacts associated with an accidental pipeline rupture or other unplanned release	High	Energean shall develop an Oil Spill Contingency Plan (OSCP) that covers its current offshore and onshore operations using the three tiers described previously. The OSCP will define the following components: • key personnel, roles and responsibilities; • internal and external notification procedures; • the processes for managing the integration of local, regional, national and international resources; • response strategies and control procedures; and • internal and external resources.	Energean	HSE Manager	Oil Spill Contingency Plan	Management action	Prior to any project activities
P12	Unplanned events	Environmental and social impacts associated with an accidental pipeline rupture or other unplanned release	High	On-site oil spill response equipment for small to medium sized spills will be available at the FPSO and at the onshore construction areas at all times.	Energean	HSE Manager	Visual verification	Management action	Prior to any project activities
P13	Unplanned events	Environmental and social impacts associated with an accidental pipeline rupture or other unplanned release	High	Staff trained staff in oil spill response measures for Tier 1 - 3 will be present on-site (offshore and onshore).	Energean	HSE Manager	Training documentation	Training	Prior to any project activities
P14	All environmental	Adverse environmental impacts	Medium	The project will re-evaluate the indicative design and management measures included in the BAT Report once the design phase is completed. Where practicable, these measures will be applied. The project will document how these measures are being applied or where suitable alternative measures have been incorporated instead.	Energean and Technip	HSE Manager	BAT	Management action	Prior to any project activities
P15	All	Multiple	Medium	Energean will ensure that the Project will have systems in place that address the nine core elements of an Environmental and Social Management System (ESMS) per the IFC's *Environmental and Social Management System Implementation Handbook*. These elements include: an Environmental and Social Policy, a system to identify risks and impacts (e.g. the ESIA), management programmes, organisational capacity and competency, emergency preparedness and response, stakeholder engagement, external communications and grievance mechanisms, ongoing reporting to affected communities, and monitoring and review.	Energean	HSE Manager	Documentation of ESMS completeness against the guidance in the IFC's Environmental and Social Management System Implementation Handbook.	Management action	Prior to any project activities
P16	Cultural heritage	Disturbance/destruction of high value tangible cultural heritage	Medium	The Project will develop and operate a Chance Finds procedure in accordance with IFC Performance Standard 8.	Energean	HSE Manager	Chance Finds Procedure	Management action	Prior to any earthworks, subsea disturbance
P17	Cultural heritage	Disturbance/destruction of high value tangible cultural heritage	Medium	The scope of the EBS and pre-lay survey (if required), will also include an evaluation of the presence of any sensitive marine archaeology. If identified, the project will either re-route the pipeline (preferred) or implement the Chance Finds Procedure.	Energean	HSE Manager	EBS survey report, Pre-lay survey report, pipeline route drawings	Survey	May-18
P19	Terrestrial ecology	Destruction/disturbance of sensitive flora and fauna in project area	Medium	Identification of areas to be cleared prior to the beginning of the onshore works.	Energean	HSE Manager	Site clearance map and markers	Survey	Prior to an site clearance
P20	Terrestrial ecology	Destruction of sensitive flora from site clearance	Medium	Flora check surveys will be undertaken onshore prior to the start of vegetation clearance in order to identify: (1) the presence of medium or high sensitivity flora in the Project footprint; and (2) invasive flora.	Energean	HSE Manager	Survey report	Survey	Prior to an site clearance
P21	Terrestrial ecology	Damage to habitat from the spread of invasive species	Medium	If invasive flora is identified during the onshore ecological survey, an Invasive Species Management Plan will be developed with the objective of avoiding the spread/ additional introduction of these invasive species.	Energean	HSE Manager	Invasive Species Management Plan	Management action	If required (based on survey results)
P22	Terrestrial ecology	Disturbance of sensitive fauna in project area	Medium	Schedule onshore vegetation clearance works outside of the breeding bird season where practicable (outside March – August).	Energean	HSE Manager	final project schedule	Management action	Prior to an site clearance

P23	Terrestrial ecology	Disturbance to sensitive reptiles in project area (i.e. Schreiber's fringe-fingered lizard)	Medium	Undertake onshore pre-vegetation clearance reptile check surveys in order to identify the presence of any high sensitivity Schreiber's fringe-fingered lizard.	Energean	HSE Manager	Survey report	Survey	Prior to an site clearance
P24	Terrestrial ecology	Destruction/disturbance of sensitive flora and fauna in project area	Medium	Capture all biodiversity mitigation, management and monitoring measures in a Project Biodiversity Action Plan (BAP)	Energean	HSE Manager	Biodiversity Action Plan	Management action	Prior to an site clearance
P25	Marine Biodiversity	Impacts from drilling waste discharges	Medium	Ensure that the drill centre location (and location for drill cutting disposal) is included in the EBS scope. The EBS survey will be done pre- and post-drilling.	Energean	HSE Manager	Survey report	Survey	Prior to drilling
P26	Marine Biodiversity	Disturbance to marine mammals	Medium	Training will be provided to crew on the drillship and FPSO on the types of marine mammals present in the area, so they can monitor the presence of sensitive species using before the onset of sound-creating activities and continue to monitor throughout construction.	Energean	HSE Manager	Training documentation	Training	Prior to drilling
P27	Unplanned events	Community safety impacts from any traffic accidents	Medium	Develop a Traffic Management Plan for construction that includes: • an Emergency Procedure, taking into account potential impacts on local communities and measures needed to ensure the safety and security of individuals in this regard; • provision of a traffic plan for heavy equipment/major items during construction by the EPC contractor to be made available to concerned stakeholders; • provision of a traffic access map to send to all contractors and suppliers involved in the construction phase; • restricting the speed of construction vehicles; • consideration of the reduction of heavy goods vehicles during the morning, afternoon and evening peak/rush hour times; • provision of sufficient advanced notice of all traffic diversions and road closures, together with details of whom to contact at the construction site in the case of complaints; • clear signing of all diversions; • requirements for driver behaviours, competency and training (i.e. they don't just have to have a drivers licence); • vehicle specifications to include safety controls such as reversing alarms and use of a spotter when reversing a heavy vehicle with large blind spots; • regular vehicle maintenance; and • If the transportation of material will be by boat the Traffic Management Plan should include avoidance measures for fishing areas.	EPC	HSE Manager	Traffic Management Plan	Management action	Prior to any road deliveries to site or port
P28	Unplanned events	Community safety impacts from any traffic accidents	Medium	Prior to onshore construction, review the EPC Traffic Management Plan to ensure that requirements and procedures are adequately addressed by the EPC contractor. Integrate the Traffic Management Plan related activities as part of the Project's Stakeholder Engagement Plan (SEP) to ensure that relevant stakeholders are adequately engaged. It is recommended to formalise and centralise communication through a Community Liaison Officer. As part of the Project SEP implement a grievance mechanism that will be communicated to relevant stakeholders so that to collect and address as required grievances in line with IFC PS and with Israeli law.	Energean	HSE Manager	Traffic Management Plan	Management action	Prior to any road deliveries to site or port
P29	Unplanned events	Onsite accidents with a member of the local community	Medium	Develop Site Security Plan	EPC	HSE Manager	Site Security Plan	Management action	Prior to pipeline construction
P30	Unplanned events	Onsite accidents with a member of the local community	Medium	Review Site Security Plan	Energean	HSE Manager	Site Security Plan	Management action	Prior to pipeline construction
P31	Wastes	Adverse environmental or health impacts associated with poor waste management	Medium	A Waste Management Plan (WMP) will be developed and sent to the Israeli Authorities for comment. The WMP will define how wastes will be reduced, re-used, collected, managed, recycled and disposed of in an appropriate manner and in accordance with good international practice. The WMP will provide the basis for all the waste management arrangements and act as a central point of reference for how wastes will be managed by the Project. Appropriate disposal routes have already been identified for the whole range of wastes that are likely to be generated by the Project. The WMP will include: • clear objectives and targets with respect to waste management; • an analysis of types/quantities of waste that will be produced by the drilling operation and support activities; • an analysis of potential opportunities to reduce, reuse or recycle waste in accordance with the waste hierarchy (reduction, re-use, recycling, disposal) and a description of how this will be achieved at the Project sites; • a description of roles, responsibilities and resources to ensure that the objectives and targets are achieved; • procedures governing the handling, treatment and disposal of all wastes; and • verification procedures for appropriate assessment of contractors and third-party facilities used for waste transport, management and disposal. A requirement of the WMP will be a comprehensive waste inventory will be prepared detailing information about the types and quantities of each type of waste generated by the Project as well as statistics regarding the amounts of waste recycled, treated, incinerated and landfilled. This information will be used for the declaration of the hazardous wastes generated and will be submitted to the Israeli authorities on an annual basis. The WMP will also set out how all potential third party waste or recycling contractors will be evaluated by Energean prior to contract award. As well as requiring that the organisation and/or facility has all the necessary permits and authorisations, Energean will check that it meets acceptable health, safety and environmental standards. This will apply to all waste streams but audits will be focussed on more hazardous wastes. This may be two separate WMPs (i.e. pre-production, production phase) or one unified Plan.	Energean and Technip	HSE Manager	Waste Management Plan	Management action	Prior to any project activities
P32	Wastes	Adverse environmental or health impacts associated with poor waste management	Medium	A waste tracking system will be used to monitor the transfer of all consignments of project waste. The transfer notes will be used to record movements of hazardous waste. All transfers of waste, from the point of arising through to the final disposal point, will be documented using this system. Each individual load of waste will have a waste transfer note that will detail the source, type and quantity of waste as well as the date of transport, the carrier being used to transport the waste, and the final destination. Use of the form will provide confirmation that each load of waste has reached the intended storage, treatment or disposal facility.	Energean and Technip	HSE Manager	Waste Management Plan	Management action	Prior to any project activities
P33	Wastes	Adverse environmental or health impacts associated with poor waste management	Medium	Any organisations contracted to transport, manage or dispose of waste, and any facility used for the processing, storage or disposal of waste, will only be used if it has all the necessary permits and authorisations. All permits and authorisations will be checked by Energean before using any waste management facility. Regular audits will be undertaken of on-site waste management practices as well as of third party waste management contractors to ensure that all practices are in compliance with the WMP and in line with Energean's expectations. Any inappropriate practices will be identified and steps will be taken to rectify them and avoid their reoccurrence.	Energean	HSE Manager	Waste Management Plan	Management action	Prior to any project activities
P34	Unplanned events	Onsite accidents with a member of the local community	Low	If existing port facilities will be used, review the port's security access measures and confirm that access is restricted.	Energean	HSE Manager	Port security review	Management action	Prior to pipeline construction

P35	Social	Enhancement Measures for Job Creation and Employment Opportunities	Low	OPTIONAL: Develop requirements and procedures for maximising local and regional employment (priority will be placed on hiring skilled, semi-skilled and unskilled labour from within the project area of influence (first priority), Haifa region (second priority), and then nationally).	Energean	HSE Manager	Employment procedures	Management action	Prior to pipeline construction
P36	Social	Enhancement Measures for Job Creation and Employment Opportunities	Low	OPTIONAL: Outline and require a fair and transparent recruitment process for all openings including working with regional and local authorities to advertise openings as early as possible in ways that are accessible to local communities and with clear information on skills requirements.	Energean	HSE Manager	Employment procedures	Management action	Prior to pipeline construction
P37	Social	Enhancement Measures for Job Creation and Employment Opportunities	Low	OPTIONAL: Disclose clear information on the number and limited timescales of employment opportunities.	Energean and Technip	HSE Manager	Employment procedures	Management action	Prior to pipeline construction
P38	Social	Enhancement Measures for Job Creation and Employment Opportunities	Low	OPTIONAL: Develop a *Local Procurement Plan* including a comprehensive demand-and-supply-side analysis to identify which of the goods and services can be supplied locally and within Israel and to identify contractors and suppliers that are able to comply with the project's requirements.	Energean	HSE Manager	Employment procedures	Management action	Prior to pipeline construction
P39	Social	Enhancement Measures for Job Creation and Employment Opportunities	Low	OPTIONAL: In line with the *Local Procurement Plan*, advance information on tendering opportunities will be provided to local businesses through trade and industry chambers and local business organisations in the Project's area of influence.	Energean	HSE Manager	Employment procedures	Management action	Prior to pipeline construction
P40	Social	Enhancement Measures for Job Creation and Employment Opportunities	Low	OPTIONAL: Break tendering opportunities into smaller components to increase the likelihood of granting individual pieces of work to Israeli companies.	Energean	HSE Manager	Employment procedures	Management action	Prior to pipeline construction
P41	Social	Enhancement Measures for Job Creation and Employment Opportunities	Low	OPTIONAL: As part of the tendering process, require contractors to develop a *Local Procurement Strategy* that stipulates how national and local purchase of goods and services will be optimized to maximise local procurement. Priority will be placed on procuring goods and services from within the area of influence, then the Haifa region, and then Israel.	Energean	HSE Manager	Employment procedures	Management action	Prior to pipeline construction
P42	Social	Decreased Economic Activity and Opportunity in Tourism and Recreation Sectors	Medium	As part of the *Stakeholder Engagement Plan*, conduct additional stakeholder consultations with local authorities, tourism associations if any, and village heads to address information gaps regarding nearshore and offshore recreational activities.	Energean	HSE Manager	SEP	Management action	Prior to pipeline construction
P43	Social	Decreased Economic Activity and Opportunity in Tourism and Recreation Sectors	Medium	Implement appropriate measures to project design to minimise the footprint of onshore and coastal /offshore project activities to minimise the potential impacts on tourism and recreational activities in the area of influence.	Energean	HSE Manager	review of design measures	Management action	Prior to pipeline construction
P44	Social	Decreased Economic Activity and Opportunity in Tourism and Recreation Sectors	Medium	As part of the *Stakeholder Engagement Plan*, and in-line with previous engagement activities, ensure ongoing consultation with stakeholders including regional and local authorities, managers of protected areas, relevant ministry departments and village heads on proposed project activities and its expected impacts on the area.	Energean	HSE Manager	SEP	Management action	Prior to pipeline construction
P45	Social	Decreased Economic Activity and Opportunity in Tourism and Recreation Sectors	Medium	Provide local tourist operators and village heads with the project Grievance Procedure, as well as information on how they can give feedback and raise concerns about project activities.	Energean	HSE Manager	grievance procedure	Management action	Prior to pipeline construction
P46	Social	Loss of Fishing-Related Livelihoods during Pipeline	Low	As part of the *Stakeholder Engagement Plan*, conduct additional stakeholder consultations with local	Energean	HSE Manager	SEP	Management action	Prior to pipeline construction
P47	Social	Disruption to Offshore Navigation and Marine Traffic	Low	As part of the *Stakeholder Engagement Plan*, conduct additional stakeholder consultations with maritime	Energean	HSE Manager	SEP	Management action	Prior to pipeline construction
P48	Social	Disruption to Offshore Navigation and Marine Traffic during Construction	Low	The proposed pipeline route does not include crossing the MED Nautilus fibre optic cable route; however, Energean will engage with MED Nautilus prior to any subsea construction activities to ensure no damage to the cable occurs.	Energean	HSE Manager	SEP	Management action	Prior to pipeline construction
P49	Social	Disruption to Offshore Navigation and Marine Traffic during Construction	Low	Interaction with fishermen and other users will be monitored through the fishing authority, meetings with village heads, and through the Project's grievance procedure.	Energean	HSE Manager	SEP	Management action	Prior to pipeline construction
P50	Social	Impacts on Workforce Rights, Health and Safety during Construction	Low	Facilities and activities will be developed, planned and maintained such that robust barriers are in place to prevent accidents. All employees have the duty to stop any works if adequate systems to control risks are not in place.	Energean	HSE Manager	H&S procuedures	Management action	Prior to pipeline construction
P51	Social	Impacts on Workforce Rights, Health and Safety during Construction	Low	Ensure that Energean's *HSE Management System* covers all contractors and sub-contractors including identification and provision of PPE, training and monitoring as well as ongoing safety checks and safety audits.	Energean	HSE Manager	H&S procuedures	Management action	Prior to pipeline construction
P52	Social	Impacts on Workforce Rights, Health and Safety during Construction	Low	Development of a Workers Health and Safety Plan that should consider the following: · Employee should not be under the influence of intoxicants which could adversely affect the ability of that Employee to perform the work or adversely affect the health and safety of other Employees, other persons or the environment. · Those involved in the handling and management of waste will be provided with appropriate personal protective equipment (PPE) and training in handling of waste materials. · Surveillance programs for health status shall be established and implemented.	Energean	HSE Manager	Workers Health and Safety Plan	Management action	Prior to pipeline construction
P53	Social	Impacts on Workforce Rights, Health and Safety during Construction	Low	In all Contractor and supplier contracts explicit reference will be made to the need to abide by Israeli law, international standards and Energean's policies in relation to health and safety. Energean will undertake periodic due diligence of contractors and suppliers to monitor compliance.	Energean	HSE Manager	Contracts	Management action	Prior to pipeline construction
P54	Social	Impacts on Workforce Rights, Health and Safety during Construction	Low	As part of the Contractor and supplier selection process Energean will take into consideration performance with regard to worker health and safety and Human Rights.	Energean	HSE Manager	Contracts	Management action	Prior to pipeline construction
P55	Social	Impacts on Workforce Rights, Health and Safety during Construction	Low	Energean will provide support to contractors and sub-contractors to ensure that labour and working conditions are in line with Israeli law.	Energean	HSE Manager	Contractor procedures	Management action	Prior to pipeline construction
P56	Community Health and Safety	Physical Injury due to Site Trespass and Interaction with Project Workforce during Construction	Low	In line with Energean's embedded measure regarding site protection, develop a Community Health and Safety Plan including measures such as: • Fencing camps and storage facilities. • Undertaking a programme of education on risks of trespass at local schools and in the community. • Providing access to health care for those injured by Project activities. • Ensure that signs are put up around work fronts and construction sites advising people of the risks associated with trespass. • Community education programs and awareness programs targeted particularly at young girls in the community. • Implement the project Traffic Management Plan with measures controlling vehicle speed, vehicle maintenance and driver behaviour.	Energean	HSE Manager	Community Health and Safety Plan	Management action	Prior to pipeline construction
P57	Community Health and Safety	Physical Injury due to Site Trespass and Interaction with Project Workforce during Construction	Low	As part of the Stakeholder Engagement Plan and Grievance Mechanism, inform village heads (including the villages of Dor, Nahsholim, Fureidis and Ma'ayan Tzvi) of the grievance mechanism in place.	Energean	HSE Manager	SEP	Management action	Prior to pipeline construction
P58	Community Health and Safety	Physical Injury due to Site Trespass and Interaction with Project Workforce during Construction	Low	During the contractor selection process implement the following measures: • Conduct a pre-employment worker health screening and regular health screenings including for employees of contractors and sub-contractors making sure that in the case of communicable diseases, workers will commence treatment and be non-infectious before taking-up their post. • Conduct induction training for workers on the Worker Code of Conduct including guidelines on worker-community interactions, alcohol consumption, and illegal activities. • As part of the induction process provide consistent training and education to all workers to ensure awareness of transmission routes and methods of prevention of STDs and other diseases of concern such as TB as well as early symptoms of such diseases. • Provide access to confidential and voluntary HIV/AIDs testing.	Energean	HSE Manager	Contractor procedures	Management action	Prior to pipeline construction

Ref No	Aspect	Potential Impact Managed	Project Phase	Priority of Impact Managed	Management Control	Responsibility - Organisation	Responsibility - Individual	Completion Indicator	Type of Action (e.g. management action, monitoring, meetings, training)	Frequency
C1	Air quality, Community health	Reduced air quality impacting local community health	Pipeline commissioning	High	Avoid placement of the engines along the eastern border of Staging Area 2 to avoid elevated concentrations of NO at villages to the east.	Technip	TBC	Siting of engines Site layout drawings	Management action	One time verification
C2	Air quality, Community health	Reduced air quality impacting local community health	Pipeline commissioning	High	Restrict access of the beach in the vicinity (e.g. with 200 m) of Staging Area 1 if multiple engines over 300 kW are operating.	Technip	TBC	Documentation of restricted access	Management action	When multiple engines over 300 kW are operating
C3	Air quality, Terrestrial biodiversity	Reduction in onshore air quality affecting sensitive flora	Post-pipeline commissioning	High	If negative effects are observed in the existing vegetation, appropriate measures to rehabilitate the habitat will be planned and implemented. Energean will engage a trained ecologist to support on the development of any such measures.	Energean	HSE Manager	The design of additional measure(s) to manage observed effects	Management action	If required (based on visual evidence)
C4	Terrestrial biodiversity	Disturbance to nesting birds from artificial light	Pipeline construction and commissioning	High	Low-level or directional lighting will be used to avoid light spill near the beach and near any nesting bird sites identified in the fauna survey checks.	Energean	HSE Manager	visual inspection records	Management action	Continuous at night (if triggered)
C5	Terrestrial biodiversity	Disturbance to nesting birds from artificial light	Pipeline construction and commissioning	High	If nesting birds are identified in the fauna check survey, Energean will consult a trained ornithologist to determine what additional measures may be required to manage impacts from light disturbance.	Energean	HSE Manager	Additional measures for ESMP (if required)	Management action	Once
C6	Marine Biodiversity	Disturbance to marine mammals	Drilling and Well completions/ installation	High	If marine mammals are sighted congregating within 500 m of project activities, postpone works until they have moved away, allowing 20 minutes following the last sighting before recommencing.	Technip	TBC	Observation and response	Management action	If required (based on any observations)
C7	Stakeholder Engagement	Impacts to the local community (real and perceived)	Pipeline construction	High	Following Energean's Stakeholder Engagement Plan, Energean will facilitate a community forum during the construction phase (i.e. when impacts are predicted to be most significant). This event will be publicised in Dor, Nahsholim, Fureidis, Zichron Ya'akov and Ma'ayan Tzvi. This event will be an opportunity for local community members to voice any concerns that they have about the project and will provide Energean with the opportunity to respond to any such concerns.	Energean	HSE Manager	Meeting minutes	Meeting	Once
C8	Terrestrial ecology, Air quality, Community health and safety	Destruction/disturbance of sensitive flora and fauna in project area	Pipeline construction	High	Restricted access for the machinery to the areas out of the clearing limits	Energean	HSE Manager	visual verification of suitable methods to obstruct access	Management action	Continuous
C9	Unplanned events	Environmental and social impacts associated with an accidental pipeline rupture or other unplanned release	Pipeline construction, drilling, and commissioning	High	Implement EPC Emergency Response Plan. Maintain internal audit records of how the Plan is being implemented.	Technip	TBC	Records indicating how plan is being implemented	Management action	Continuous
C10	Unplanned events	Environmental and social impacts associated with an accidental pipeline rupture or other unplanned release	During pipeline construction, drilling, and commissioning	High	Monitor and supervise the EPC contractor to ensure that the Emergency Response Plan is implemented in line with the Project's requirements. It is recommended to formalise and centralise communication through a local Community Liaison Officer to ensure that key stakeholders (including affected communities but also relevant authorities) will be provided with appropriate information communicating the nature and extent of any potential incidents that could arise and procedures to be followed in the case of an unplanned accident or emergency.	Energean	HSE Manager	Audit records	Audit	Every 6 months
C11	Air quality, Terrestrial biodiversity	Disturbance to birds and turtles in project area	Pipeline commissioning	Medium	Schedule commissioning activities to avoid, as much as feasible, the breeding bird season and the marine turtle nesting season (i.e. avoid March – August).	Technip	TBC	final project schedule	Management action	Continuous
C12	Air quality, Terrestrial biodiversity	Reduction in onshore air quality affecting sensitive flora	Pipeline pre-commissioning, and post-commissioning	Medium	Conduct vegetation surveys pre-commissioning and post-commissioning, in order to assess potential effects in the vegetation in the sandy beach.	Energean	HSE Manager	Survey report	Survey	Once
C13	Marine Biodiversity	Impacts from drilling waste discharges	Drilling	Medium	Conduct a post-drill survey of the drill centre location will be undertaken to quantify and monitor the impact of the drilling discharges.	Energean	HSE Manager	Survey report	Survey	Once, post drilling
C14	Noise, Community health and safety	Disturbance to local community from noise emissions	Pipeline construction and commissioning	Medium	Install site hoardings to provide screening between the public (e.g. recreational users of the beach) and activities at the onshore worksites.	Technip	TBC	Visual documentation	Management action	Once, at the start of pipeline construction
C15	Noise, Community health and safety	Disturbance to local community from noise emissions	Pipeline construction and commissioning	Medium	Maintain Energean's grievance procedure to collect and manage potential complaints from local communities and seek appropriate solutions to resolve the grievance.	Energean	HSE Manager	grievance procedure and associated grievance/ response records	Management action	Continuous
C16	Noise, Community health and safety	Disturbance to local community from noise emissions	Pipeline construction and commissioning	Medium	Work with Energean to respond to any grievances received from the local community.	Technip	TBC	grievance procedure and associated grievance/ response records	Management action	Continuous
C17	Terrestrial ecology	Destruction/disturbance of sensitive flora and fauna in project area	Pipeline construction	Medium	Ecological awareness training should be provided to all personnel, with a focus on medium and high sensitivity flora and fauna.	Energean	HSE Manager	Training records	Training	Once
C18	Terrestrial ecology	Disturbance to sensitive turtles in project area	Pipeline construction, commissioning	Medium	Artificial lighting at the microtunnel compound will only be used outside of the turtle nesting season (May – August).	Energean	HSE Manager	Inspection records	Management action	Continuous
C19	Terrestrial ecology	Disturbance of sensitive bird species in project area	Pipeline construction, commissioning	Medium	Work with relevant stakeholders including the Society for the Protection of Nature in Israel (Birdlife Israel) to raise awareness of the importance of the Carmel Coast IBA	Energean	HSE Manager	Meeting minutes	Meeting	As required (~2-4 meetings)
C20	Unplanned events	Community safety impacts from any traffic accidents	Pipeline construction and commissioning	Medium	Implement the Traffic Management Plan. Maintain internal audit records of how the Plan is being implemented.	Technip	TBC	Traffic Management Plan	Management action	Continuous
C21	Unplanned events	Community safety impacts from any traffic accidents	Pipeline construction and commissioning	Medium	Monitor and supervise Technip to ensure that the Traffic Management Plan is implemented in line with the Project's requirements. It is recommended to formalise and centralise communication through a local Community Liaison Officer to ensure that key stakeholder (including affected communities but also relevant authorities) will be provided with appropriate information communicating the nature and extent of any potential incidents that could arise and procedures to be followed in the case of an unplanned accident or emergency.	Energean	HSE Manager	Review of Traffic Management Plan	Audit	Every 6 months

C22	Unplanned events	Onsite accidents with a member of the local community	Pipeline construction and commissioning	Medium	Implement Site Security Plan. This should include measures such as: · secure the Project site, including the lay-down area, with a permanent fence at an early stage of construction; · employ security guards to patrol the site and control access on a 24 hour/7 day basis to restrict access to community members. Security will serve to prevent theft and damage of equipment on-site and to avoid potential injury to community members; and · require all personnel to display personal identification and all visitors will be required to sign in to prevent unauthorised access.	Technip	TBC	Site Security Plan	Management action	Continuous
C23	Unplanned events	Onsite accidents with a member of the local community	Pipeline construction and commissioning	Medium	Monitor and supervise Technip's security measures (implementation of Site Security Plan)	Energean	HSE Manager	Review of site security records	Audit	Every 6 months
C24	Visual amenity	Loss of visual amenity for sensitive visual receptors	Pipeline construction	Medium	The following mitigation measures will be implemented where practicable throughout the construction phase to minimise visual impacts: · machinery and materials will be stored tidily during the works – tall machinery will not be left in place for longer that required for construction purposes, in order to minimise impacts on views; · temporary roads providing access to site compounds and work areas will be maintained and where feasible free of dust; · unsightly works and stockpiles areas shall be screened to minimise adverse visual impacts at close range(especially near tourist areas/or near residential areas from where direct views are available); · outdoor construction lighting, where required shall be unobtrusive as possible, will be directional and shall not allow light to shine upwards or into residents windows; and · use of tall mast lights shall be carefully assessed and avoided wherever possible during both construction and operation.	Technip	TBC	visual inspection records	Management action	Continuous
C25	Wastes	Adverse environmental or health impacts associated with poor waste management	Drilling	Medium	All waste materials will be stored properly in containers that are non-leaking and compatible with the waste being stored. All containers will have their lids, rings, covers, bungs, and other means of closure properly installed at all times except when waste is being added or removed.	Drillship operator	TBC	visual inspection records	Management action	Continuous
C26	Wastes	Adverse environmental or health impacts associated with poor waste management	Drilling, installation, pipeline construction, and pipeline commissioning	Medium	Implement the EPC's Waste Management Plan	Technip	TBC	Waste Management Plan and associated records (e.g. waste inventory, transfer records)	Management action	Continuous
C27	Wastes	Adverse environmental or health impacts associated with poor waste management	Drilling, installation, pipeline construction, and pipeline commissioning	Medium	Verify that the EPC's Waste Management Plan is being correctly implemented.	Energean	HSE Manager	Waste Management Plan	Management action	Every 6 months
C28	All	Multiple	Drilling, installation, pipeline construction, and pipeline commissioning	Medium	Energean will implement the nine elements of the ESMS.	Energean	HSE Manager	ESMS documentation	Management action	Continuous
C29	Noise, Terrestrial biodiversity	Disturbance to local community from noise emissions and disturbance to sensitive fauna in project area	Pipeline construction and commissioning	Low	Undertake periodic visual checks of the active worksites to ensure that, for any construction equipment that is fitted with noise abatement, abatement is operating as designed, and that equipment panelling is not left open while operating.	Technip	TBC	Inspection records	Management action	Monthly
C30	Social	Loss of Fishing-Related Livelihoods during Pipeline Cons	During nearshore and offshore pipeline construction	Low	Limit exclusion zones around Project infrastructure and vessels to those required legally, without compromising safety measures.	Energean	HSE Manager	exclusion zone design	Management action	Once
C31	Social	Loss of Fishing-Related Livelihoods during Pipeline Cons	During nearshore and offshore pipeline construction	Low	Implement the *Grievance Procedure* to collect and address potential grievances and claims from fishers, in particular with respect to compensation for any proven damage to fishing gear due to project activities.	Energean	HSE Manager	grievance procedure and associated grievance/ response records	Management action	Continuous
C32	Social	Loss of Fishing-Related Livelihoods during Pipeline Cons	During nearshore and offshore pipeline construction	Low	Provide village heads (including the villages of Dor, Nahsholim, Fureidis and Ma'ayan Tzvi) and the fishing authority with the project Grievance Procedure, as well as information on how they can give feedback and raise concerns about project activities.	Energean	HSE Manager	grievance procedure and associated grievance/ response records	Management action	Continuous
C33	Social	Loss of Fishing-Related Livelihoods during Pipeline Cons	During nearshore and offshore pipeline construction	Low	A vessel transit route will be agreed with Israeli Maritime Authorities and communicated to fishers and other marine users. Project vessels will keep within the agreed routes.	Energean	HSE Manager	documentation of agreed route(s)	Management action	Once
C34	Social	Loss of Agricultural Livelihoods during Pipeline Construction and Production	Pipeline construction and commissioning	Low	As part of the Stakeholder Engagement Plan, conduct additional stakeholder consultations with village heads (including the villages of Dor, Nahsholim, Fureidis and Ma'ayan Tzvi) and relevant farmers' associations, if any, to confirm the status of land ownership and land use in the area of influence.	Energean	HSE Manager	SEP	Management action	Once
C35	Social	Loss of Agricultural Livelihoods during Pipeline Construction and Production	Pipeline construction and commissioning	Low	Implement a Livelihood Restoration Plan (LRP) for the project that identifies previous users of the land. The LRP ascertain the extent of livelihood impacts and specify options for livelihood restoration.	Energean	HSE Manager	LRP	Management action	Once
C36	Social	Impacts on Workforce Rights, Health and Safety during Construction	Pipeline construction and commissioning	Low	Contractor contracts will establish the right for Energean to monitor and audit all contractors and sub-contractors and clearly articulate the consequences for the contractor if they are found to be breaching national legal requirements, international standards. Contractor contracts will specify that the same standards will be met by their sub-Contractors and suppliers.	Energean	HSE Manager	Contracts	Management action	Every 6 months

Ref No	Aspect	Potential Impact Managed	Priority of Impact Managed	Management Control	Responsibility - Organisation	Responsibility - Individual	Completion Indicator	Type of Action (e.g. management action, monitoring, meetings, training)	Frequency
O1	Unplanned events	Environmental and social impacts associated with an accidental pipeline rupture	High	Implement EPC Emergency Response Plan. Maintain internal audit records of how the Plan is being implemented.	Energean	HSE Manager	Audit record	Audit	Continuous
O2	Unplanned events	Environmental and social impacts associated with an accidental pipeline rupture	High	Implement a programme of simulation exercises to test the different aspects of oil spill response preparedness to build familiarity and promote competence.	Energean	HSE Manager	Training records	Training	Once to twice a year
O3	All	Multiple	High	Energean will commission a qualified environmental and social auditing firm to carry out semi-annual compliance verification against the measures set out in this ESMP.	Energean	HSE Manager	Audit report detailing the findings of the assessment and an update of the Equator Principles Action Plan	Audit	Semi-annually (audit) Annually (emissions report)
O4	All	Multiple	Medium	Energean will implement the nine elements of the ESMS.	Energean	HSE Manager	ESMS documentation	Management action	Continuous
O5	Wastes	Adverse environmental or health impacts associated with poor waste management	Medium	Implement the Waste Management Plan.	Energean	HSE Manager	Waste Management Plan and associated records (e.g. waste inventory, transfer records)	Management action	Continuous
O6	Climate change	Significant contribution of emissions resulting in climate change effects	Low	Develop and implement a routine maintenance plan for all key GHG emission sources identified in the annual GHG inventory.	Energean	HSE Manager	Maintenance plan	Management action	Continuous
O7	Climate change	Significant contribution of emissions resulting in climate change effects	Low	Have a system in place to periodically review annual GHG performance and evaluate options for improving energy efficiency over the life of the Project.	Energean	HSE Manager	Audit record	Audit	Annually
O8	Climate change	Significant contribution of emissions resulting in climate change effects	Low	Quantify GHG emissions annually in accordance with internationally recognised methodologies and good practice.	Energean	HSE Manager	Annual Emissions Report (which will include GHGs and emissions of air quality pollutants)	Management action	Annually
O9	Marine Biodiversity	Disturbance to marine mammals	Low	Record incidental sightings of marine species from the FPSO and supply vessels and produce annual monitoring reports that document the sightings.	Energean	HSE Manager	Observation records	Monitoring	Continuous

Annex E:
Stakeholder Engagement Plan (SEP)

STAKEHOLDER ENGAGEMENT PLAN

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1 INTRODUCTION

1.1 CONTEXT AND PURPOSE OF THE DOCUMENT

This Stakeholder Engagement Plan (SEP) provides a framework for stakeholder engagement for the Karish Field Development Project (hereafter 'the Project'). The Project is being developed and will be operated by Energean Israel Limited ('Energean').

The purpose of the SEP is to ensure that stakeholders are provided with opportunities to express their views on Project risks, impacts and mitigation measures throughout the life of the Project. It is a 'living' document that will be updated as the Project evolves, in accordance with key milestones, to ensure full stakeholder participation in Project decision making.

In summary, the key objectives of the SEP are to:

- identify and map key stakeholders of the Project, including vulnerable groups, as well as providing a methodology for updating this periodically throughout the life of the project;
- provide a practical framework to guide effective stakeholder engagement through the life of the Project;
- support two-way communication between the company and stakeholder groups through identifying effective consultation methods;
- ensure that project decision-making is informed by stakeholder views, such that conflict is avoided wherever possible, or effectively addressed should it arise; and
- provide an effective mechanism for reporting and managing grievances.

1.2 PROJECT OVERVIEW

The Karish field is located approximately 75 km from shore at its closest point in 1,700 m water depth. The base case of the development includes three production wells tied back via subsea system to a Floating Production Storage and Offloading (FPSO) vessel with full offshore processing of the reservoir fluids. Conditioned gas will be exported to shore through a 90 km pipeline and will tie-in to the Israeli gas distribution grid (INGL) and the associated light oil will be exported offshore by tandem offloading to a shuttle tanker.

The pipeline landfall is located approximately 1.3 km south of Dor. The pipeline's onshore route will follow a corridor defined by national outline plan ("TAMA") 37/H and connect to the existing INGL gas pipeline approximately 1.5 km onshore. A Coastal Valve Station (CVS) and Dor Valve Station (DVS) will also be constructed close to the landfall for metering purposes. The onshore section of the pipeline will be approximately 1.6 km in length. The location of the pipeline corridor, CVS, DVS and proposed construction staging areas are illustrated in *Figure 1.1*.

Construction activities in Israel are expected to start in Q4 2018 and Q1 2019 for offshore and onshore activities, respectively. Offshore activities are expected to finish in Q4 2019 and include well drilling, installation of the subsea system, and FPSO installation and hook-up. Onshore activities are expected to finish in Q3 2019 and include excavation of the pipeline trench, construction of the CVS, pipeline laying, DVS and tie-in. First gas is expected during Q3 2010.

Figure 1.1 Landfall Location

1.3 BASELINE CONTEXT

A summary of the social baseline context for the area is provided below.

- The settlements in the vicinity of the project's onshore operations are: Dor, Nahsholim, Fureidis, and Ma'ayan Tzvi. Dor is the closest settlement located 500 m northwest of the Dor Valve Station, while Nahsholim is located immediately north of Dor. Fureidis is located about 3 km to the east of the landfall. Ma'ayan Tzvi and Zichron Ya'akov are located about 3.3 km southeast of the landfall.

- Tourism and recreation are both key activities in Dor and Nahsholim, especially the beach areas.

- Large scale onshore fish farms exist along an 8 km stretch of the Israeli coast between Dor and Jisr az-Zarqa, an Arab town south of Dor. These fish farms are predominately to the south of the landfall but one (namely Dor Fish Farm) is located north, close to Dor.

- There are avocado plantations to the east and southeast of the Project area, including some smaller olive and avocado groves within the pipeline corridor. The land is government owned but leased to farmers. Additional information on the lease agreements and the relationship between the government, lease holders and land users for the land within the pipeline corridor is required.

- The two closest ports are Haifa Port to the north and Submarinean Port in Caesarea to the south. There is a railway line passing parallel with the main road Kvish HaHof, which runs along the coastline.

1.4 STRUCTURE OF THIS SEP

The remainder of this SEP is organised as follows:

- *Section 2:* Regulations and requirements;
- *Section 3:* Stakeholder identification and mapping;
- *Section 4:* Communication methods;
- *Section 5:* Stakeholder engagement process;
- *Section 6:* Grievance mechanism;
- *Section 7:* Roles and responsibilities; and
- *Section 8:* SEP data management and monitoring.

This SEP is supported by the following appendices:

- *Appendix A:* Grievance Mechanism Procedure.

2 REGULATIONS AND REQUIREMENTS

2.1 INTRODUCTION

The framework for engagement for this Project is guided by requirements set out within the Israeli national legal framework, international good practice, and Energean's corporate requirements. These requirements are summarised in the following sections.

2.2 NATIONAL REQUIREMENTS

Israel is not a signatory of Aarhus Convention (1), however it does have robust regulatory tools for access to information and public participation on environmental matters. There are three processes enabling public participation:

- development of TAMA 37/H regulated under the building and planning law for onshore and offshore within territorial waters;
- the official publication of permit conditions and survey results on Ministry of Environment Protection and Ministry of Energy websites; and
- a voluntary Strategic Environmental Assessment (SEA) initiated by the Ministry of Energy (MoE) covering all environmental and socioeconomic aspects within Israel Exclusive Economic Zone.

2.2.1 *Tochnit Mit'ar Artzit (TAMA) 37/H*

The key national regulation that provides the foundation for public access to information, public consultation and disclosure on environmental and socioeconomic impacts is through an Environmental Impact Assessment (EIA) process and an Environmental Impact Statement (EIS), which reports the EIA. In Israel an EIS is required under the Planning & Building Law 5725-1965 (with amendments) and the Planning & Building Regulations (Environmental Impact Statements) 5763-2003.

The law and its subordinate regulations provide a legal foundation for conducting EIAs and other requirements for environmental analysis. The process requires public notice of project approval and disclosure of the final approved EIS at a ministry or agency office and on the internet. Public participation is limited to review of the approved EIS, although the public does not need to be notified that it has been made available. A Ministry Interior Investigator will conduct public hearings in the case of objections.

The Government of Israel has produced a National Outline Plan (TAMA 37/H) that provides the statutory framework, land allocation and the process for

(1) UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matter.

obtaining building permits for gas treatment facilities for natural gas produced from offshore fields. In developing TAMA 37/H an EIS was prepared by an independent consultancy following the guidelines prepared by the Israeli Ministry of Environmental Protection (MoEP), which provided the platform to enable public participation into the process.

The application for future building permits through the TAMA 37/H process will also include stakeholder participation. This participation will involve members of public and government agencies that may be affected by the activities of an upcoming project. One of the requirements for obtaining building permit is the development of an Environmental Management and Monitoring Plan (EMMP) for both offshore and onshore elements of a project. The public will have access to the details of the EMMP through the Planning Administration website and stakeholders will be able to comment on its content through the building permit process.

2.2.2 Environmental Permits, Licenses and Surveys

Under Israel's environmental laws and regulations operators are required to obtain various permits, including for discharges, emissions, PRTR (pollutant release and transfer register), which are made available to the public. Specifically to emission permits, the public are entitled to comment on the content of the draft permit within 45 days and the comment will be made public.

In addition all environmental survey work such as baseline pre-drill and post-drill surveys are disclosed on the Ministry of Energy's public website.

2.2.3 Strategic Environmental Assessment (SEA)

The Natural Resources Administration (NRA) of the Ministry of Energy is the regulator for onshore and offshore oil and gas exploration and production (E&P). The NRA began a Strategic Environmental Assessment (SEA) process in 2014 for the offshore E&P activities following the process provided in European Directive EC/42/2001. The SEA was designed to cover the entirety of Israel's marine area in the Mediterranean Sea (i.e. territorial waters and exclusive economic zone), taking into consideration active licenses or leases at the time of the study [2].

In addition to considering the environmental and social impacts of E&P activities, the SEA was to provide recommendations to improve decision making processes regarding resource development, taking into account a comprehensive view of the environment as well as economic and social aspects. The SEA preparation was overseen by a steering committee, comprising representatives of government ministries, public sector, NGOs, industry sector and other relevant stakeholders.

(2) This included the Karish and neighbouring Tanin fields.

2.3 INTERNATIONAL REQUIREMENTS

The International Finance Corporation (IFC) Performance Standards (PS) on environmental and social sustainability, PS1: Assessment and Management of Environmental and Social Risks and Impacts, will be used as a benchmark of international good practice on stakeholder engagement. The IFC defines the objective of stakeholder engagement as being:

"the basis for building strong, constructive, and responsive relationships that are essential for the successful management of a project's environmental and social impacts"(3).

The IFC PS also requires impact assessments to consider social as well as environmental issues (ie the development of an Environmental and Social Impact Assessments (ESIA)) and to be informed by engagement processes.

Box 2.1 detail the IFC's key principles of stakeholder engagement.

Box 2.1 *IFC's Key Principles of Stakeholder Engagement*

- Provide affected communities with opportunities to express their views on project risks, impacts and mitigation measures, and allow the Project developer to consider and respond to them.
- Begin early in the process of identification of environmental and social risks and impacts and continue on an ongoing basis as risks and impacts arise.
- Stakeholder engagement should be based on the prior disclosure and dissemination of relevant, transparent, objective, meaningful and easily accessible information which is in a culturally appropriate local language(s) and format and is understandable to affected communities.
- Where the project has potentially significant adverse impacts on affected communities, an "informed consultation and participation" (ICP) process should take place. ICP is an organized and iterative consultation that involves a more in-depth exchange of views and information.
- The development and implementation of a "Stakeholder Engagement Plan" (SEP) that is scaled to the project risks and impacts at the development stage.
- Stakeholder engagement should be inclusive of all the relevant groups within the community (including the vulnerable and marginalised), focused on those directly affected as opposed to those not directly affected, be free of external manipulation, interference, coercion, or intimidation.
- Stakeholder engagement should be documented and include opinions and concerns as well as the measures taken to respond to them, i.e. the actions taken by the project to avoid or minimize risks to, and adverse impacts on, the affected communities.

Information disclosure is a key requirement of stakeholder engagement and should include:

(3) IFC, January 2012, Performance Standard 1. Assessment and Management of Environmental and Social Risks and Impacts. Available at http://www1.ifc.org/wps/wcm/connect/3be1a68049a78dc8b7e4f7a8c6a8312a/PS1_English_2012.pdf?MOD=AJPERES.

- the purpose, nature, and scale of the project;
- the duration of proposed project activities;
- any risks to and potential impacts on such communities and relevant mitigation measures;
- the envisaged stakeholder engagement process; and
- a grievance mechanism, by which community concerns are received, answered and addressed in a timely manner.

3 STAKEHOLDER IDENTIFICATION AND MAPPING

3.1 INTRODUCTION

The IFC defines stakeholders as:

"Stakeholders are persons or groups who are directly or indirectly affected by a project, as well as those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively. Stakeholders may include locally affected communities or individuals and their formal and informal representatives, national or local government authorities, politicians, religious leaders, civil society organizations and groups with special interests, the academic community, or other businesses."

The level of interest and impact of any given group of stakeholders is dependent on a number of factors including level of authority, socio-economic context, influence, education and cultural factors.

3.2 STAKEHOLDER IDENTIFICATION

The purpose of the stakeholder identification process is to establish which organisations and individuals are interested in the Project, or have the potential to be directly or indirectly affected, positively or negatively, by the Project. The identification and mapping is an ongoing process requiring periodic review and update.

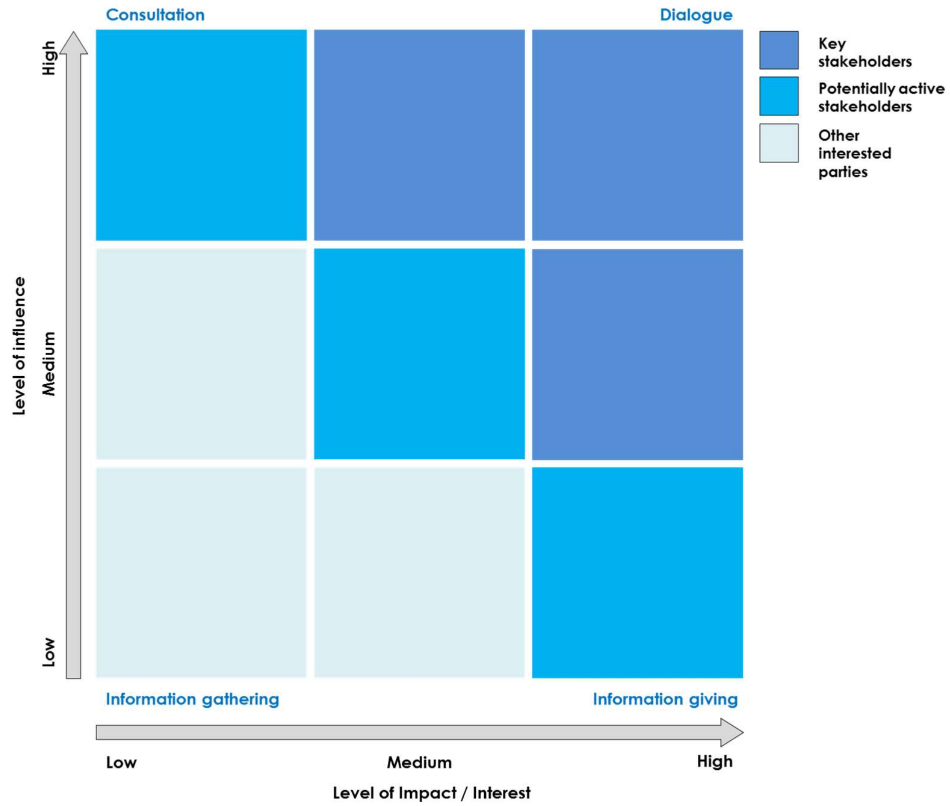
The identification of stakeholders enables engagement with stakeholders to be proactively planned, to ensure that their views and concerns are considered in the ESIA and that adequate channels of engagement are in place through the lifetime of the Project.

3.3 STAKEHOLDER MAPPING

Stakeholder mapping involves considering the level of impact experienced by each stakeholder and/or their interest in the Project. Stakeholder mapping allows the Project to consider the level and frequency of engagement required with each group.

Figure 3.1 shows how stakeholders are mapped in this way.

Figure 3.1 Stakeholder Mapping



Analysing the influence versus interest of stakeholders in this way yields the following stakeholder categories:

- **Key stakeholders:** Stakeholders who have a high level of interest in the project and high level of impact / influence on the project, such as the Government of Israel, the determining authority for regulatory approval, and the communities or people who fall within the Project's area of influence. These stakeholders require ongoing dialogue and consultation from early in the Project planning and throughout the life of the Project.

- **Potentially active stakeholders:** Stakeholders who are likely to voice their opinions and/or concerns about the project and who may experience some of its impacts. These stakeholders require information updates about the project and some consultation. The project may also require some information from them to feed into various project aspects.

- **Other interested parties:** Stakeholders that are likely to voice their opinions and/or concerns but unlikely to experience any impacts from the project. These stakeholders require some level of information regarding the project. The project may also require some information from them to feed into various project aspects.

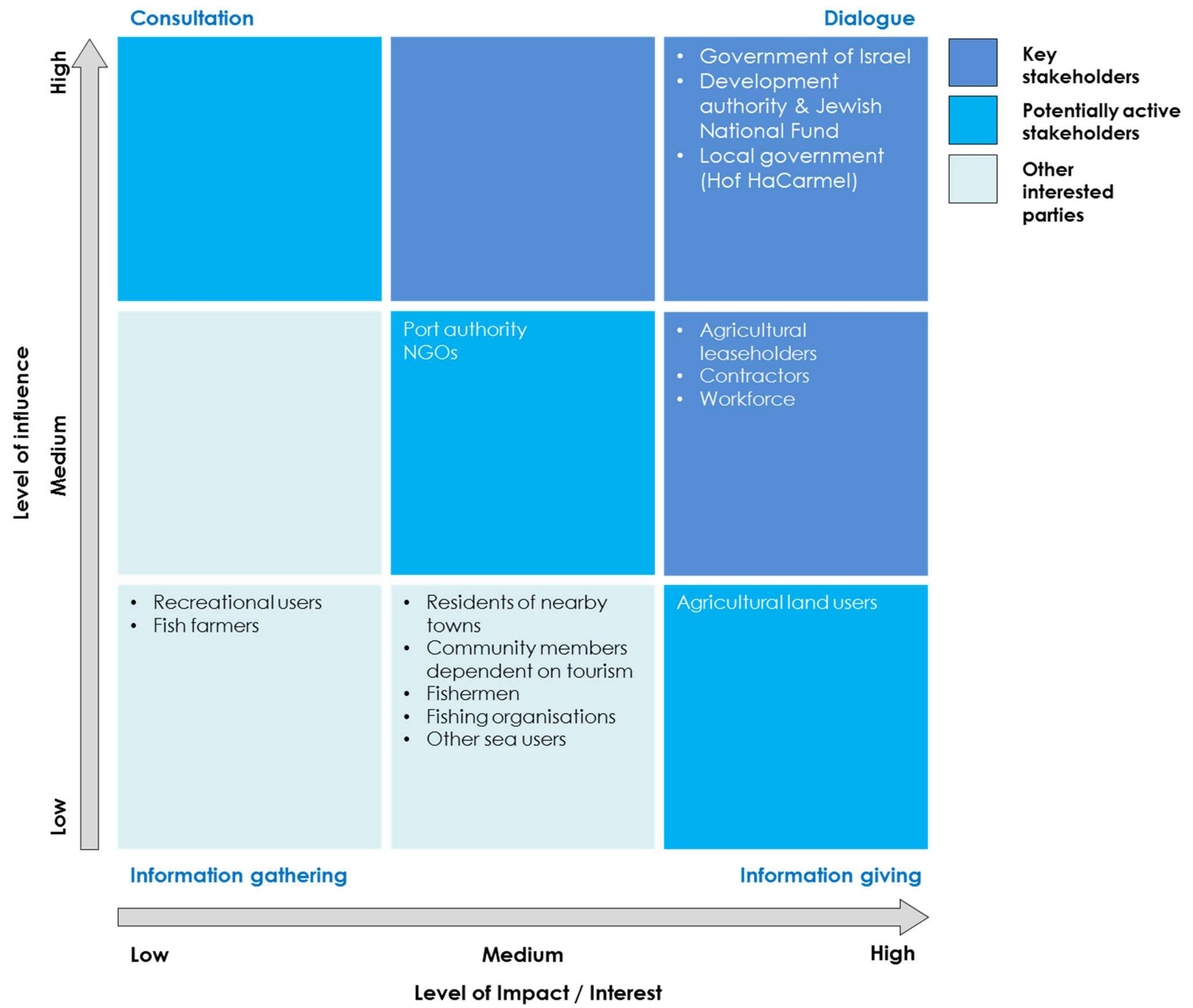
Table 3.1 sets out the main stakeholders identified as part of the ESIA scoping and their likely interest in the Project and what is understood to be their level of interest and influence at this stage.

Table 3.1 Identification and Prioritisation of Stakeholder Groups

Stakeholder Group	Stakeholders	Potential Topics of Interest	Level of Interest/ Impact	Level of Influence	Prioritisation
Local population	Residents of nearby towns: Dor, but may be extended to include Nachsholim and Fureidis	• Access to employment opportunity • Access to social investment • Disturbance • Restriction of access	M	L	Other interested parties
	Community members dependent on tourism as a livelihood	• Impact on tourism	M	L	Other interested parties
	Recreational users (eg beach, cycle path)	• Access restriction during construction (to beach) • Disturbance	L	L	Potentially active stakeholders
Administrative bodies and authorities	Government of Israel including: • Ministry of Environmental Protection • Ministry of National Infrastructures, Energy and Water Resources (Petroleum Unit) • Ministry of Education (Department of Antiquities and Museums)	• Receipt of tax / royalty payments for supporting Government budget • Employment and income generation for the local population, skills development • Fulfilment of commitments in the supply natural gas • Collaboration on ESIA preparation and submission • Fulfilment of ESIA commitments • Permitting • Licence renewals and payments • Antiquities	H	H	Key stakeholders
	Development Authority & Jewish National Fund	• Project land take • Compensation for land	H	H	Key stakeholders
	Local government (Hof HaCarmel Regional Council)	• Employment and income generation for the local population, skills development • Land issues (acquisition / leasing) • Tourism • Public engagement / opinion • Antiquities	H	H	Key stakeholders

Stakeholder Group	Stakeholders	Potential Topics of Interest	Level of Interest/ Impact	Level of Influence	Prioritisation
Other stakeholders including local groups and international NGOs	Fishermen	• Access restriction / exclusion zones • Potential for equipment damage	M	L	Potentially active stakeholders
	Fishing organisations	• Access restriction / exclusion zones • Potential for equipment damage	M	L	Potentially active stakeholders
	Fish farmers	• Access restriction	L	L	Other interested parties
	Other users of the sea	• Access restriction / exclusion zones	M	L	Potentially active stakeholders
	Port authority	• Port / berth use / business opportunity • Schedule	M	M	Potentially active stakeholders
	NGOs	• Environmental impacts • Community impacts	M	M	Potentially active stakeholders
Land users within pipeline corridor	Agricultural leaseholders	• Compensation for lost land usage • Access restriction	H	M	Key stakeholders
Organisations involved in implementation	Contractors	• Access to new contracts • Schedule	H	M	Other interested parties
	Workforce	• Labour and working conditions • Project health and safety	H	M	Key stakeholders

Figure 3.2 Mapped Stakeholders



4 COMMUNICATION METHODS

Energean will utilise different communication methods depending on the stakeholders being engaged, reflecting their level of authority, context, and cultural and educational factors. These methods may be discussed and agreed with stakeholders beforehand to ensure the engagement is being done in the most appropriate manner.

At this stage it is believed the most appropriate means of communication are the following:

- **Formal meetings.** Held with government authorities and other regulatory agencies.

- **Targeted meetings and focus groups.** Held with key stakeholder groups to present the Project and discuss particularly issues.

- **Community forum.** Held during construction, i.e. when most impacts are predicted to occur, to ensure that all stakeholders have the opportunity to give their views about any impacts that are occurring and allow Energean to respond and address these concerns in a pro-active manner. The venue, timing and format of the community forum will be determined to enable maximum participation from all stakeholders, particularly those that may be impacted by the Project. Planning of this event will be coordinated with the Chairman of Dor. The public exhibition will be publicised in advance.

- **Annual Energy Conference in Tel Aviv**. Energean will be presenting the project in this conference on December 02 2017. This conference being held annually with all the regional energy market players and relevant ministries participation.

Materials will be prepared in support of the engagement. These will include:

- Background Information Document (BID);
- Flyers; and
- Exhibition posters.

5 STAKEHOLDER ENGAGEMENT PROCESS

5.1 STAGES OF ENGAGEMENT

Stakeholder engagement is planned for the following stages of the project:

- Stage 1: National Engagement Programmes;
- Stage 2: Pre-ESIA and Scoping Disclosure;
- Stage 3: ESIA Disclosure;
- Stage 4: Implementation (including construction and production); and
- Stage 5: Decommissioning.

These stages are described in the following sections. These sections will be expanded as the stages of engagement planned and completed.

5.2 STAGE 1: NATIONAL ENGAGEMENT PROGRAMMES

5.2.1 Overview

Two national level engagement programmes have been conducted in Israel that complement the project-specific engagement activities. These were:

- the TAMA 37/H process that was carried out when designating the pipeline corridor route that would be used by multiple projects; and
- engagement around the Strategic Environmental Assessment (SEA) that was carried out for Israeli waters.

These two programmes are directly applicable to the project because they include the entire project footprint. The TAMA 37/H includes the onshore and nearshore project area, and the SEA includes the offshore project area.

5.2.2 TAMA 37/H Process

Public meetings in support of the EIS for the TAMA 37/H were held at the regional and local level to review the findings of the environmental studies as they progressed. The outcome of the public consultation and disclosure process was the eventual selection of offshore sites for gas production and the least obtrusive design for the onshore landing, including a Coastal Valve Station and connection of the offshore pipelines with the existing domestic export pipeline at an existing INGL facility near Dor Beach.

The process of developing TAMA 37/H from its initiation in 2009 until its final approval by Government of Israel in October 2014 included 18 publicised and documented public consultation meetings with local councils and interest groups. In addition there were 65 planning meetings involving the NPC and other planning committees related to TAMA 37/H. All protocols were publicised and most planning meetings included the public and other stakeholders. These meetings included 15 hearing sessions in which members of the public voiced their remarks and objections to various aspects of the plan. All content and outcome of these meetings were made public on the planning administration website.

A summary of the meetings that were held as part of this process is provided in *Table 5.1*.

Table 5.1 TAMA 37/H Engagement Meetings

Date	Stakeholders	Objective
Early 2010	Public hearing with the steering committees for 50 district councils	To discuss potential onshore gas processing terminal sites
October 2011	Public hearing with heads of municipalities (including Fureidis)	Further discussion on potential onshore gas processing terminal sites
November 2011	Twenty-five public forums, representing all districts within which a potential terminal site was located; district councils; government officials (including Furedis)	Further discussion on potential onshore gas processing terminal sites
July 2012	Meetings with local officials	Discuss the status of design and the determination to select five locations as final potential sites
October 2012	30-day public consultation period for EIA Chapters A and B	Garner public feedback on five potential sites
May – June 2013	30-day public consultation period for EIA Chapters C, D and E	Garner public feedback on two potential sites
February to April 2014	15-day period of public hearings involving 100 project opponents, including regional planning and building boards and representatives of the district planners from the North, Haifa, Central and Tel Aviv districts	To hear the views of opponents and allow project proponents to discuss the objections

5.2.3 Strategic Environmental Assessment

Public involvement was an integral part of the overall SEA process. This included providing data and relevant material regarding the progress of the SEA to relevant stakeholders and the public, and incorporation of their comments within the SEA. The programme for public involvement approved by the steering committee included the following stakeholders:

- 12 Government agencies;
- 78 companies and organisations operating within the affected marine area;
- 15 environmental and social NGOs;
- 12 academic and research organisations; nine planning institutions;
- 23 local councils; and
- the public.

Three meetings were held during the SEA process addressing specific issues. These were in February 2015, December 2015 and February 2016. In June 2016, the SEA was published for public comment for 32 days. During this period the findings of the SEA were presented to the public during a disclosure meeting. The resulting feedback, which included 51 public comments on various topics, was collected and addressed by the SEA team in the final SEA report.

5.3 *PRE-ESIA AND SCOPING DISCLOSURE*

Engagement activities in this stage are all project-specific and led by Energean. ***Error! Reference source not found.*** sets out the completed pre-ESIA engagements conducted by Energean.

Table 5.2 Planned Stages of Engagement, Timing and Proposed Communication Methods and Format

Date	Type	Purpose	Stakeholders	Location	Participants
17-19 July 2017	Formal meeting	Scoping Report Consultation including discussions around: • Discussion around project design • Environmental baseline survey planning • Discussion of how the project plans to align the Israeli EIS requirements with international finance standards • Discussion around scoping process and flagging of any topics of specific environmental or social concern • General ground-truthing of issues and collecting feedback	• Ministry of Environmental Protection • Ministry of National Infrastructures, Energy and Water Resources (Petroleum Unit)	Energean offices in Tel Aviv (Ministry of National Infrastructures, Energy and Water Resources), Ministry of National Infrastructures, Energy and Water Resources offices in Jerusalem, Ministry of Environmental Protection offices in Haifa	• 12 representatives from Energean and their contractors • ~25 representatives from the ministries
17 September 2017	Formal meeting	Development of Karish/Tanin – Initial coordination meeting	Minister of Defense	Minister of Defense Offices	• representatives from Energean • representatives from IDF General Staff Planning Division/Planning and • Development Head of South area, Navy – Gas Infrastructure Branch, IAF.
18 October 2017	Formal meeting	Karish & Tanin Development – Permitting Execution Plan and general project update	Haifa Shipping Authority Offices	Haifa Shipping Authority Offices	• 2 representatives from Energean • 2 representatives from the shipping authority
19 October 2017	Formal meeting	Karish & Tanin Development – Regulatory Execution Plan (REP) and general project update	Village of Ma'ayan Zvi	Village of Ma'ayan Zvi	• 1 representatives from Energean • 2 representatives from Ma'ayan Zvi local government
22 October 2017	Formal meeting	Karish & Tanin Development – Regulatory Execution Plan (REP) and general project update	Haifa District Authority	Haifa District Authority (DA) Offices	• 2 representatives from Energean and their contractors • 3 representatives from the DA
26 October 2017	Formal meeting	Karish & Tanin Development – Regulatory Execution Plan (REP) and general project update	Village of Dor	Village of Dor	• 1 representative for Energean • Dor Chairman
30 October 2017	Formal meeting	Karish & Tanin Development – Permitting Execution Plan and general project update	Nature & Natural Reserves Authority	Michmoret NNRA Offices	• 2 representatives from Energean and their contractors • 1 representative from the NPA
31 October 2017	Formal meeting	presenting the Karish-Tanin project Conceptual Plan	Ministry of Agriculture – The Fishery and Water Agriculture Division	Beit Dagan	• 1 representative for Energean • 1 representative from the Maritime Agriculture Department • 1 representative from the Planning and Development Rural Area
1 November 2017	Formal meeting	Karish & Tanin Development –Environmental Design Basis and Environmental Baseline Study	Ministry of Environmental Protection (MOEP)	MOEP Offices in Haifa	• 2 representatives from Energean and their contractors • 4 representatives from the MOEP • 1 representative from MOE
6 November 2017	Formal meeting	Karish & Tanin Development – Regulatory Execution Plan (REP) and general project update	Hof Carmel Regional Authority	Regional Authority (RA) Offices – Ein Carmel	• 3 representatives from Energean and their contractors • 5 representatives from the RA
8 November 2017	Formal meeting	Karish & Tanin Development – Regulatory Execution Plan (REP) and general project update	Town of Zichron Ya'akov	Zichron Ya'akov	• 2 representatives from Energean • 4 Zichron Ya'akov community members
12 November 2017	Formal meeting	Karish & Tanin Development – Regulatory Execution Plan (REP) and general project update	Village of Dor	Village of Dor	• 1 representatives from Energean • 3 representatives from Dor local government
12 November 2017	Conference	Karish & Tanin Development – Annual Energy Conference in Tel Aviv, Presentation of Karish and Tanin project	Regional Energy Market Players Representatives from Israeli Ministries Energy Industry Executives	Tel Aviv	• Representatives from Energean • TBC, Energy Market Executives • TBC, representatives from Israeli Ministries

5.4 *STAGE 3: ESIA ENGAGEMENT*

The purpose of the ESIA engagement is to update stakeholders on the following information:

- updates regarding the nature, scale and purpose of the project;
- disclosure of ESIA findings, including identification of impacts; and
- grievance mechanism and company contact details.

The ESIA will be formally submitted as part of the FDP to the Ministry of Energy (MOE) for review and approval. MOE will have the Ministry of Environmental Protection (MOEP) advising on all environmental aspects and proposed mitigations. The reviewing and approving process by both MOE and MOEP will include the following main steps post submission:

- First meeting - Initial presentation and open discussion
- Second meeting - Comments discussion and clarifications
- Third meeting – Discussion on proposed response to comments and draft revised documentation
- Forth meeting – Presentation of the proposed final documentation and formal submission.

After those steps Energean would expect a formal approval by the MOE.

The approved mitigation and measures under the ESIA will be carried on to the detailed permitting processes and be applied in the Building Permits and EMMP documentation. Approved Building Permits and EMMPs are by the law public documentation and be posted on the media and sent to every relevant stakeholder and entities.

The implication of permitting documentation provisions are in practice being put under each executor contractor contract and supervision entities to ensure compliance.

5.5 *STAGE 4: IMPLEMENTATION*

The purpose of engagement during implementation is for the project to inform stakeholders of project activities, gather and respond to feedback from community members who may be impacted by the project's activities, and maintain relationships throughout construction and production.

The primary mechanisms for engagement during this stage will be the project's grievance mechanism (see *Section 6*) and a community forum that will be led by Energean during the construction phase (i.e. when impacts are predicted to be most significant).

5.6 *STAGE 5: DECOMMISSIONING*

The purpose of engagement during decommissioning is to consult with stakeholder groups to ensure that feedback regarding the impacts of decommissioning is taken into account.

This section will be updated once the engagement is planned.

6 GRIEVANCE MECHANISM

The grievance mechanism is a process that enables stakeholders to make a complaint or a suggestion regarding the way a project is being implemented. This includes ensuring that all grievances that are received are acknowledged and logged and that the complainant knows what to expect in terms of response and when. Grievances may take the form of specific complaints for damages/injury, concerns about routine project activities, perceived incidents or impacts or requests for more information / clarity on project activities.

The primary objectives of a grievance mechanism are to:

- enhance trust and positive relationships with stakeholders;
- prevent the negative consequences of failure to adequately address grievances; and
- proactively identify and manage stakeholder concerns and thus support effective risk management.

The grievance mechanism allows stakeholders to submit complaints and comments at no cost, without retribution and with the assurance of a timely response.

All stakeholders will be able to submit a grievance by post, e-mail, website or facsimile. Any grievance may be delivered to the company at:

Contact: Yaron Daissy
E-mail: ydaissy@energean.com
Telephone: 0972 3779 1184

Energean's detailed grievance mechanism procedure is included as *Appendix A* of this SEP.

7 ROLES AND REPSONSIBILITIES

7.1 PRINCIPLES OF TEAM ORGANISATION

Stakeholder engagement is a core element of the Energean's overall business and will be managed with clearly defined objectives, lines of responsibility, accountability and budgets.

The community relations team will follow the overarching key principles of team organisation:

- **Overall responsibility and clear reporting lines:** Clear reporting lines and internal lines of communication will be discussed and agreed with the Community Liaison/ Social Performance Manager and other senior managers to ensure harmonization of key messages to stakeholders.

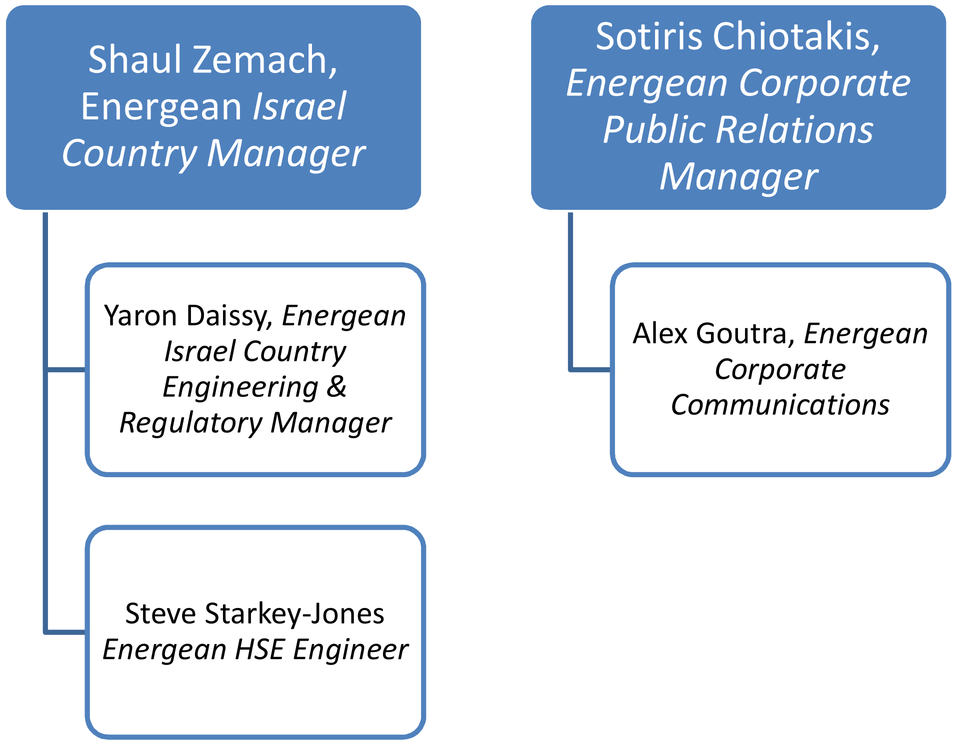
- **Defined responsibilities of third parties regarding communication:** The role of third parties in communicating the stakeholders will be clearly defined and regularly monitored to ensure that all engagement is culturally appropriate, does not exclude stakeholder groups (in particular women and vulnerable groups), raise false expectations that result into perceived promises/commitments without having obtained prior agreement.

- **Hire, train and deploy the right personnel:** All staff interacting with stakeholders will be able to develop good working relationships with all groups, from government to settlement level, in order to maintain and build trust and cooperation.

7.2 GENERAL TEAM STRUCTURE

The team structure provided on *Figure 7.1* provides a general overview of the roles specific for effective implementation of the SEP, reporting lines and lines of communication.

Figure 7.1 Relevant Energean Team Structure



Note that Energean will also use contractors to support on stakeholder engagement activities (e.g. Environmental Resources Management is the ESIA contractor and has supported Energean on the development of the stakeholder engagement planning for the development). Where contractors are used to support engagement activities, specific roles and responsibilities will be clearly defined in advance.

8 DATA MANAGEMENT AND MONITORING

8.1 OVERVIEW

In order to assess the effectiveness of this SEP and associated engagement activities, Energean will implement a SEP data management and monitoring process as part of the overall monitoring of ESIA commitments and performance. The SEP data management and monitoring process will include measurement of the realisation of stakeholder engagement activities, the effectiveness of these activities and how the feedback of stakeholders are addressed through the ESIA and other Project mechanisms.

8.2 DATA MANAGEMENT

All engagement activities, throughout the ESIA process and the life of the project, will be documented and filed in order to track and refer to records when required and ensure delivery of commitments made to stakeholders. The following stakeholder engagement records and documentation will be used and maintained by Energean:

- **Stakeholder engagement database / log:** Used to store, analyse and report on stakeholder engagement activities. It will be populated with details of the event, participation (disaggregated by stakeholder group), details on information presented, stakeholder questions, Energean's responses and commitments made and actions, and meeting evaluation results, when appropriate. The database will also be used to track frequency of meetings over the life of the project.

- **Meeting minute template:** Used to collect full meeting minutes to be filed with the stakeholder database.

- **Stakeholder list:** On-going updates to the list, including key contacts and contact details (telephone number, email address etc.) as additional stakeholders are identified.

- **Grievance log:** To record all grievances received, management actions and whether it has satisfactorily been closed out.

- **Media monitoring:** To keep up to date of press and radio stories relevant to the project**.**

Records will be reviewed on a quarterly basis to ensure that records are being used and maintained. Commitments and actions recorded during engagement activities will also be regularly reviewed to ensure they are taken forward.

8.3 *MONITORING ENGAGEMENT ACTIVITIES*

As part of the overall engagement strategy, in line with best practice, engagement activities will be monitored through a feedback mechanism. Feedback will be sought on individual meetings and also periodically on the overall process of engagement. Grievances will also be periodically analysed to identify patterns, avoid recurrent problems and improve the company's overall environmental and social performance.

Feedback on individual meetings allows for information to be gathered regarding the effectiveness of meetings and the process undertaken to present information. The feedback process allows for continual improvements to be made to individual stakeholder engagement activities.

The evaluation process will complement analysis of grievances to identify trends over time and make improvements to engagement and other processes. If necessary, additional meetings will be organised with stakeholders to further understand the main areas of concern and to obtain further feedback to improve engagement.

8.4 *PROVIDING FEEDBACK TO STAKEHOLDERS*

Energean will document the feedback received and providing feedback on how stakeholder concerns and ideas have been taken into account through the ESIA and post the ESIA. The Stakeholder Engagement chapter of the ESIA sill also summarise how stakeholder input has been used to inform the impact assessment process.

Annex F:
Oil Spill Modelling Report

Oil Spill Modelling Report: Karish Tanin Project, Israel

Energean Oil and Gas

Document Number: GEOM0085 R03
Issued: 20 October 2017

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EXECUTIVE SUMMARY

This document summarises the oil spill modelling work carried out by Oil Spill Response Ltd. (OSRL) on behalf of Energean Oil and Gas, for the Karish Tanin Project, Israel.

This report evaluates the impact of three different oil spill scenarios:

Scenario 1. Continuous 90 day release of 6,720 bbls/day as a result of Karish Well blowout

- Winter (Dec-Feb)
- Spring (Mar-May)
- Summer (Jun-Aug)
- Autumn (Sep-Nov)

Scenario 2. Phased release of 500,000 bbls because of a FPSO tank rupture.

- Winter (Dec-Feb)
- Spring (Mar-May)
- Summer (Jun-Aug)
- Autumn (Sep-Nov)

Scenario 3. Instantaneous release (5 hours) of 25,000 bbls because of a FPSO tank rupture.

- Summer (Jun-Aug)

Four trajectories were also run. These covered the following metocean conditions:

1. Extreme winter wave storm: Dec 9 2010 - Jan 8 2011
2. Winter wave storm: Jan 26 2008 - Feb 14 2008
3. Swell in summer: Jul 17 2008 - Aug 16 2008
4. Strong north-easterly wind (spring and autumn): Sep 25 2007 - Oct 25 2007

The three scenarios were simulated using SINTEF's Oil Spill Contingency and Response (OSCAR) 3D modelling tool.

During the well blowout scenario, the most likely season for shoreline oiling is summer with 58% (177 out of 303) of simulations result in light shoreline oiling. Most of the time, this scenario results in no significant shoreline impact. The larger tank rupture scenario (500,000 bbls) results in more potential shoreline oiling; the summer season has the highest probability of heavy oiling (20% or 61 of 303 scenarios) and the highest probability of moderate oiling (27% or 83 of 303 scenarios). The smaller tank rupture release (25,000 bbls), during only the summer months, has a 22 % (68 of 303 scenarios) of light oiling and 12% (37 of 303 scenarios) of moderate oiling. No heavy oiling occurs in this scenario.

The maximum emulsion mass onshore is:

- 115.26 MT during the well blowout
- 4,700 MT during the 500,000 bbls tank rupture
- 280 MT during the 25,000 bbls release

Oil could potentially cross the maritime boundaries of several countries, although all scenarios are showing potential to enter either Lebanese or Cypriot waters.

DOCUMENT HISTORY

Document Number	Revision	Document Type	Author	Technical Review	Format Review	Date of Issue
GEOM0085	R01	Draft Modelling Report	LEJ/JKM	JKM	LEJ	20-Oct-17
GEOM0085	R02	Draft Modelling Report	LEJ/SJB	LHM	JKM	11-Oct-17

JKM – Jenny Kirsty Mitchell LEJ - Lucy Elizabeth Jenkins LHM – Liam Harrington-Missin
SJB – Simon James Blaen

DISCLAIMERS

- Modelling results are to be used for guidance purposes only and response strategies should not be based on these results alone.
- The resolution / quality of wind and current data vary between regions and models. As with any model, the quality and reliability of the results are dependent on the quality of the input data.

Giving consideration to the above, all advice, modelling, and other information provided is generic and illustrative only and not intended to be relied upon in any specific instance. The recipient of any advice, modelling or other information from, or on behalf of, OSRL acknowledges and agrees that any number of variables may impact on an oil spill and, as such, should be addressed on an individual basis. OSRL has no liability in relation to such advice, modelling or other information and the recipient of such information hereby fully indemnifies and holds harmless OSRL its officers, employees, shareholders, agents, contractors and sub-contractors against any costs, losses, claims or liabilities arising in connection with such advice, modelling, training or other information.

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1 INTRODUCTION

1.1 Background

Oil spill modelling was completed by Oil Spill Response Ltd. (OSRL) on behalf of Energean Oil and Gas for the Karish Tanin project. The aim of this report is to identify the fates of oil released in two scenarios at the Karish Well and the FPSO (Figure 1). The modelled scenarios are summarised in Table 1.

Scenario 1 Continuous 90 day release of 6,720 bbls/day as a result of Karish Well blowout.

- Winter (Dec-Feb)
- Spring (Mar-May)
- Summer (Jun-Aug)
- Autumn (Sep-Nov)

Scenario 2 Phased release of 500,000 bbls because of a FPSO tank rupture.

- Winter (Dec-Feb)
- Spring (Mar-May)
- Summer (Jun-Aug)
- Autumn (Sep-Nov)

Scenario 3 Instantaneous release (5 hours) of 25,000 bbls because of a FPSO tank rupture.

- Summer (Jun-Aug)

The modelling was carried out using SINTEF's Oil Spill Contingency and Response (OSCAR) model. OSCAR is a 3D modelling tool used to predict the movement and fate of oil on the sea surface and throughout the water column (see APPENDIX G for further details).

1.2 Aims

The aim of this report is to present the risk to the sea surface and shoreline by creating spatial maps of:

1. Probability - to estimate how likely an area is to be impacted
2. Arrival time - to estimate how quickly an area could be impacted
3. Emulsion thickness - to estimate how severely an area could be impacted.

The data behind these maps allow us to answer the following questions:

1. How quickly oil could oil reach nearby shorelines?
2. What mass of oil could reach nearby shorelines?
3. Which countries are more likely to be affected by an oil spill at the Karish Well?

Table 1: Scenario setup

Scenario Reference	Scenario 1	Scenario 2	Scenario 3
Description	Well Blowout	FPSO Tank Rupture	FPSO Tank Rupture
Latitude	33° 13' 55.2432" N	33° 12' 15.1704" N	33° 12' 15.1704" N
Longitude	034° 17’ 27.51" E	034° 17’ 24.842" E	034° 17’ 24.842" E
Total Oil Volume/ Mass Released	604,800 bbls 77,064.3 MT	500,000 bbls 63,710.6 MT	25,000 bbls 3,185.5 MT
Duration of Release	90 days	4 days	5 hours
Depth of Release	1,725 m	surface	surface
Nearest Shoreline	~77 km, Haifa, Israel		

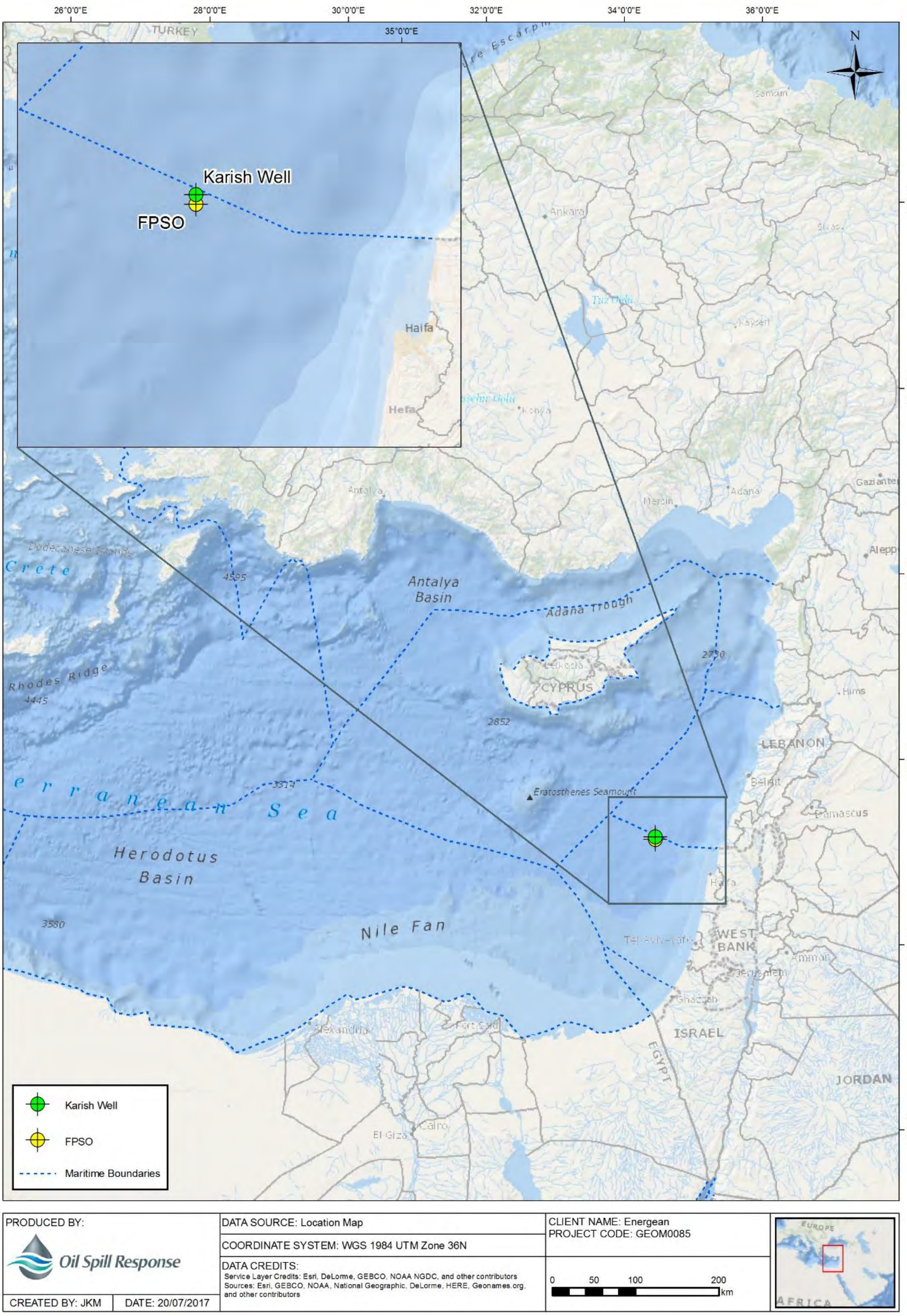


Figure 1: Map showing the location of Karish Well & FPSO

2 SCENARIO SETUP

2.1 Modelling Setup

Nine stochastic simulations were run at the Karish Well (Table 2). A total of 1,052, 1,160 and 303 individual trajectories were post-processed for Scenario 1, Scenario 2 and Scenario 3 respectively, to create the stochastic results for each scenario. Each trajectory began on a different start date, so that each oil spill was simulated using a range of wind and current conditions.

Five years of hydrodynamic data were used as model inputs. See APPENDIX A to APPENDIX E for more information on the model setup.

Table 2: Summary of stochastic setup for spill scenarios

Scenario Reference	Scenario 1 (S01 -S04)	Scenario 2 (S05-S08)	Scenario 3 (S09)
Description	Well Blowout	FPSO Tank Rupture	FPSO Tank Rupture
Location	33° 13' 55.2432" N; 034° 17' 27.51" E	33° 12' 15.1704" N 034° 17' 24.842" E	33° 12' 15.1704" N 034° 17' 24.842" E
Time of Year	S01 – Dec-Feb S02 – Mar-May S03 – Jun-Aug S04 – Sep-Nov	S05 – Dec-Feb S06 – Mar-May S07 – Jun-Aug S08 – Sep-Nov	S09 – Jun-Aug
Release Period	90 days	4 days	5 hours
Release Rate	6,720 bbls/day	10,000 bbls/12 hours 6,000 bbls/12 hours 5,000 bbls/24 hours 4,000 bbls/47 hours	5,000 bbls/hour
Total Release (Volume)	604,800 bbls	500,000 bbls	25,000 bbls
Total Release (Mass)	77,064.6 MT	63,710.6 MT	3,185.5 MT
Total Run Duration	118 days	32 days	28 days
Total Number of Trajectories	1,052	1,160	303
Time Between Trajectories	22 hours	22 hours	22 hours

2.2 Thresholds

Thresholds define the point below which data are no longer informative. For example, when surface emulsion thickness is less than 0.04 µm, the oil is no longer visible to the naked eye so may be considered insignificant to a response. The thresholds applied to this study are given in Table 3.

Table 3: Thresholds used in the post-processing stage of the modelling

Threshold	Value	Description
Surface	0.04 µm	The Bonn Agreement Oil Appearance Code defines five oil layer thicknesses based on their optic effects and true colours. 0.04 µm is the minimum thickness that can be seen with the naked eye.
Shoreline	0.1 litres/m^2	Lower threshold for light oiling from the ITOPF document "Recognition of oil on shorelines".

The thickness key used in the surface emulsion thickness maps throughout this document is derived from the Bonn Oil Appearance Code (Table 4).

Table 4: Key used for sea surface emulsion thickness outputs

Appearance	Layer Thickness Interval	Colour
Sheen	0.04 µm - 0.3 µm	
Rainbow	0.3 µm -5 µm	
Metallic	5 µm - 50 µm	
Discontinuous True Colour	50 µm - 200 µm	
Continuous True Colour	>200 µm	

The thickness key used in the shoreline maps throughout this document is derived from the ITOPF Technical Information Paper (TIP) No. 6 "Recognition of oil on shorelines" (ITOPF, 2011b; Table 5). Very light oiling is deemed insignificant by ITOPF (ITOPF, 2011b); no practical response is required for a very lightly oiled shoreline, apart from monitoring the oil spill.

Table 5: Key used for shoreline emulsion thickness outputs

Shoreline Oiling Classification	Concentration	Thickness	Colour
Light Oiling	0.1 – 1 litres/m^2	0.1 mm – 1.0 mm	
Moderate Oiling	1 – 10 litres/m^2	1 mm – 10 mm	
Heavy Oiling	> 10 litres/m^2	> 10 mm	

3 RESULTS

3.1 Summary of Stochastic Results

Table 6, Table 7 and Table 8 summarise the results of the stochastic simulations run for each scenario at the Karish Well and the FPSO. For more information on the thresholds used when post-processing the data see Section 2.2.

Table 6: Summary of stochastic results for scenario 1

Oil Spill Modelling Summary				
Spill Scenario/Description	Scenario 1		Well Blowout	
Median Crossing				
Identified Median Line	**Probability and Shortest Time to Reach Median Line**			
	Winter	**Spring**	**Summer**	**Autumn**
Cyprus	86 %	90 %	78 %	49 %
	2 day 15 hrs	2 days	1 day 3 hrs	2 days, 12 hrs
Egypt	<1 %	17 %	-	-
	88 days, 15 hrs	48 days, 15 hrs	-	-
Israel	100 %	100 %	100 %	100 %
	9 hrs	12 hrs	12 hrs	9 hrs
Lebanon	100 %	100 %	100 %	100 %
	<1 hr	<1 hr	<1 hr	<1 hr
Syria	-	-	43 %	-
	-	-	3 days, 6 hrs	-
Turkey	-	<1 %	-	-
	-	80 days, 3 hrs	-	-
Landfall				
Identified Shoreline	**Probability and Shortest Time to Reach Shoreline**			
	Winter	**Spring**	**Summer**	**Autumn**
Israel	-	8 %	36%	-
	-	13 days, 8 hrs	9 day 4 hours	-
Lebanon	-	8 %	90 %	1 %
	-	27 days, 14 hrs	8 days, 23 hrs	14 days, 12 hrs
Maximum Volume Beached				
Mass of oil onshore	1.04 MT	115.26 MT	64.99 MT	4.06 MT
Volume[1] of oil onshore	1.37 m^3	151.86 m^3	85.63 m^3	5.35 m^3
Water content	0.05 %	0.05 %	0.05 %	0.05 %
Volume of emulsion onshore	1.44 m^3	159.85 m^3	90.13 m^3	5.63 m^3

[1] OSCAR does not provide the volume of oil onshore only the mass. To convert from mass to volume we assume that the density of the spilt oil is constant and the same as the source product (e.g. 0.843). In reality the density of the spill will be different over time and space but the model is unable to capture this complex interaction. Therefore the volume estimates presented in this report should be treated as approximate.

Table 7: Summary of stochastic results for scenario 2

Oil Spill Modelling Summary				
Spill Scenario/Description	Scenario 2		FPSO Tank Rupture	
Median Crossing				
Identified Median Line	**Probability and Shortest Time to Reach Median Line**			
	Winter	**Spring**	**Summer**	**Autumn**
Cyprus	44 %	26 %	51 %	13 %
	1 day 9 hrs	1 day, 9 hrs	2 days 6 hrs	1 day, 12 hrs
Egypt	5 %	9%	2 %	21 %
	4 days, 9 hrs	4 days	11 days, 21 hrs	6 days, 12 hrs
Gaza Strip	-	-	-	2 %
	-	-	-	17 days, 3 hrs
Israel	100 %	100 %	100 %	100 %
	<1 hr	<1 hr	<1 hr	<1 hr
Lebanon	92 %	86 %	96 %	36 %
	6 hrs	6 hrs	6 hrs	6 hrs
Syria	3 %	7 %	50 %	-
	7 days, 15 hrs	10 days, 21 hrs	5 days, 6 hrs	-
Turkey	-		17 %	-
	-		11 days, 6 hrs	-
Landfall				
Identified Shoreline	**Probability and Shortest Time to Reach Shoreline**			
	Winter	**Spring**	**Summer**	**Autumn**
Cyprus	<1 %	-	2 %	-
	3 days, 7 hrs	-	12 days, 22 hrs	-
Israel	-	24 %	27%	30 %
	-	5 days, 11 hrs	8 days 18 hours	7 days, 16 hrs
Lebanon	2 %	9 %	47 %	11 %
	5 days	4 days, 20 hrs	6 days, 17 hrs	7 days, 12 hrs
Gaza Strip	-	-	-	2 %
	-	-	-	17 days, 2 hrs
Syria	-	<1 %	15 %	-
	-	22 days, 12 hrs	10 days, 14 hrs	-
Turkey	-	-	<1 %	-

	-	-	17 days, 2 hrs	-
Maximum Volume Beached				
Mass of oil onshore	95 MT	3,264.57 MT	4,700.34 MT	2,427.06 MT
Volume[2] of oil onshore	125 m^3	4,301 m^3	6,193 m^3	3,198 m^3
Water content	0.05 %	0.05 %	0.05 %	0.05 %
Volume of emulsion onshore	132 m^3	4,528 m^3	6,519 m^3	3,366 m^3

[2] OSCAR does not provide the volume of oil onshore only the mass. To convert from mass to volume we assume that the density of the spilt oil is constant and the same as the source product (e.g. 0.843). In reality the density of the spill will be different over time and space but the model is unable to capture this complex interaction. Therefore the volume estimates presented in this report should be treated as approximate.

Table 8: Summary of stochastic results for scenario 3

Oil Spill Modelling Summary		
Spill Scenario/Description	Scenario 3	FPSO Tank Rupture
Median Crossing		
Identified Median Line	**Probability and Shortest Time to Reach Median Line**	
	Summer	
Cyprus	30 % 2 days 9 hrs	
Israel	100 % <1 hr	
Lebanon	88 % 6 hrs	
Syria	16 % 5 days, 21 hrs	
Turkey	<1 % 14 days, 6 hrs	
Landfall		
Identified Shoreline	**Probability and Shortest Time to Reach Shoreline**	
	Summer	
Israel	15% 9 days 7 hours	
Lebanon	23 % 8 days, 21 hrs	
Syria	3 % 11 days, 12 hrs	
Maximum Volume Beached		
Mass of oil onshore	280.35 MT	
Volume[3] of oil onshore	369 m^3	
Water content	0.05 %	
Volume of emulsion onshore	388 m^3	

[3] OSCAR does not provide the volume of oil onshore only the mass. To convert from mass to volume we assume that the density of the spilt oil is constant and the same as the source product (e.g. 0.843). In reality the density of the spill will be different over time and space but the model is unable to capture this complex interaction. Therefore the volume estimates presented in this report should be treated as approximate.

3.2 Scenario 1 – Well Blowout

3.2.1 Stochastic Maps

A release from the Karish Well was modelled over winter (Dec-Feb), spring (Mar-May), summer (Jun-Aug) and autumn (Sep-Nov). The scenario involves the release of 604,800 bbls of oil over 90 days during winter (Dec-Feb). The oil is tracked for a further 28 days, resulting in a total model duration of 118 days.

To simulate a range of possible metocean conditions, stochastic results were calculated from 1,052 trajectories.

The following results are presented:

Sea Surface

Figure 2: Probability that a cell could be impacted by a well blowout.

Figure 3: Minimum arrival time of oil from a well blowout.

Figure 4: Maximum emulsion thickness of oil from a well blowout.

Shoreline

Figure 5: Shoreline Contamination based on emulsion mass from a well blowout.

Figure 6: Probability that a shoreline cell could be impacted by oil from a well blowout.

Figure 7: Minimum arrival time of oil from a well blowout.

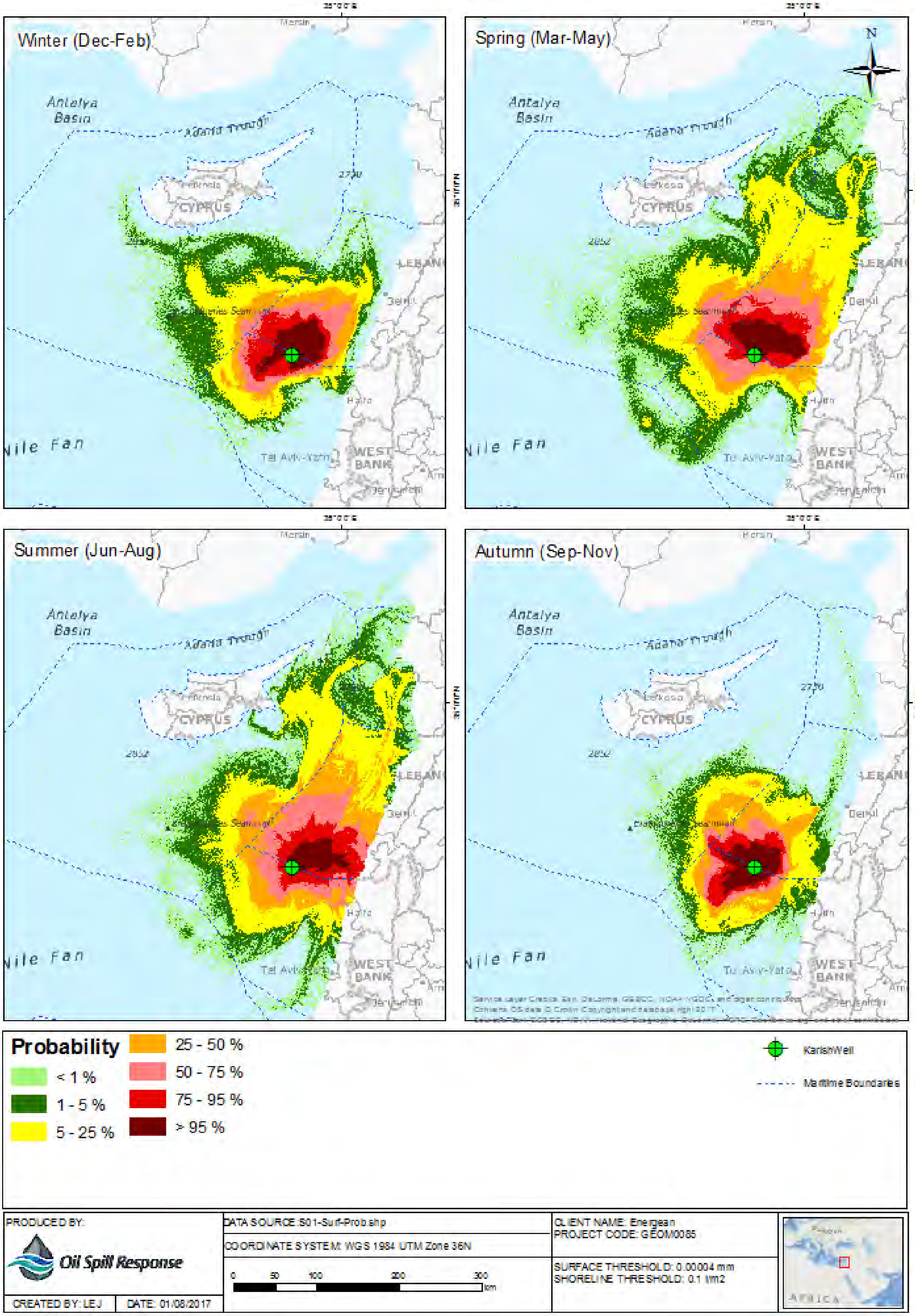


Figure 2: Probability that a cell could be impacted by a well blowout.

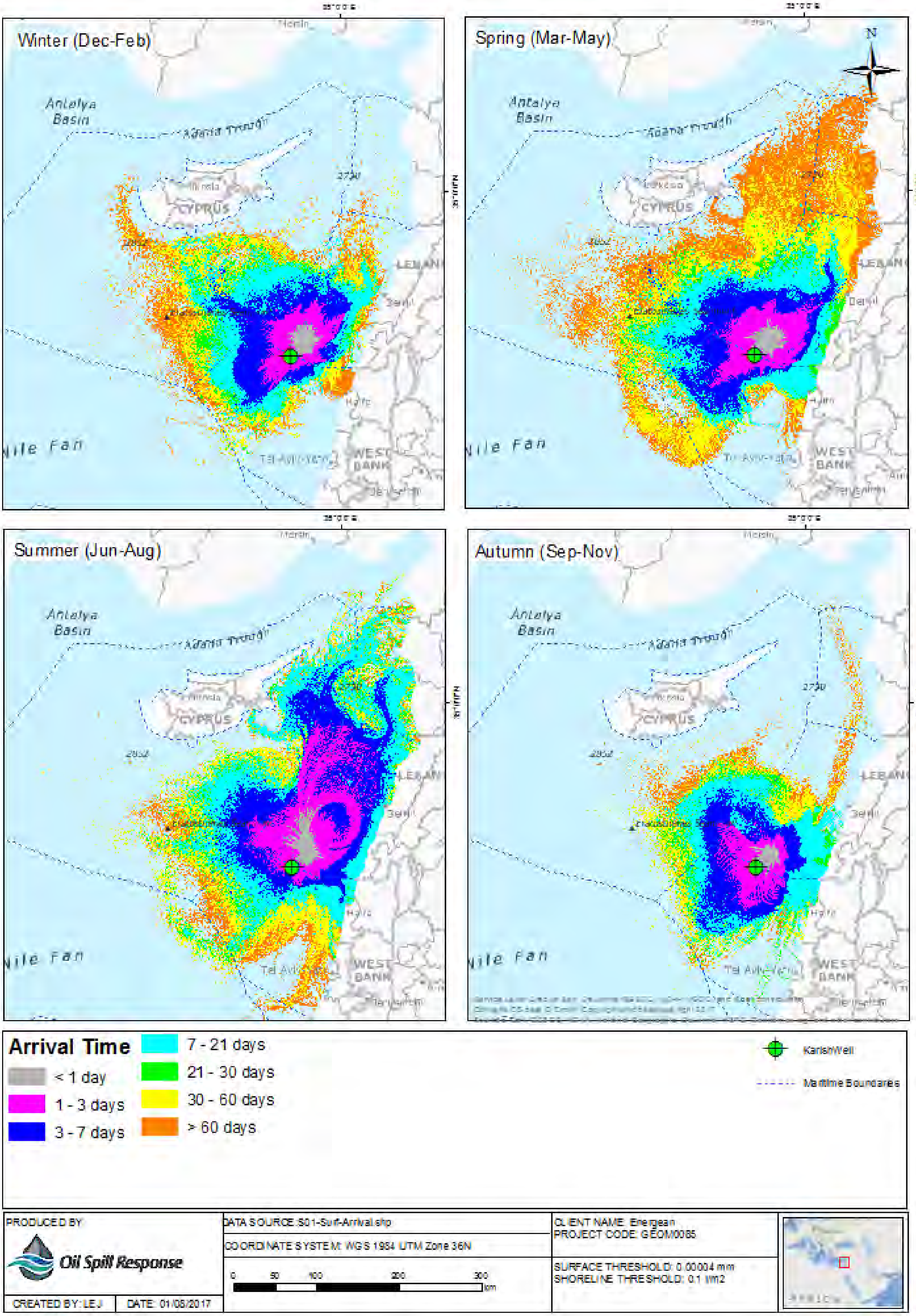


Figure 3: Minimum arrival time of oil from a well blowout.

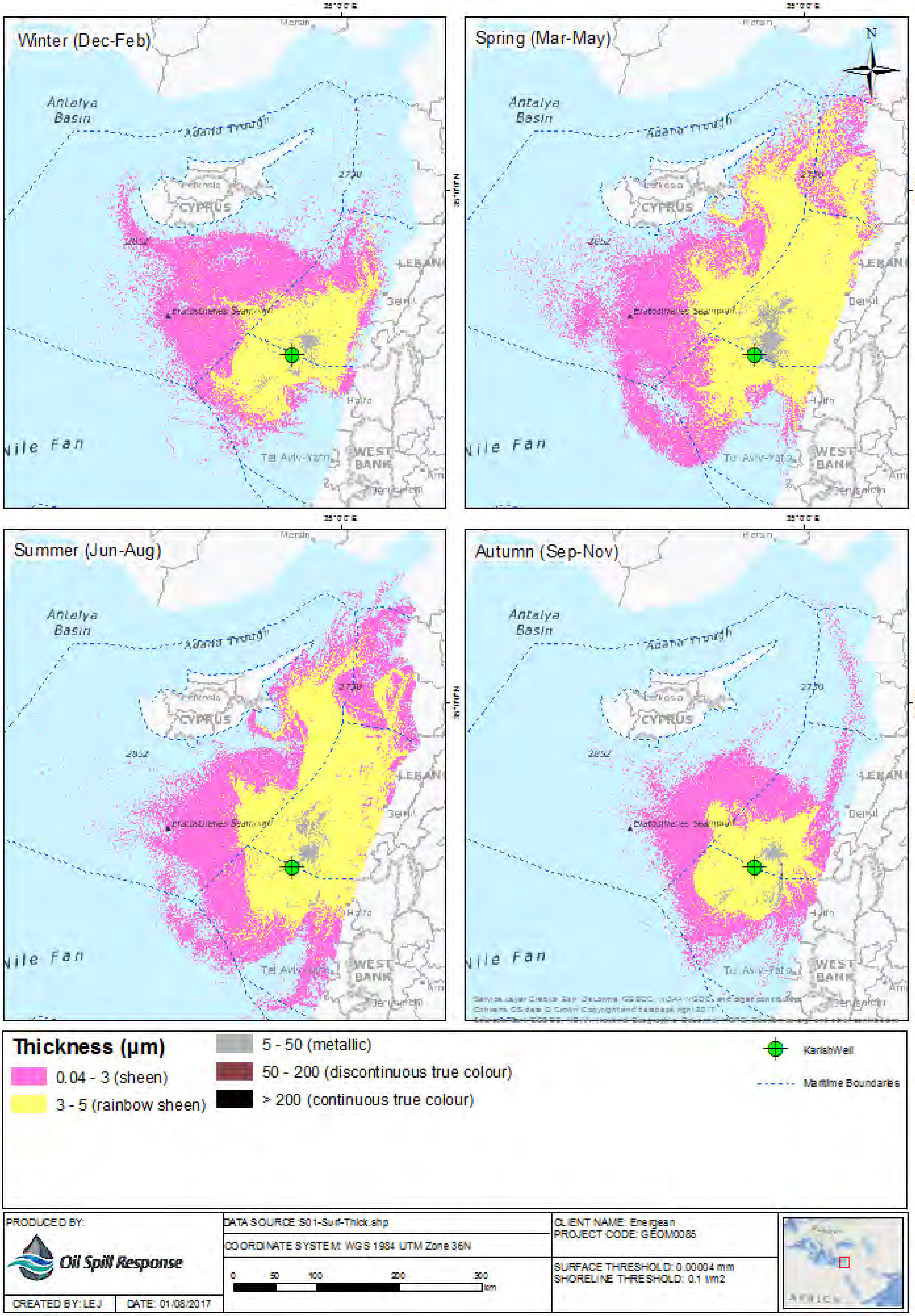


Figure 4: Maximum emulsion thickness of oil from a well blowout.

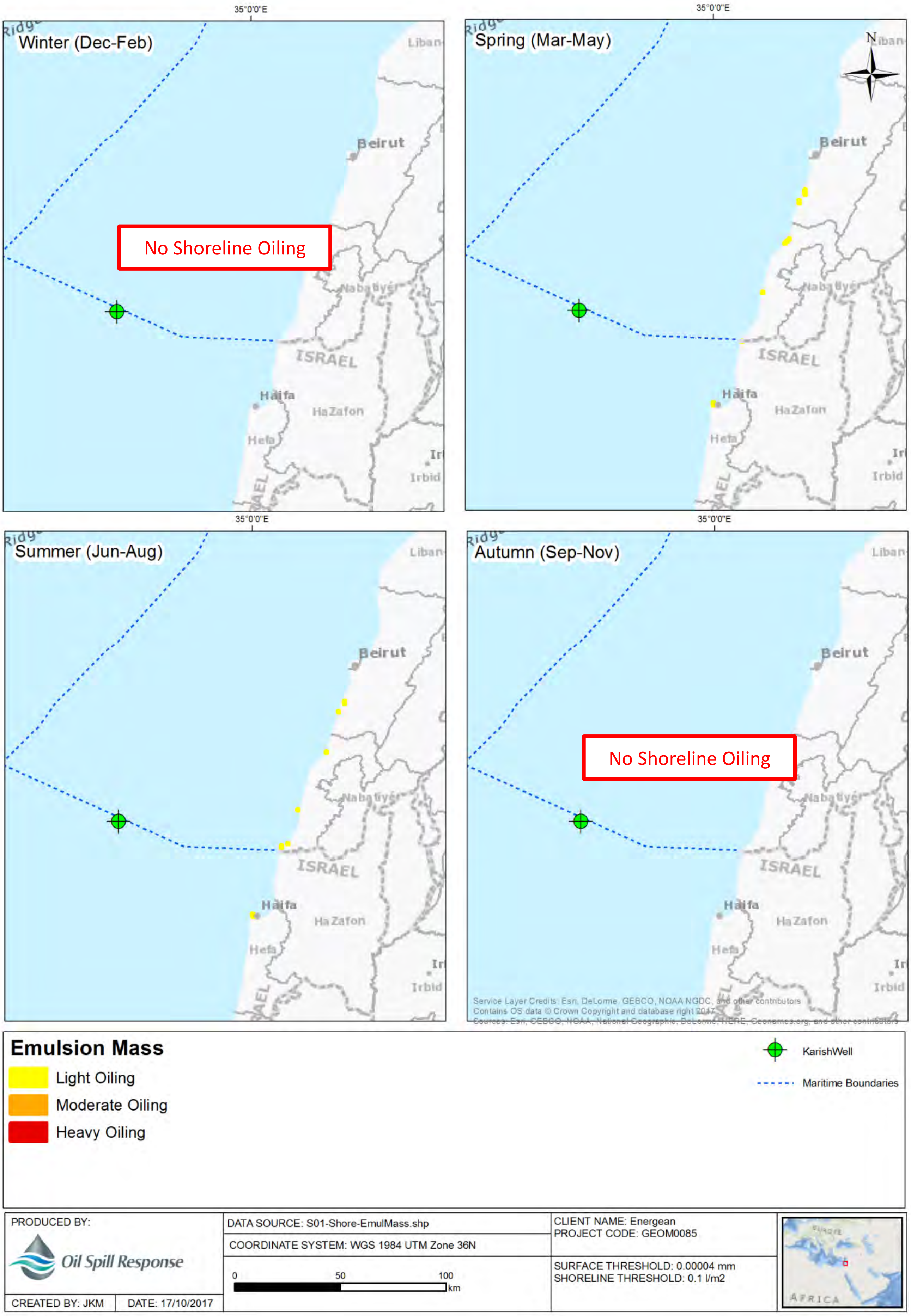


Figure 5: Shoreline Contamination based on emulsion mass from a well blowout.

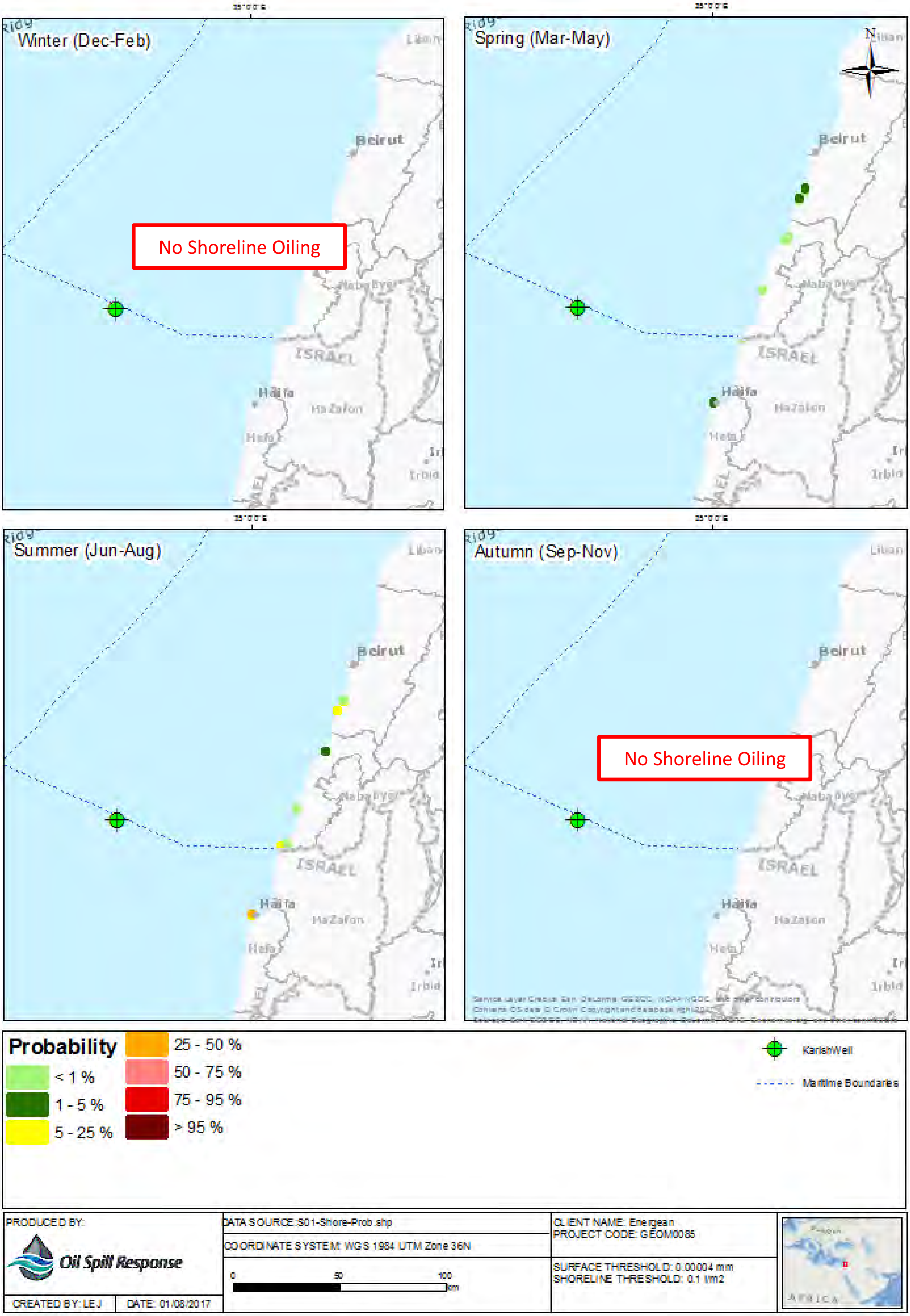


Figure 6: Probability that a shoreline cell could be impacted by oil from a well blowout.

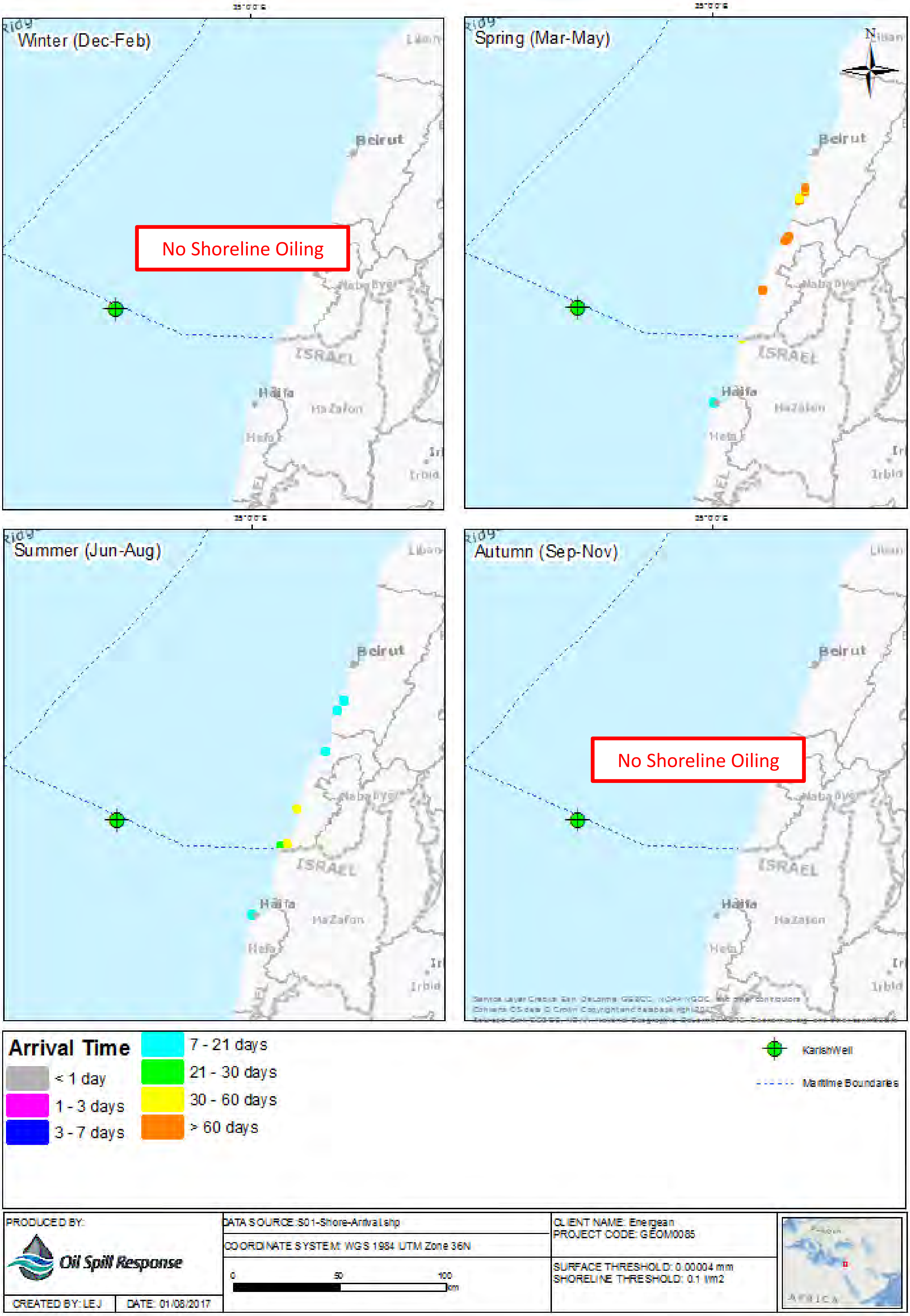


Figure 7: Minimum arrival time of oil from a well blowout.

3.2.2 Stochastic Statistics

Table to Table 10 shows how many of the simulations result in different levels of shoreline impact based on ITOPF’s Technical Information Paper (TIP) no. 6, “Recognition of Oil on Shorelines”.

Each of the 1,052 trajectories is put into a single category based on its most severe shoreline oiling. For example, a trajectory that has at least one cell classified as *Heavy Oiling* will be placed in the heavy oiling category regardless of how many of the other cells have *Moderate* or *Light* oiling.

Table 11 to Table 14 shows the length of shoreline impacted. For further information see Thresholds in Section 2.2.

Table 9: Severity of shoreline oiling following a well blowout at the Karish Well, winter (S01)

ITOPF Reference	Heavy Oiling	Moderate Oiling	Light Oiling	No Significant Impact
OSRL's SCAT Reference	Thick	Cover	Coat	No Impact
Number of Simulations	0 of 244	0 of 244	0 of 244	244 of 244
Probability	0%	0%	0%	100%

Table 10: Severity of shoreline oiling following a well blowout at the Karish Well, spring (S02)

ITOPF Reference	Heavy Oiling	Moderate Oiling	Light Oiling	No Significant Impact
OSRL's SCAT Reference	Thick	Cover	Coat	No Impact
Number of Simulations	0 of 303	0 of 303	20 of 303	283 of 303
Probability	0%	0%	7%	93%

Table 9: Severity of shoreline oiling following a well blowout at the Karish Well, summer (S03)

ITOPF Reference	Heavy Oiling	Moderate Oiling	Light Oiling	No Significant Impact
OSRL's SCAT Reference	Thick	Cover	Coat	No Impact
Number of Simulations	0 of 303	0 of 303	177 of 303	126 of 303
Probability	0%	0%	58%	42%

Table 10: Severity of shoreline oiling following a well blowout at the Karish Well, autumn (S04)

ITOPF Reference	Heavy Oiling	Moderate Oiling	Light Oiling	No Significant Impact
OSRL's SCAT Reference	Thick	Cover	Coat	No Impact
Number of Simulations	0 of 202	0 of 202	1 of 202	201 of 202
Probability	0%	0%	<1%	>99%

Table 11: Length of shoreline following a well blowout at the Karish Well, winter (S01)

Level of Shoreline Oiling	Length of Shoreline Impacted [km]		
	best case	average	worst case
Light Oiling	No shoreline oiling	No shoreline oiling	No shoreline oiling
Moderate Oiling			
Heavy Oiling			

Table 12: Length of shoreline following a well blowout at the Karish Well, spring (S02)

Level of Shoreline Oiling	Length of Shoreline Impacted [km]		
	best case	average	worst case
Light Oiling	No shoreline oiling	No shoreline oiling	21
Moderate Oiling			0
Heavy Oiling			0

Table 13: Length of shoreline following a well blowout at the Karish Well, summer (S03)

Level of Shoreline Oiling	Length of Shoreline Impacted [km]		
	best case	average	worst case
Light Oiling	No shoreline oiling	3	10
Moderate Oiling		0	0
Heavy Oiling		0	0

Table 14: Length of shoreline following a well blowout at the Karish Well, autumn (S04)

Level of Shoreline Oiling	Length of Shoreline Impacted [km]		
	best case	average	worst case
Light Oiling	No shoreline oiling	No shoreline oiling	1
Moderate Oiling			0
Heavy Oiling			0

3.3 Scenario 2 – FPSO Tank Rupture

3.3.1 Stochastic Maps

A release from the FPSO was modelled over winter (Dec-Feb), spring (Mar-May), summer (Jun-Aug) and autumn (Sep-Nov). The scenario involves the phased release of 500,000 bbls of oil over 4 days during winter (Dec-Feb). The oil is tracked for a further 28 days, resulting in a total model duration of 32 days.

To simulate a range of possible metocean conditions, stochastic results were calculated from 1,160 trajectories.

The following results are presented:

Sea Surface

Figure 8: Probability that a cell could be impacted by a phased release from the FPSO.

Figure 9: Minimum arrival time of oil from a phased release from the FPSO.

Figure 10: Maximum emulsion thickness of oil from a phased release from the FPSO.

Shoreline

Figure 11: Shoreline Contamination based on emulsion mass from a phased release from the FPSO.

Figure 12: Probability that a cell could be impacted by oil from a phased release from the FPSO.

Figure 13: Minimum arrival time of oil from a phased release from the FPSO.

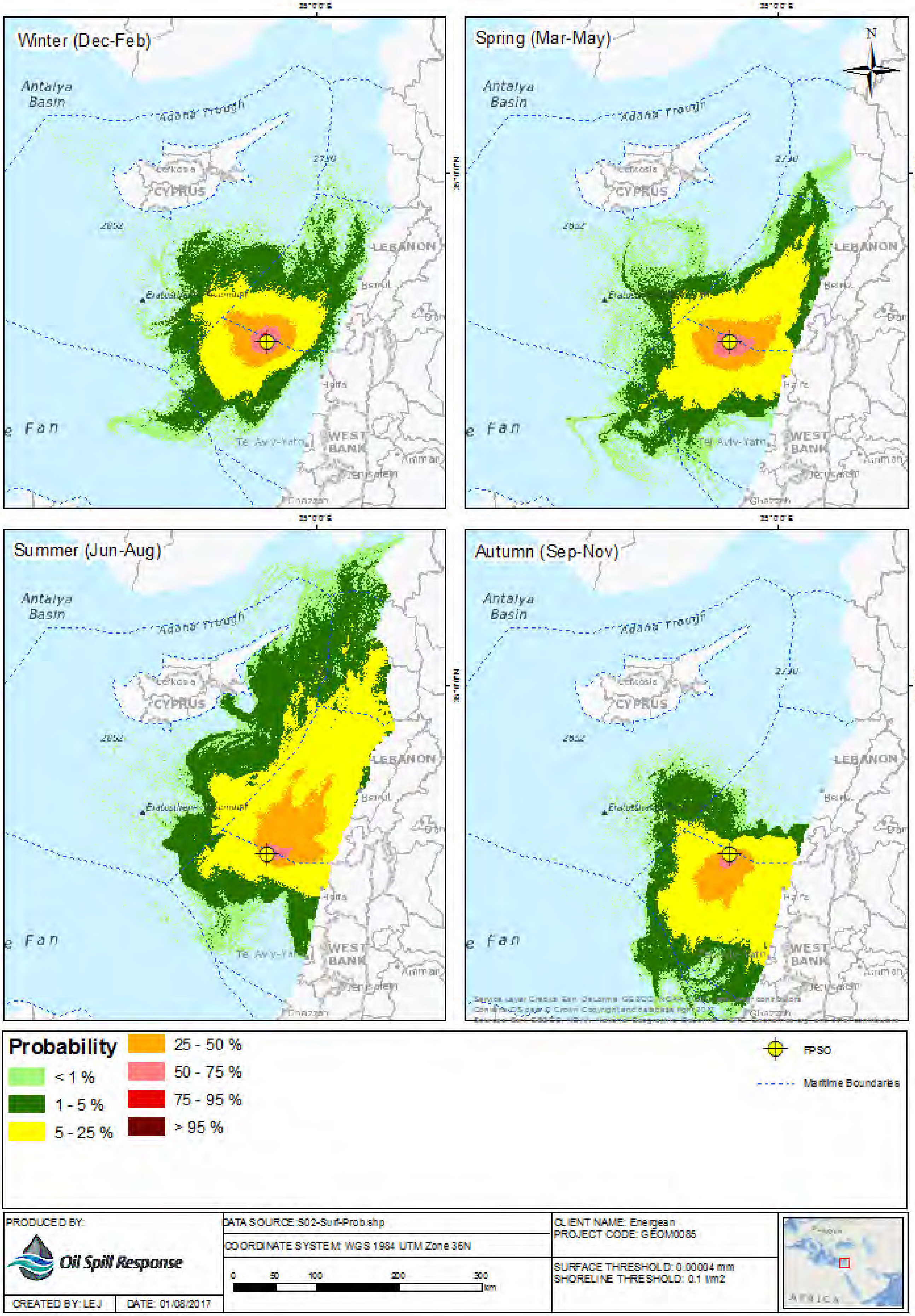


Figure 8: Probability that a cell could be impacted by a phased release from the FPSO

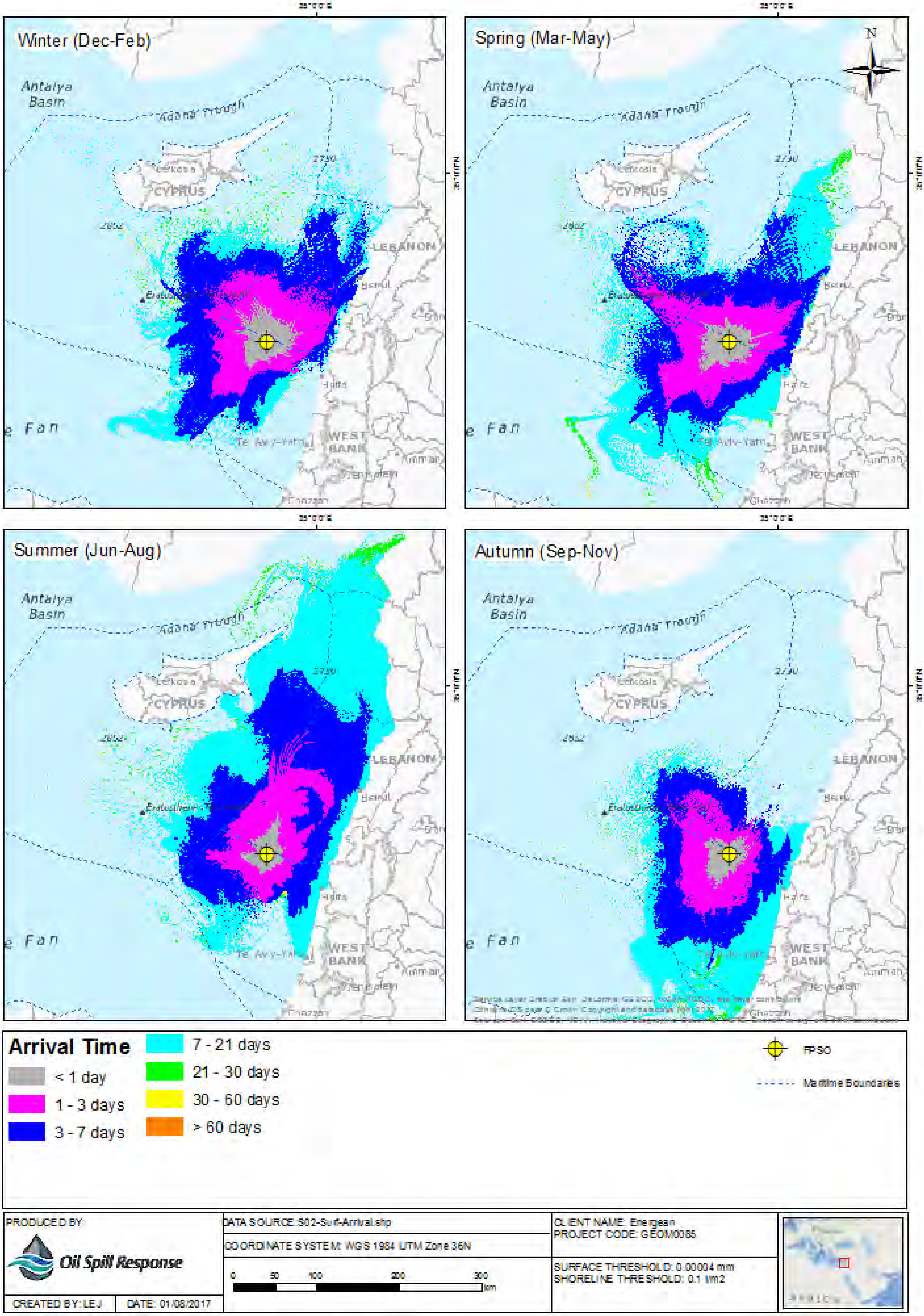


Figure 9: Minimum arrival time of oil from a phased release from the FPSO.

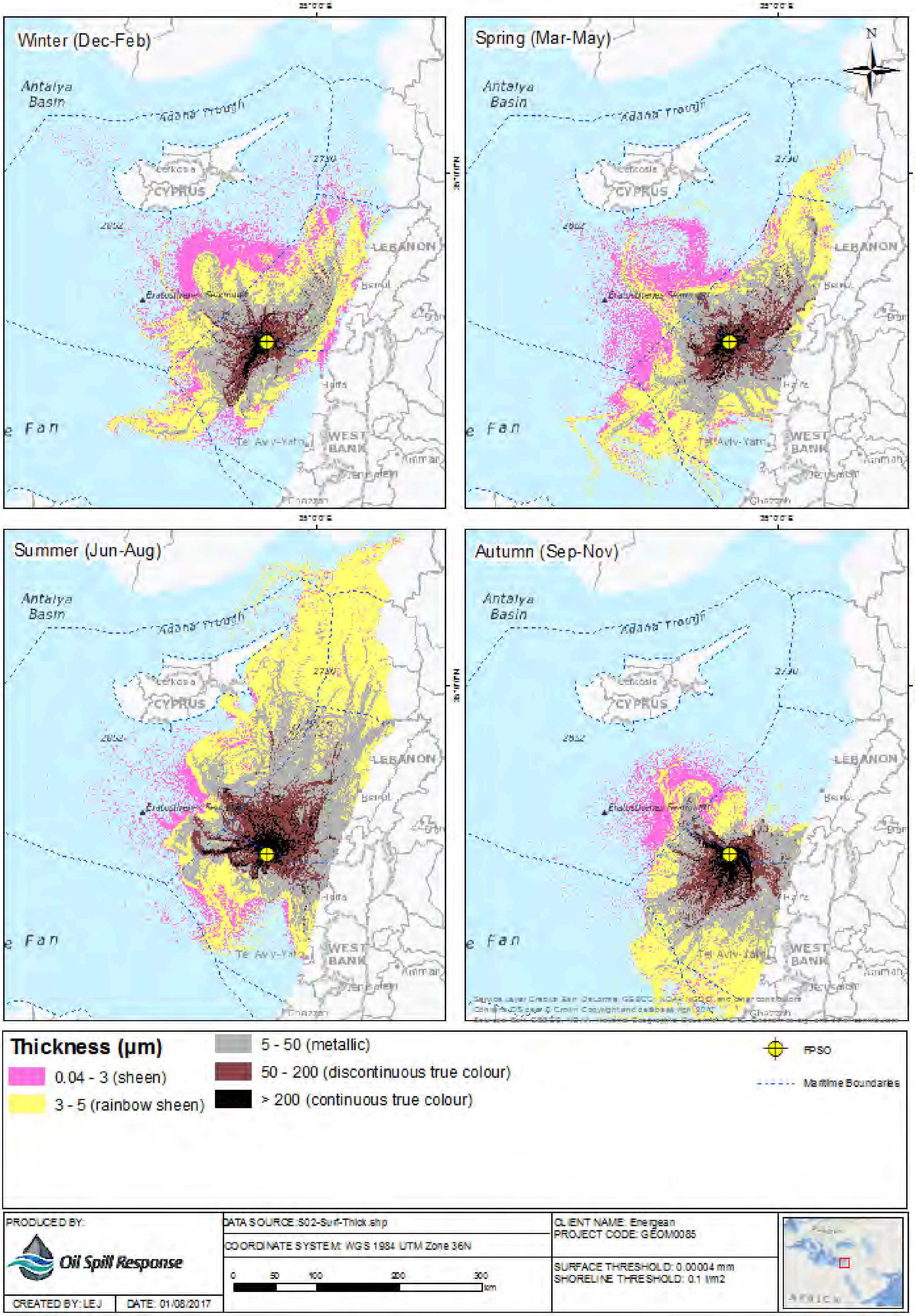


Figure 10: Maximum emulsion thickness of oil from a phased release from the FPSO.

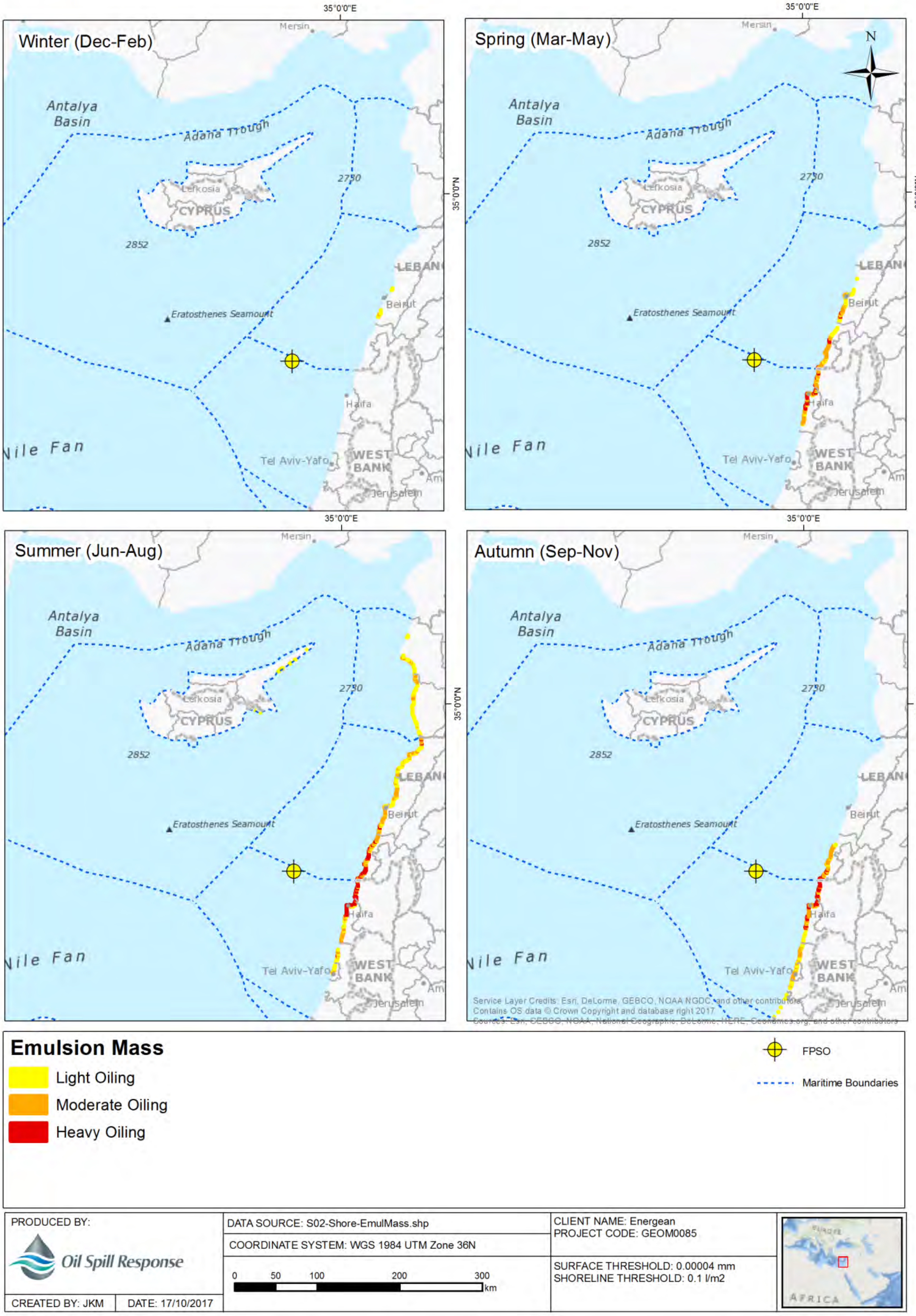


Figure 11: Shoreline Contamination based on emulsion mass from a phased release from the FPSO.

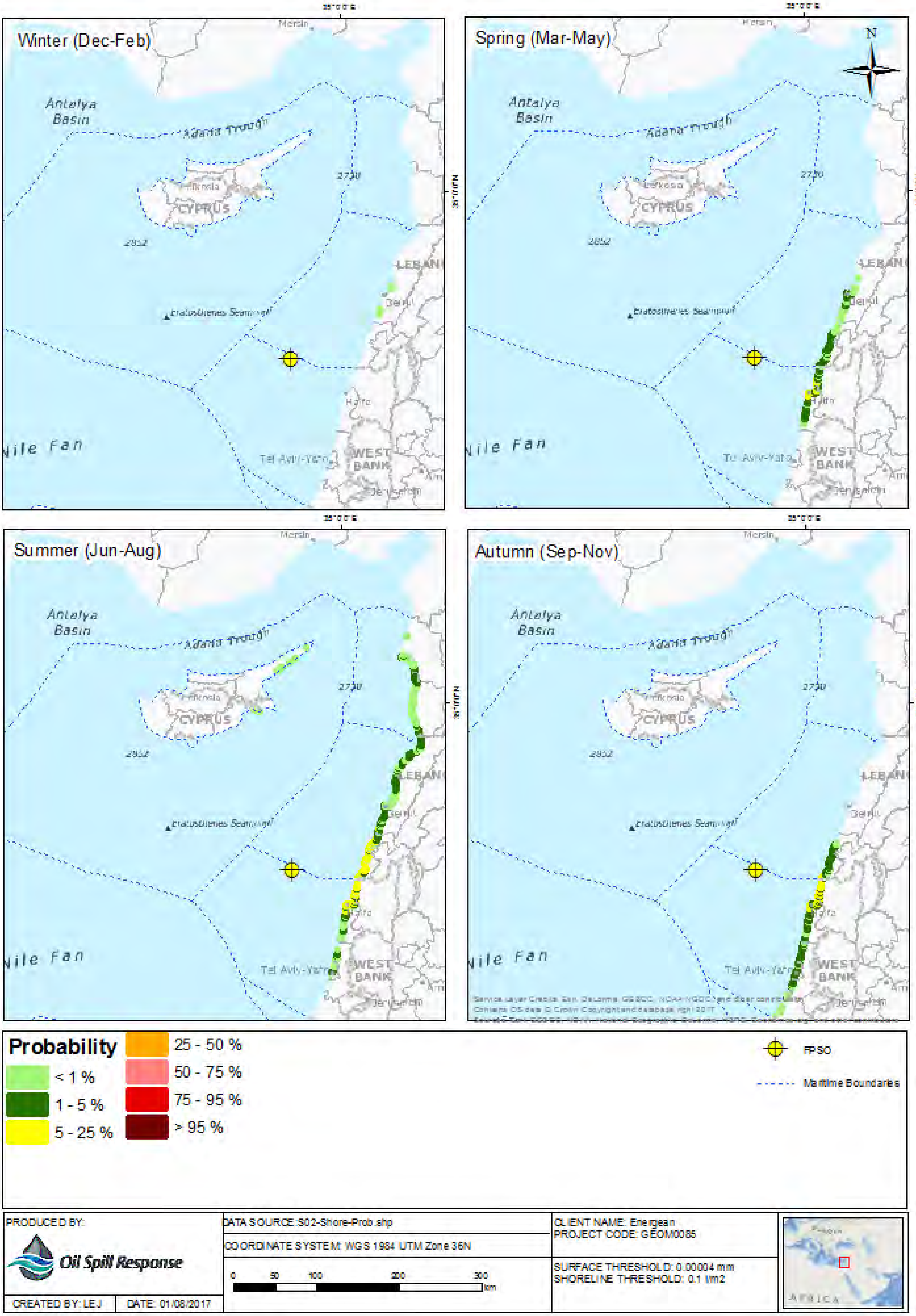


Figure 12: Probability that a cell could be impacted by oil from a phased release from the FPSO.

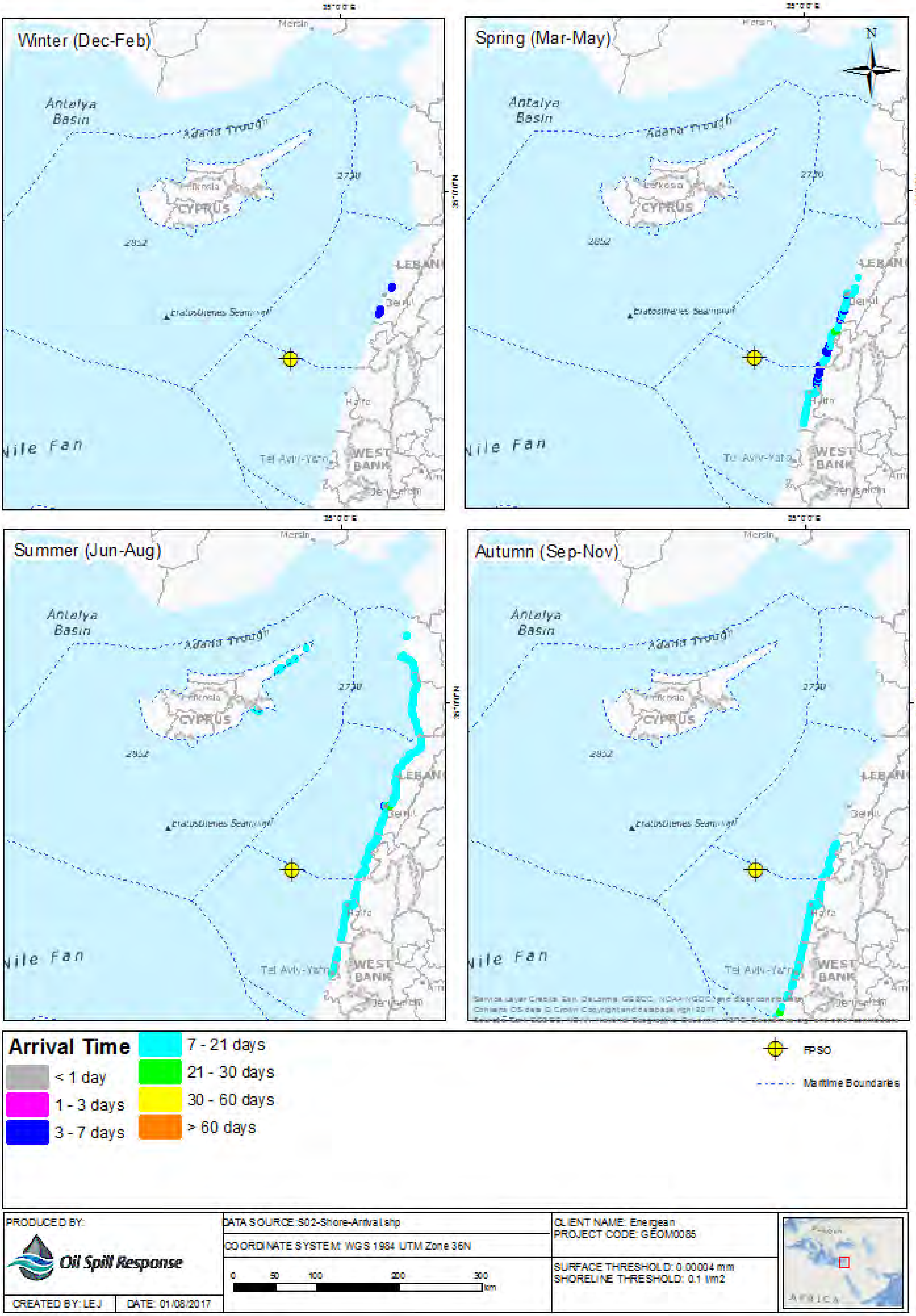


Figure 13: Minimum arrival time of oil from a phased release from the FPSO.

3.3.2 Stochastic Statistics

Table 15 to Table shows how many of the simulations result in different levels of shoreline impact based on ITOPF's Technical Information Paper (TIP) no. 6, "Recognition of Oil on Shorelines".

Each of the 1,160 trajectories is put into a single category based on its most severe shoreline oiling. For example, a trajectory that has at least one cell classified as *Heavy Oiling* will be placed in the heavy oiling category regardless of how many of the other cells have *Moderate* or *Light* oiling.

Table 18 to Table 21 shows the length of shoreline impacted. For further information see Thresholds in Section 2.2

Table 15: Severity of shoreline oiling following an FPSO tank rupture, winter (S01)

ITOPF Reference	Heavy Oiling	Moderate Oiling	Light Oiling	No Significant Impact
OSRL's SCAT Reference	Thick	Cover	Coat	No Impact
Number of Simulations	0 of 260	0 of 260	2 of 260	258 of 260
Probability	0%	0%	1%	99%

Table 16: Severity of shoreline oiling following an FPSO tank rupture, spring (S02)

ITOPF Reference	Heavy Oiling	Moderate Oiling	Light Oiling	No Significant Impact
OSRL's SCAT Reference	Thick	Cover	Coat	No Impact
Number of Simulations	19 of 303	42 of 303	20 of 303	222 of 303
Probability	6%	14%	7%	73%

Table 17: Severity of shoreline oiling following an FPSO tank rupture, summer (S03)

ITOPF Reference	Heavy Oiling	Moderate Oiling	Light Oiling	No Significant Impact
OSRL's SCAT Reference	Thick	Cover	Coat	No Impact
Number of Simulations	61 of 303	83 of 303	30 of 303	129 of 303
Probability	20%	27%	10%	43%

Table 20: Severity of shoreline oiling following an FPSO tank rupture, autumn (S04)

ITOPF Reference	Heavy Oiling	Moderate Oiling	Light Oiling	No Significant Impact
OSRL's SCAT Reference	Thick	Cover	Coat	No Impact
Number of Simulations	47 of 294	28 of 294	13 of 294	206 of 294
Probability	16%	10%	4%	70%

Table 18: Length of shoreline following an FPSO tank rupture, winter (S01)

Level of Shoreline Oiling	Length of Shoreline Impacted [km]		
	best case	average	worst case
Light Oiling	No shoreline oiling	No shoreline oiling	23
Moderate Oiling			1
Heavy Oiling			0

Table 19: Length of shoreline following an FPSO tank rupture, spring (S02)

Level of Shoreline Oiling	Length of Shoreline Impacted [km]		
	best case	average	worst case
Light Oiling	No shoreline oiling	4	69
Moderate Oiling		2	31
Heavy Oiling		0	12

Table 20: Length of shoreline following an FPSO tank rupture, summer (S03)

Level of Shoreline Oiling	Length of Shoreline Impacted [km]		
	best case	average	worst case
Light Oiling	No shoreline oiling	14	87
Moderate Oiling		7	59
Heavy Oiling		1	13

Table 21: Length of shoreline following an FPSO tank rupture, autumn (S04)

Level of Shoreline Oiling	Length of Shoreline Impacted [km]		
	best case	average	worst case
Light Oiling	No shoreline oiling	6	60
Moderate Oiling		4	38
Heavy Oiling		1	10

3.4 Scenario 3 – FPSO Tank Rupture

3.4.1 Stochastic Maps

A release from the FPSO was modelled over summer (Jun-Aug). The scenario involves a release over 5 hours of 25,000 bbls of oil. The oil is tracked for a further 28 days, meaning a total model duration of 28 days.

To simulate a range of possible metocean conditions, stochastic results were calculated from 303 trajectories.

The following results are presented:

<u>**Sea Surface**</u>

Figure 14: Probability that a cell could be impacted by a phased release from the FPSO

Figure 15: Minimum arrival time of oil from a phased release from the FPSO**.**

Figure 16: Maximum emulsion thickness of oil from a phased release from the FPSO.

<u>**Shoreline**</u>

Figure 17: Shoreline Contamination based on emulsion mass from a phased release from the FPSO.

Figure 18: Probability that a cell could be impacted by oil from a phased release from the FPSO.

Figure 19: Minimum arrival time of oil from a phased release from the FPSO.

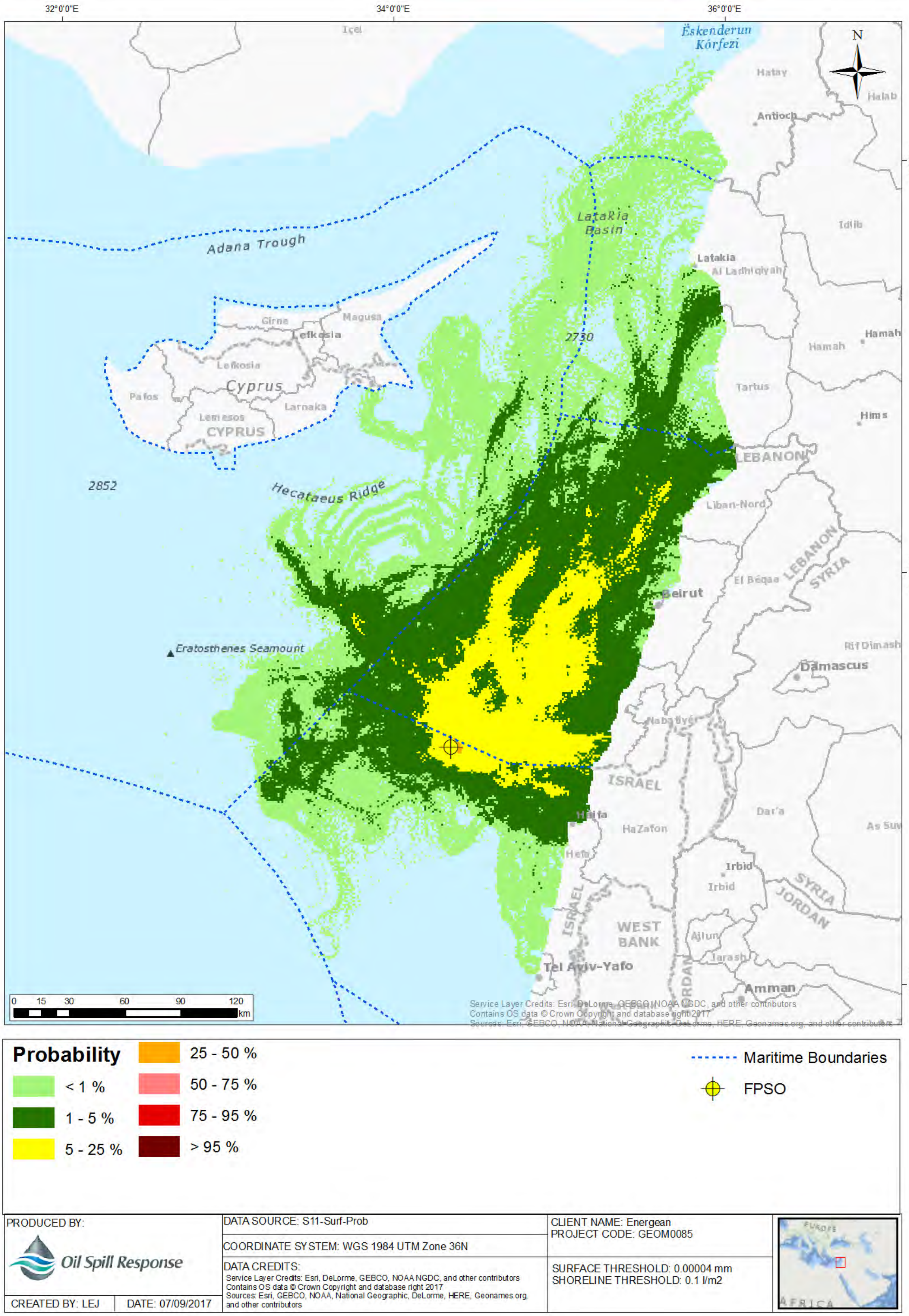


Figure 14: Probability that a cell could be impacted by a phased release from the FPSO

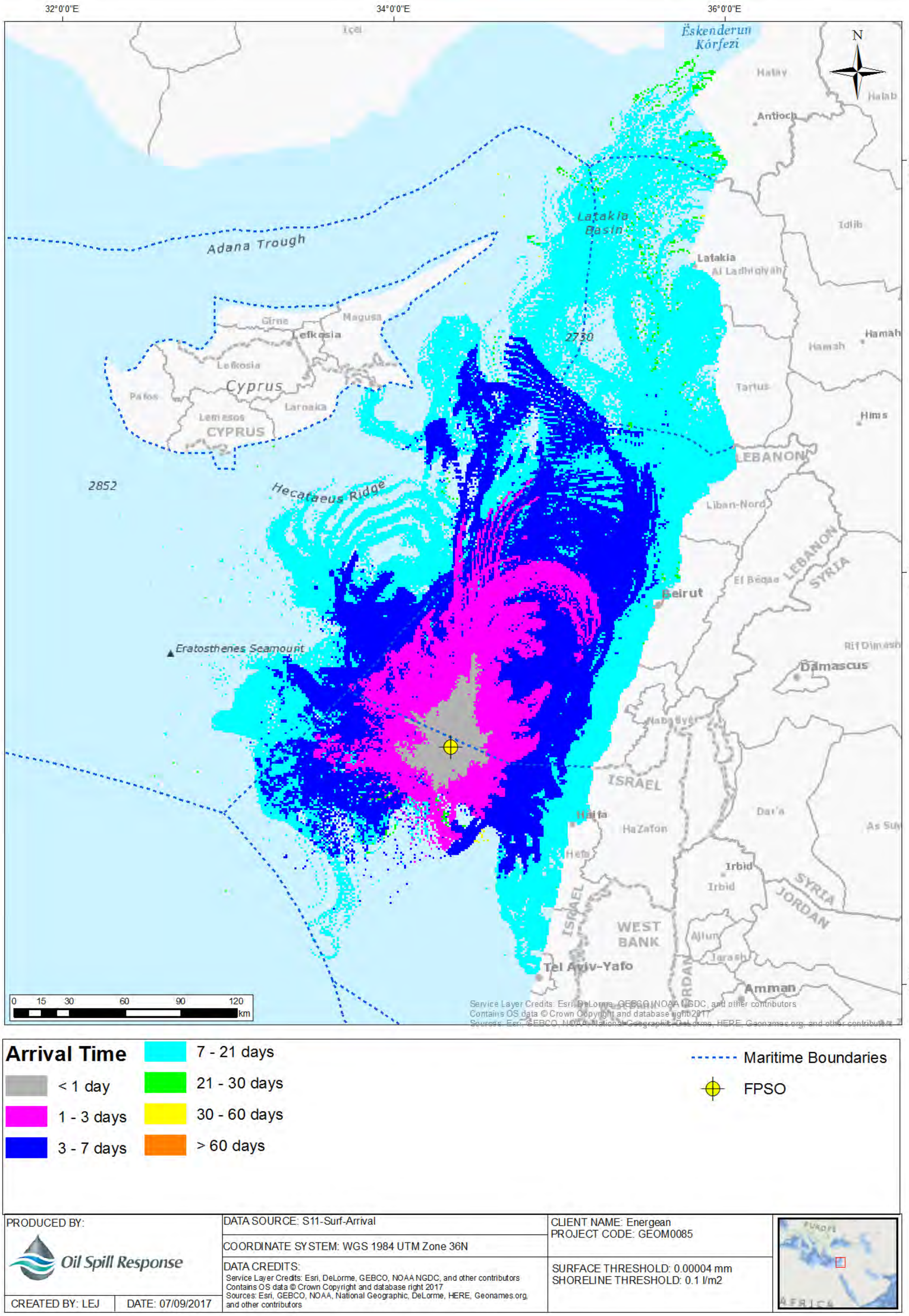


Figure 15: Minimum arrival time of oil from a phased release from the FPSO.

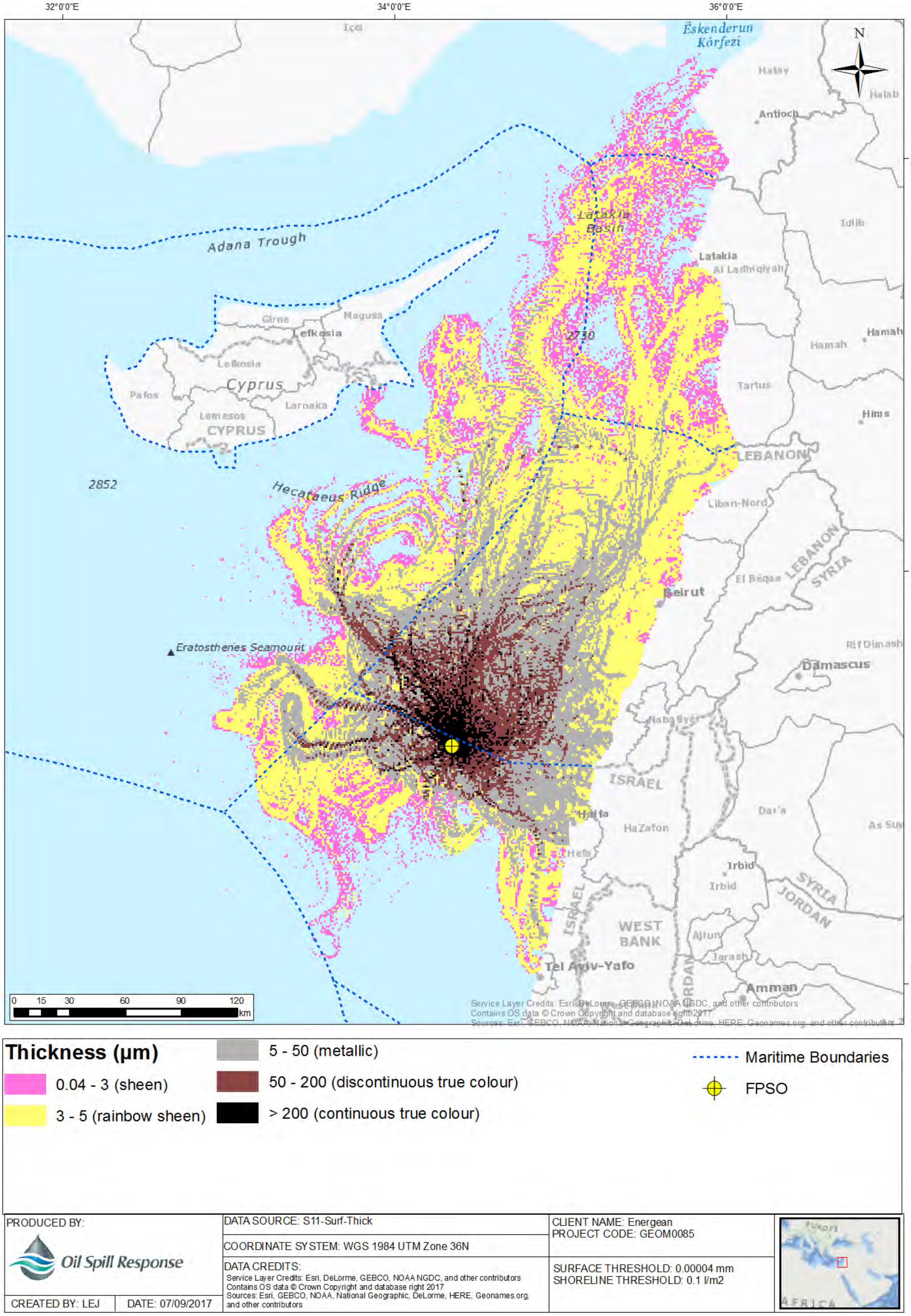


Figure 16: Maximum emulsion thickness of oil from a phased release from the FPSO.

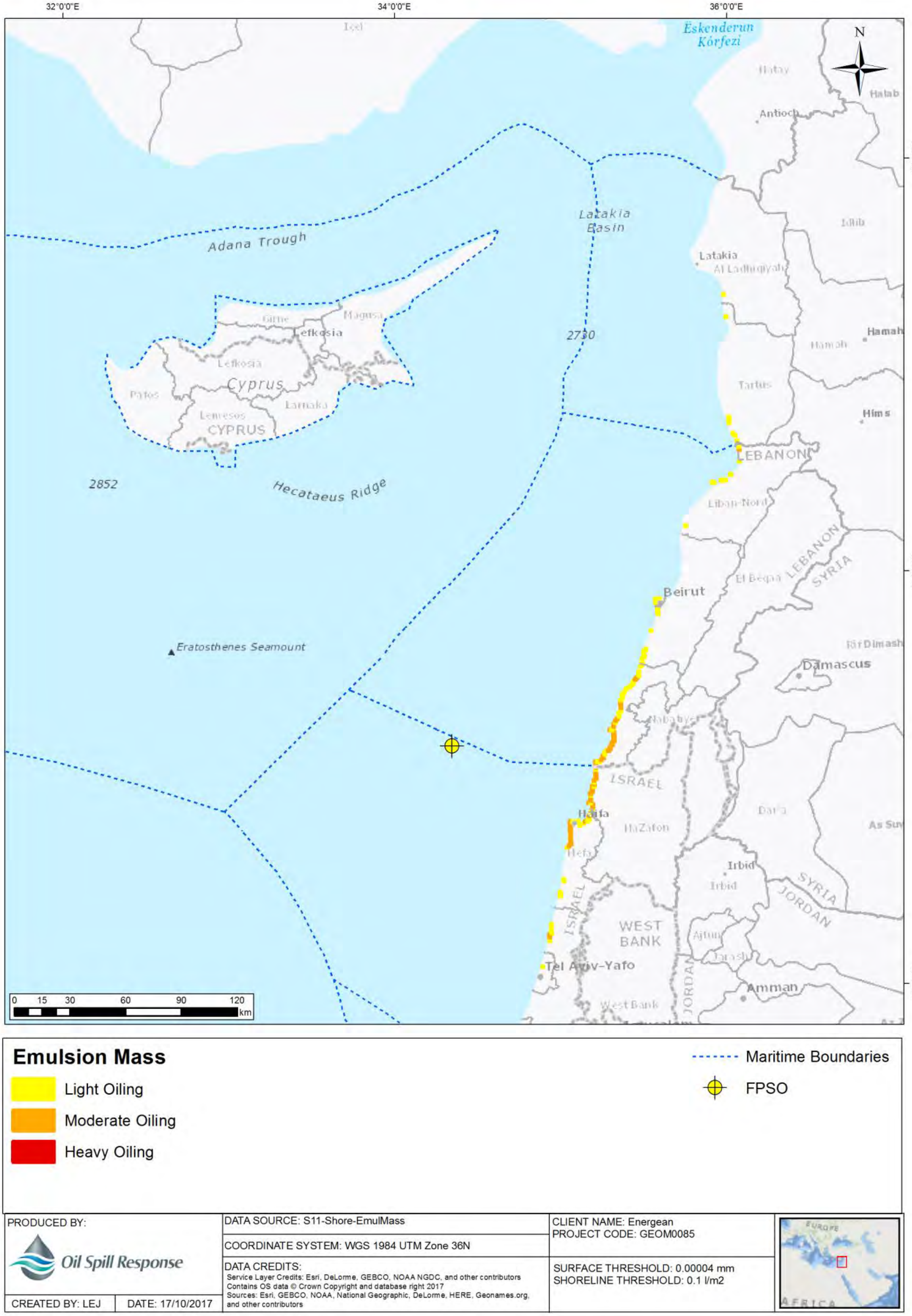
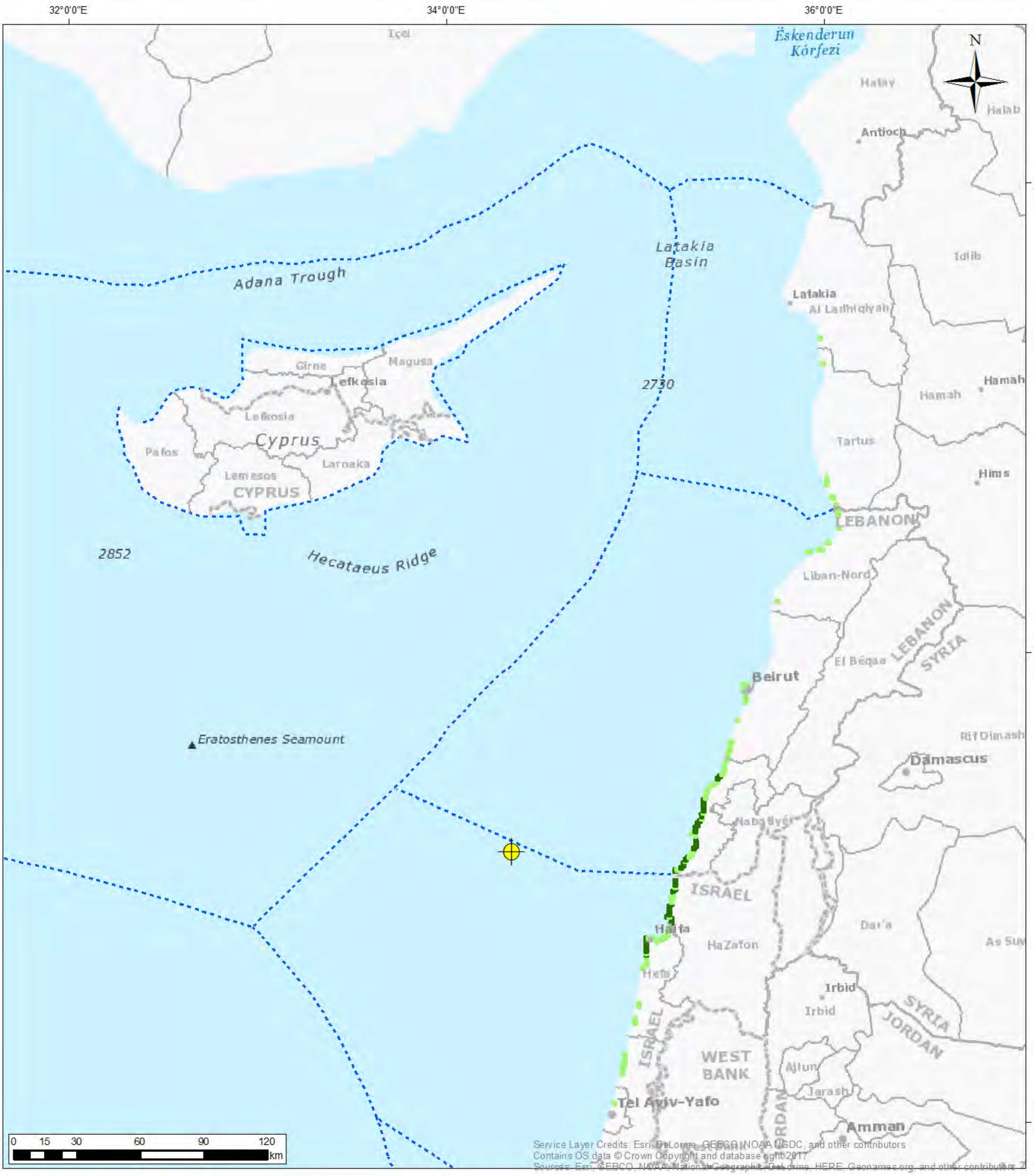


Figure 17: Shoreline Contamination based on emulsion mass from a phased release from the FPSO.



Probability

< 1 %	25 - 50 %		Maritime Boundaries
1 - 5 %	50 - 75 %		FPSO
5 - 25 %	75 - 95 %		
	> 95 %		

PRODUCED BY: Oil Spill Response	DATA SOURCE: S11-Shore-Prob	CLIENT NAME: Energean PROJECT CODE: GEOM0085	
	COORDINATE SYSTEM: WGS 1984 UTM Zone 36N		
	DATA CREDITS: Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors Contains OS data © Crown Copyright and database right 2017 Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames.org, and other contributors	SURFACE THRESHOLD: 0.00004 mm SHORELINE THRESHOLD: 0.1 l/m2	
CREATED BY: LEJ · DATE: 07/09/2017			

Figure 18: Probability that a cell could be impacted by oil from a phased release from the FPSO.

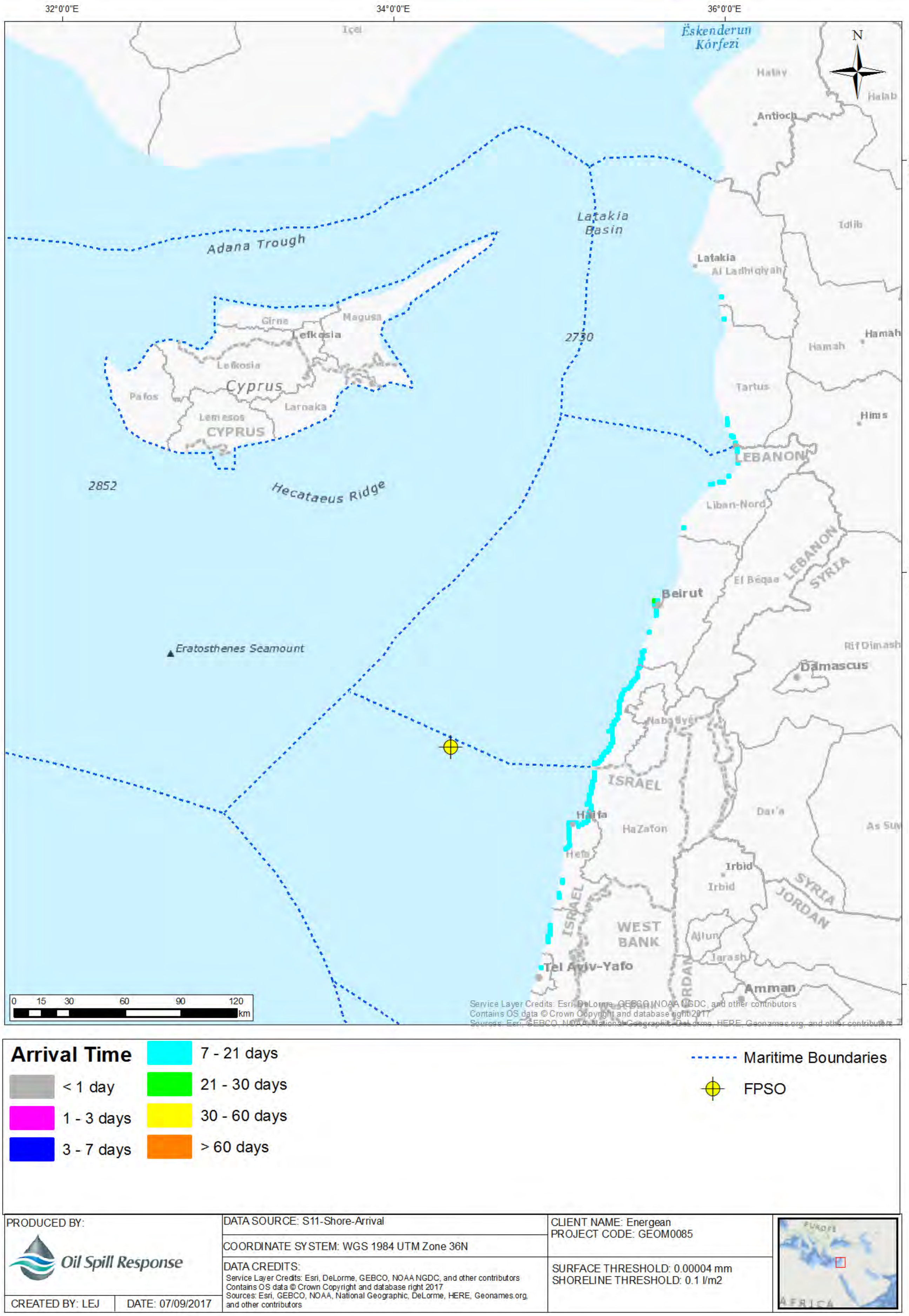


Figure 19: Minimum arrival time of oil from a phased release from the FPSO.

3.4.2 Stochastic Statistics

Table 22 shows how many of the simulations result in different levels of shoreline impact based on ITOPF's Technical Information Paper (TIP) no. 6, "Recognition of Oil on Shorelines".

Each of the 1,160 trajectories is put into a single category based on its most severe shoreline oiling. For example, a trajectory that has at least one cell classified as *Heavy Oiling* will be placed in the heavy oiling category regardless of how many of the other cells have *Moderate* or *Light* oiling.

Table 23 shows the length of shoreline impacted. For further information see Thresholds in Section 2.2

Table 22: Severity of shoreline oiling following an FPSO tank rupture, summer (S09)

ITOPF Reference	Heavy Oiling	Moderate Oiling	Light Oiling	No Significant Impact
OSRL's SCAT Reference	Thick	Cover	Coat	No Impact
Number of Simulations	0 of 260	37 of 303	68 of 303	198 of 303
Probability	0%	12%	22%	65%

Table 23: Length of shoreline following an FPSO tank rupture, summer (S09)

<table>
<tr><th rowspan="2">Level of Shoreline Oiling</th><th colspan="3">Length of Shoreline Impacted [km]</th></tr>
<tr><th>best case</th><th>average</th><th>worst case</th></tr>
<tr><td>Light Oiling</td><td rowspan="3">No shoreline oiling</td><td>2</td><td>16</td></tr>
<tr><td>Moderate Oiling</td><td>No shoreline oiling</td><td>6</td></tr>
<tr><td>Heavy Oiling</td><td>No shoreline oiling</td><td>0</td></tr>
</table>

3.5 Trajectory Results

Trajectory results are generated by simulating a single spill scenario under specific conditions on a particular date. Four 'worst case trajectories' were selected, from each pool of trajectories that make up the stochastic figures in Section 2, to investigate the fate and behaviour of oil during the course of the simulation in more detail.

In this report, the 'worst-case' trajectories are defined as:

- Extreme winter wave storm: Dec 9 2010 - Jan 8 2011
- Winter wave storm: Jan 26 2008 - Feb 14 2008
- Swell in summer: Jul 17 2008 - Aug 16 2008
- Strong north-easterly wind (spring and autumn): Sep 25 2007 - Oct 25 2007

The trajectories selected are given in Table and the main results are summarised in Table .

Table 27: Worst-case Trajectories for a release at the FPSO

Worst-case Scenario	Simulation Start Date [UTC]
Extreme winter wave storm	09-Dec-2010
Winter wave storm	26-Jan-2008
Swell in summer	17-Jul-2008
Strong north-easterly wind	25-Sep-2007

Table 28: Key results

<table>
<tr><th colspan="2"></th><th>T01
Extreme winter wave storm</th><th>T02
Winter wave storm</th><th>T03
Swell in summer</th><th>T04
Strong north-easterly wind</th></tr>
<tr><td rowspan="2">Model Setup</td><td>Release Location</td><td colspan="4">FPSO</td></tr>
<tr><td>Total Mass / Volume Spilled</td><td colspan="4">63,710.6 MT / 500,000 bbls</td></tr>
<tr><td colspan="2">First Shoreline Impact</td><td>16 days, 14 hours</td><td rowspan="3">No shoreline impact</td><td>10 days, 5 hours</td><td>20 days, 2 hours</td></tr>
<tr><td colspan="2">Maximum Mass of Oil Onshore</td><td>1.6 MT</td><td>834.7 MT</td><td>4.3 MT</td></tr>
<tr><td colspan="2">Time when Maximum Mass of Oil Onshore Occurs</td><td>29 days, 19 hours</td><td>13 days, 19 hours</td><td>29 days, 2 hours</td></tr>
</table>

The following figures are presented:

Extreme winter wave storm

Figure 20: Mass balance plot for an extreme winter wave storm

Figure 21: Overall area impacted for an extreme winter wave

Winter wave storm

Figure 22: Mass balance plot for a winter wave storm

Figure 23: Overall area impacted for a winter wave storm

Swell in summer

Figure 22: Mass balance plot for a swell in summer

Figure 23: Overall area impacted for a swell in summer

Strong north-easterly wind

Figure 24: Mass balance plot for a strong north-easterly wind

Figure 25: Overall area impacted for a strong north-easterly wind

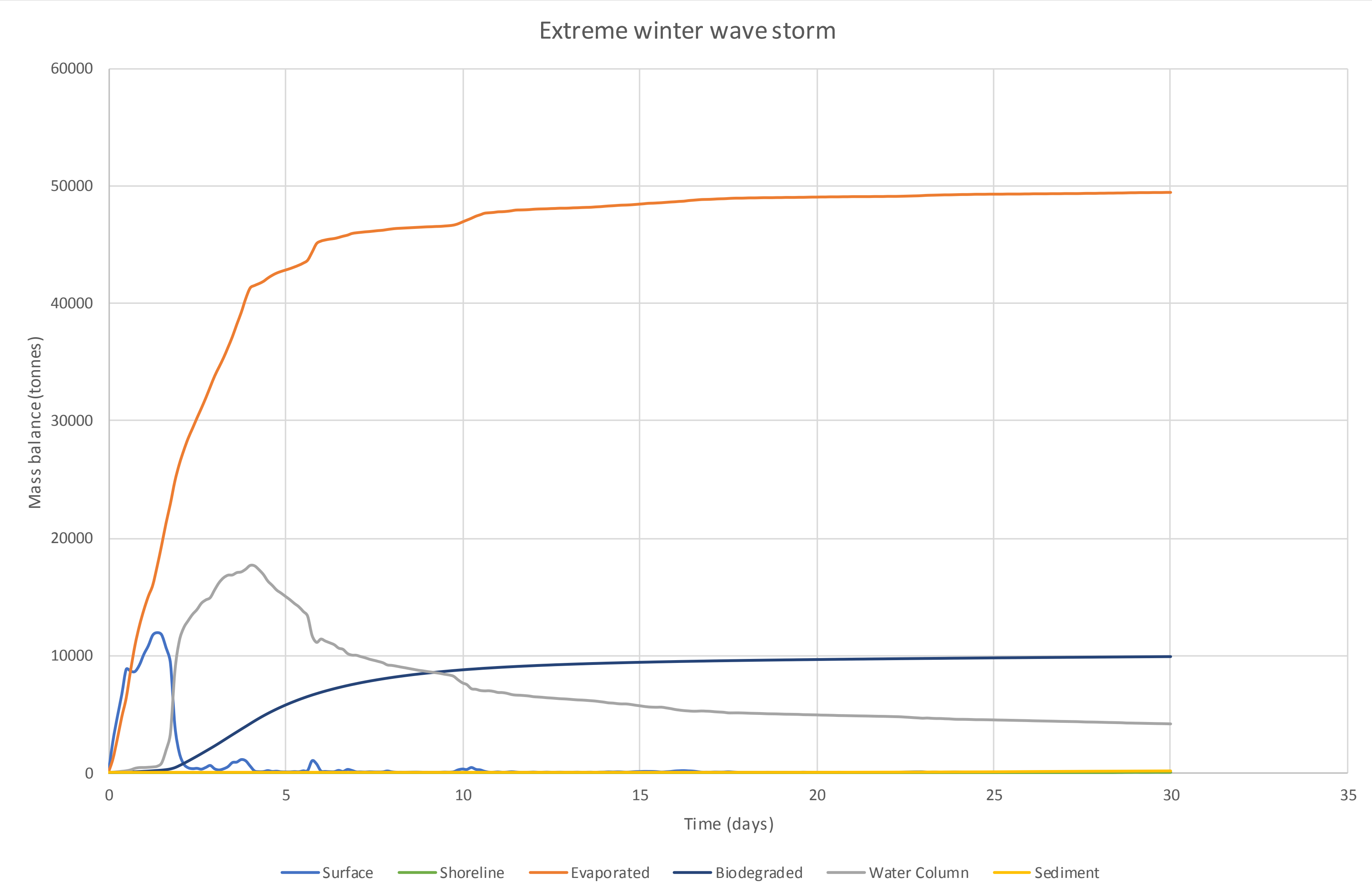


Figure 20: Mass balance plot for an extreme winter wave storm

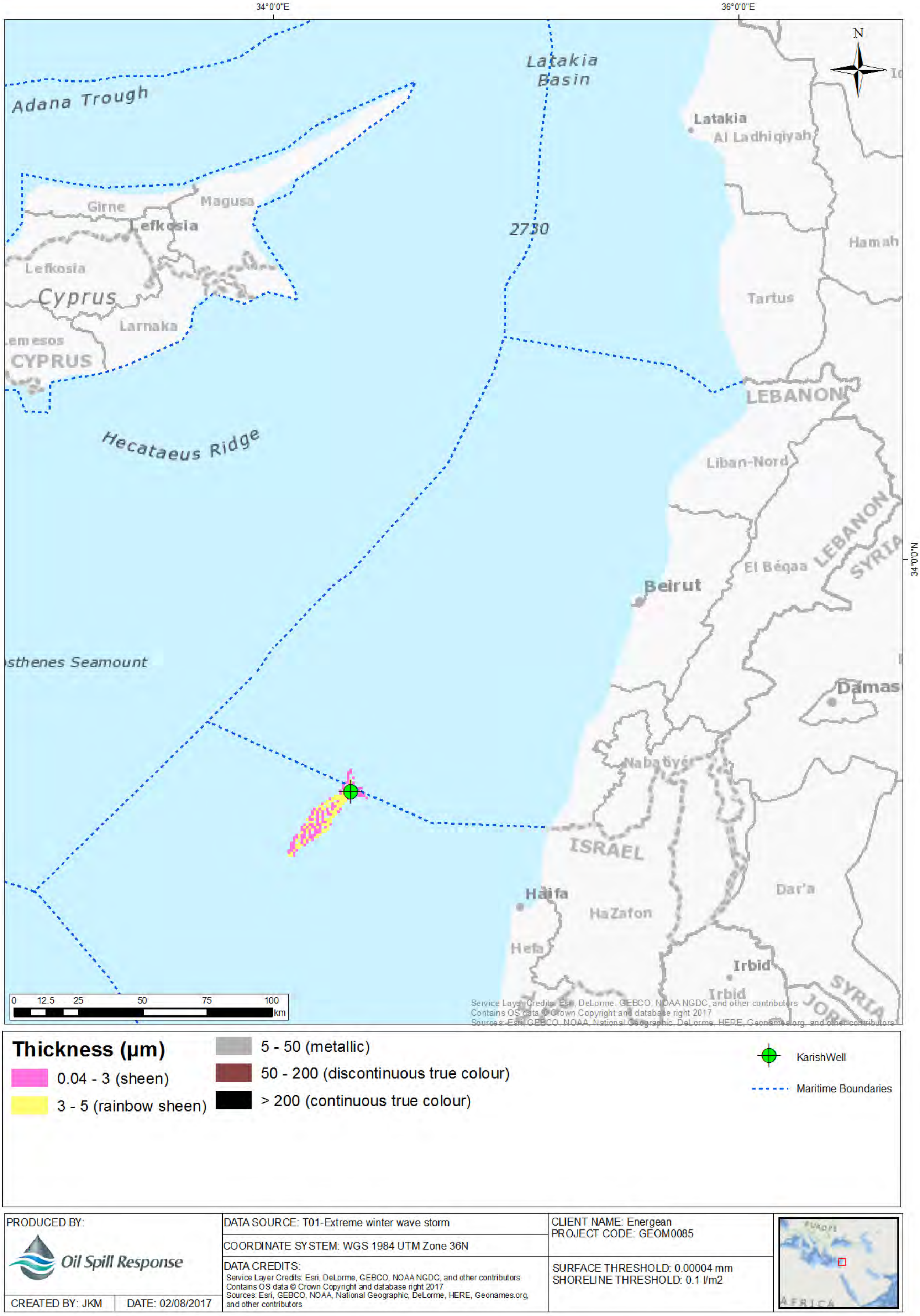


Figure 21: Overall area impacted for an extreme winter wave storm

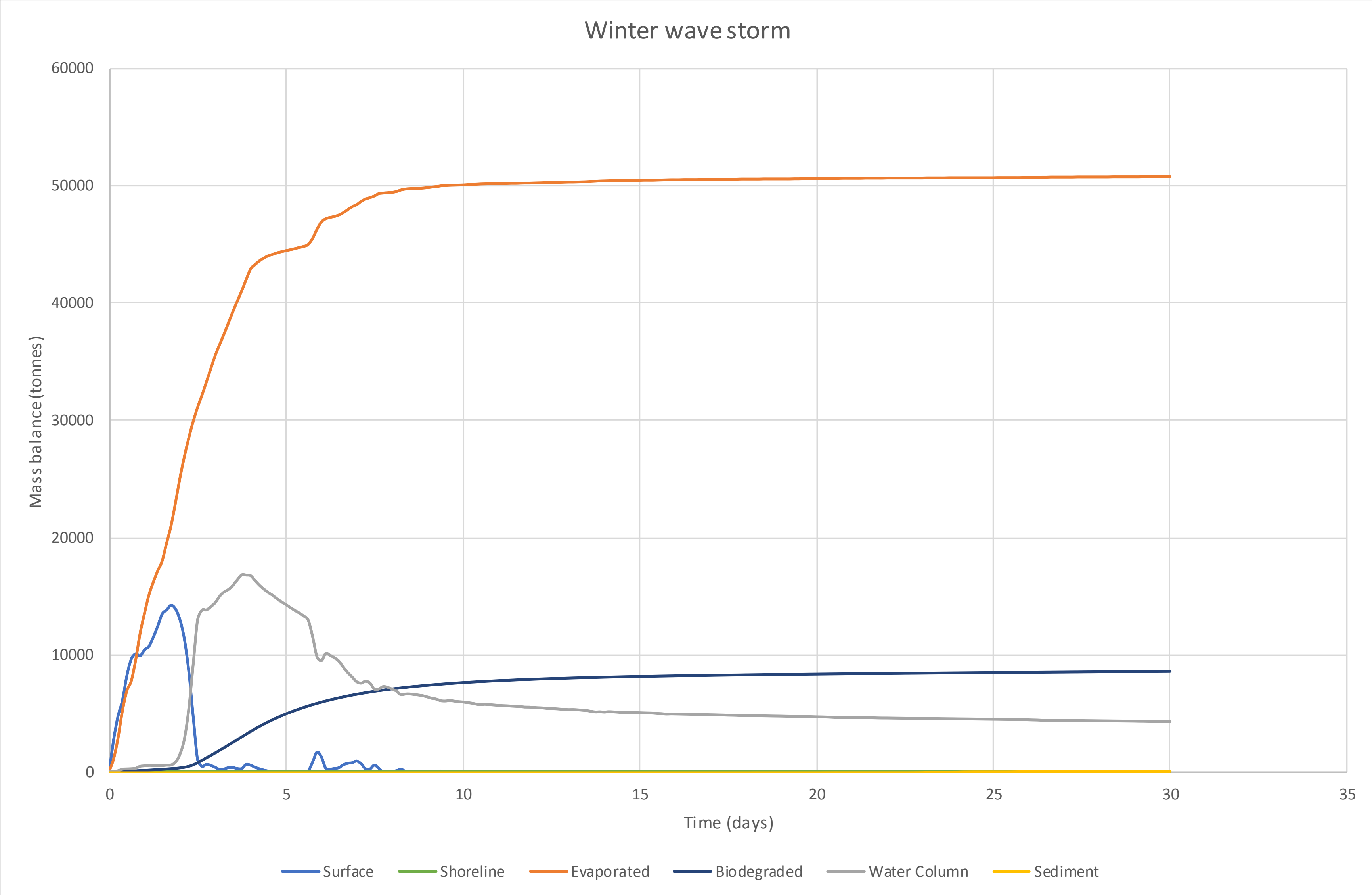
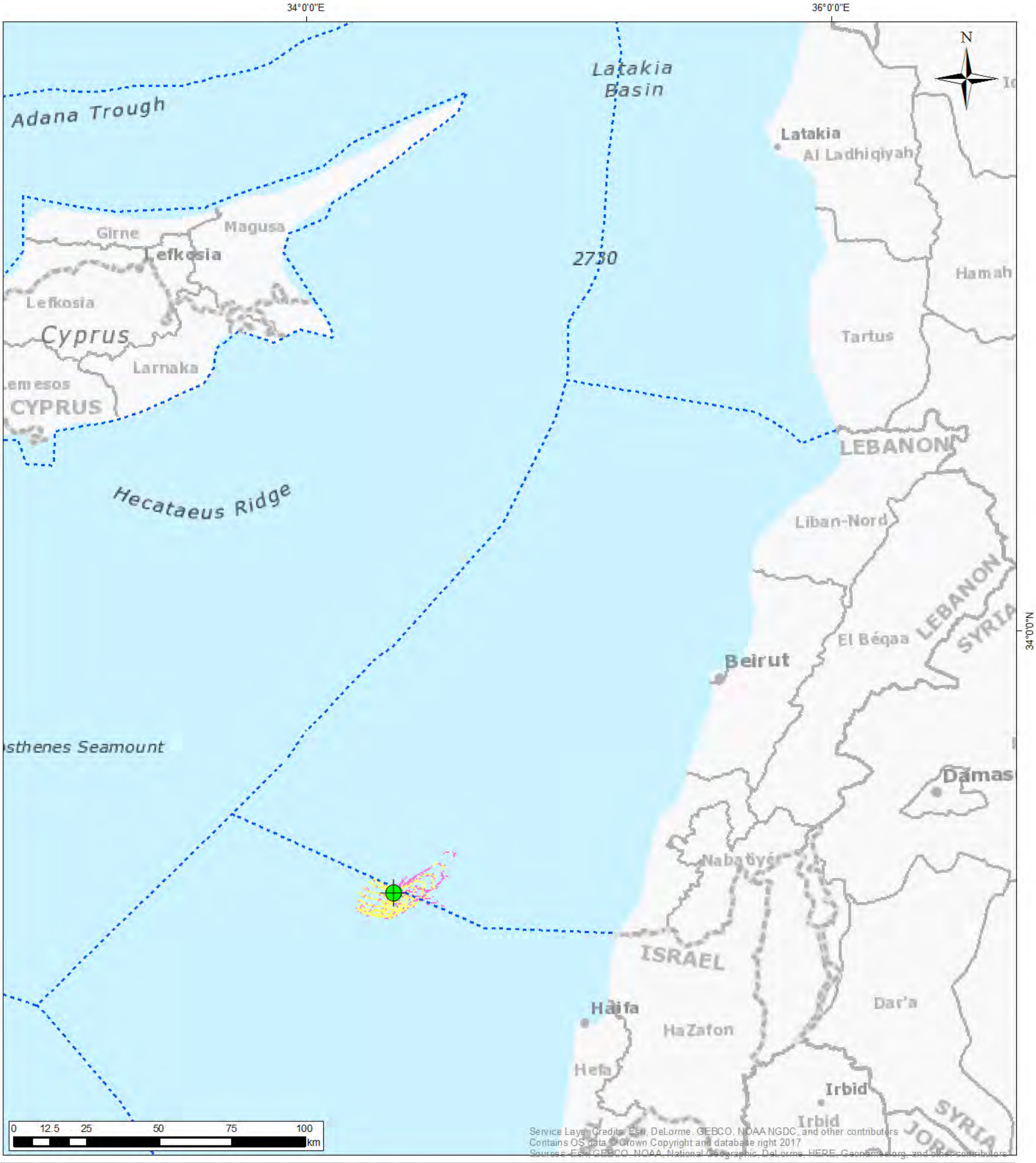


Figure 22: Mass balance plot for a winter wave storm



Thickness (µm)

- 0.04 - 3 (sheen)
- 3 - 5 (rainbow sheen)
- 5 - 50 (metallic)
- 50 - 200 (discontinuous true colour)
- > 200 (continuous true colour)

KarishWell

Maritime Boundaries

PRODUCED BY: Oil Spill Response	DATA SOURCE: T02-Winter wave storm	CLIENT NAME: Energean PROJECT CODE: GEOM0085
	COORDINATE SYSTEM: WGS 1984 UTM Zone 36N	
CREATED BY: JKM / DATE: 02/08/2017	DATA CREDITS: Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors Contains OS data © Crown Copyright and database right 2017 Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames.org, and other contributors	SURFACE THRESHOLD: 0.00004 mm SHORELINE THRESHOLD: 0.1 l/m2

Figure 23: Overall area impacted for a winter wave storm

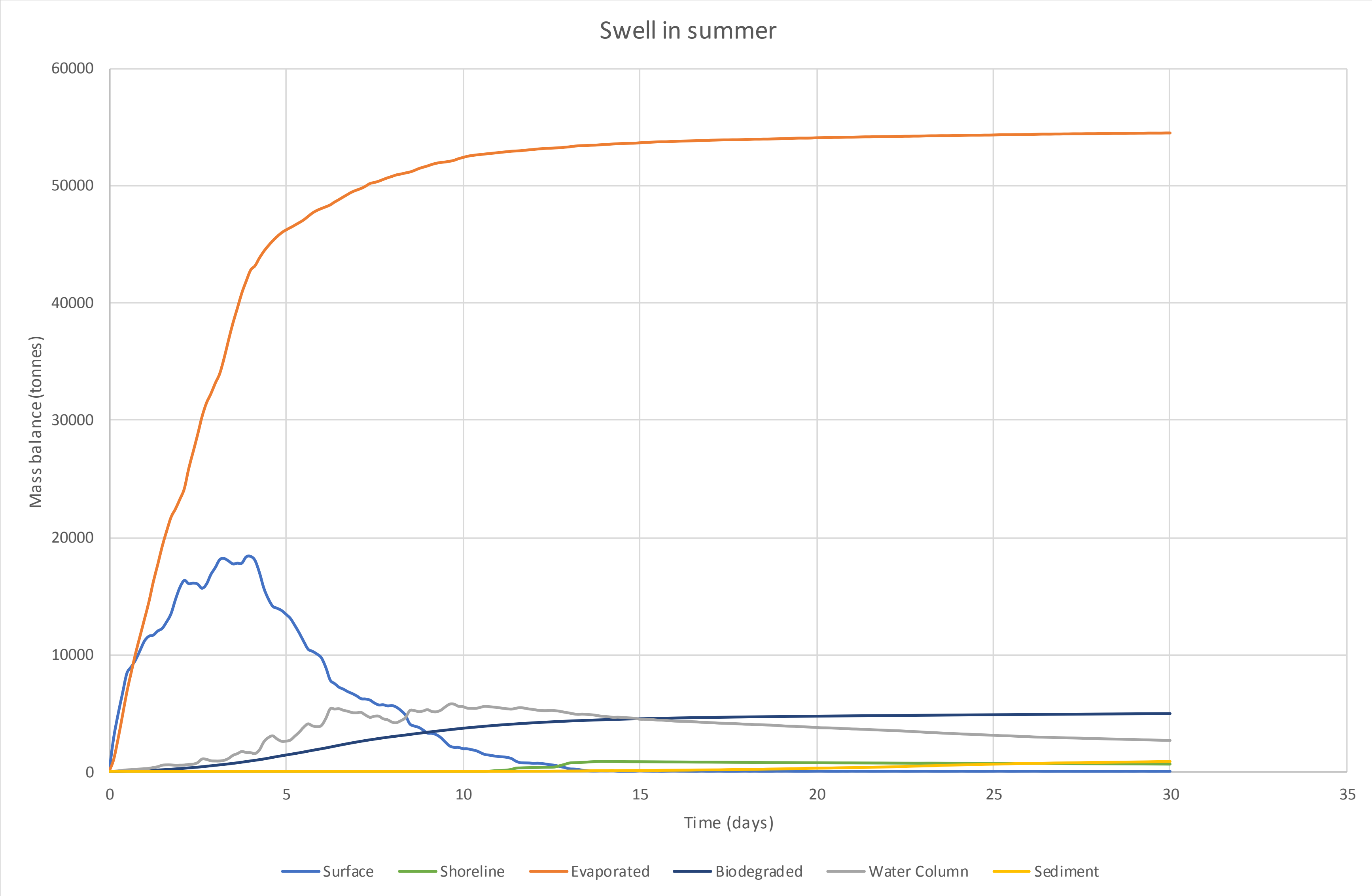


Figure 22: Mass balance plot for a swell in summer

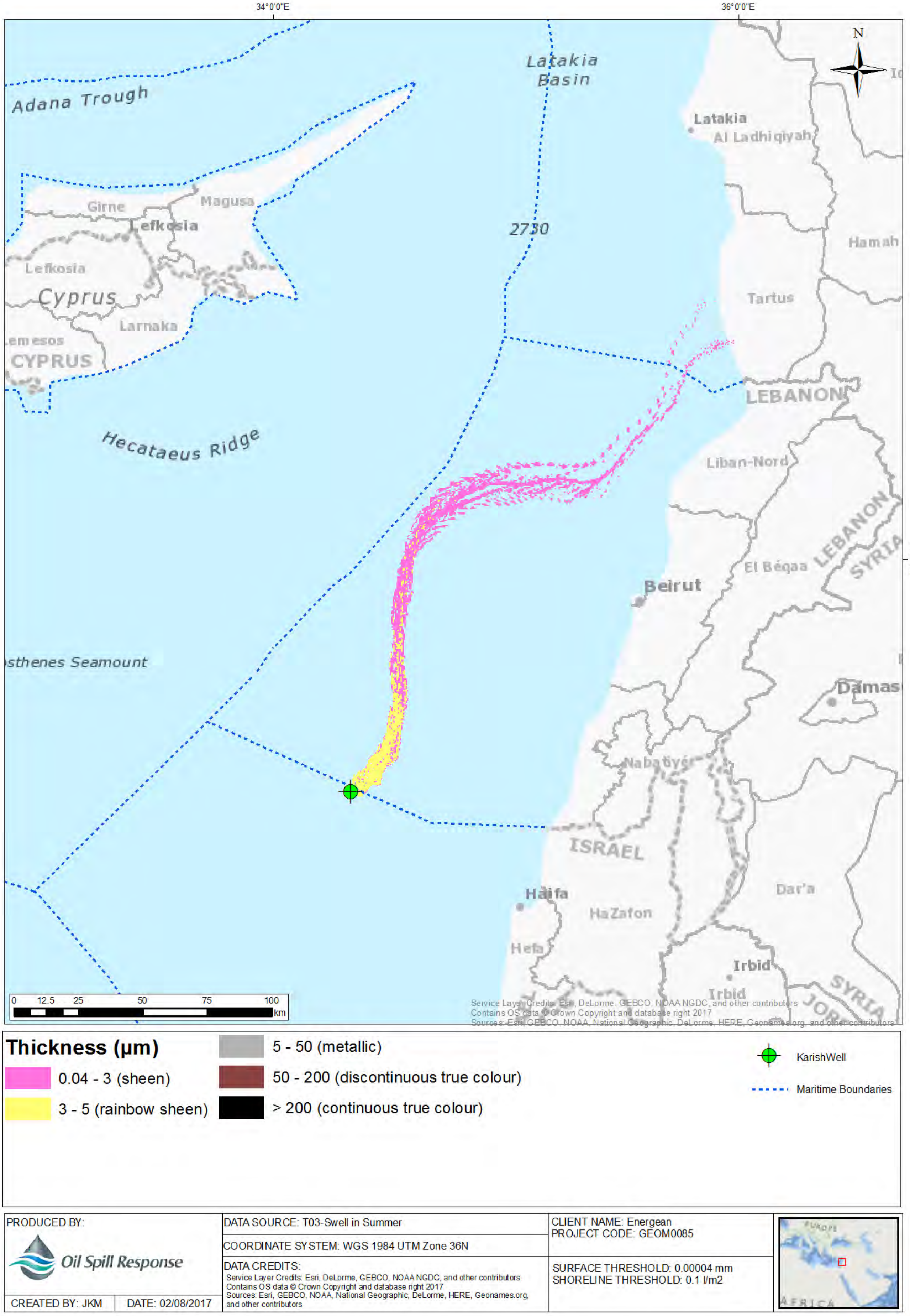


Figure 23: Overall area impacted for a swell in summer

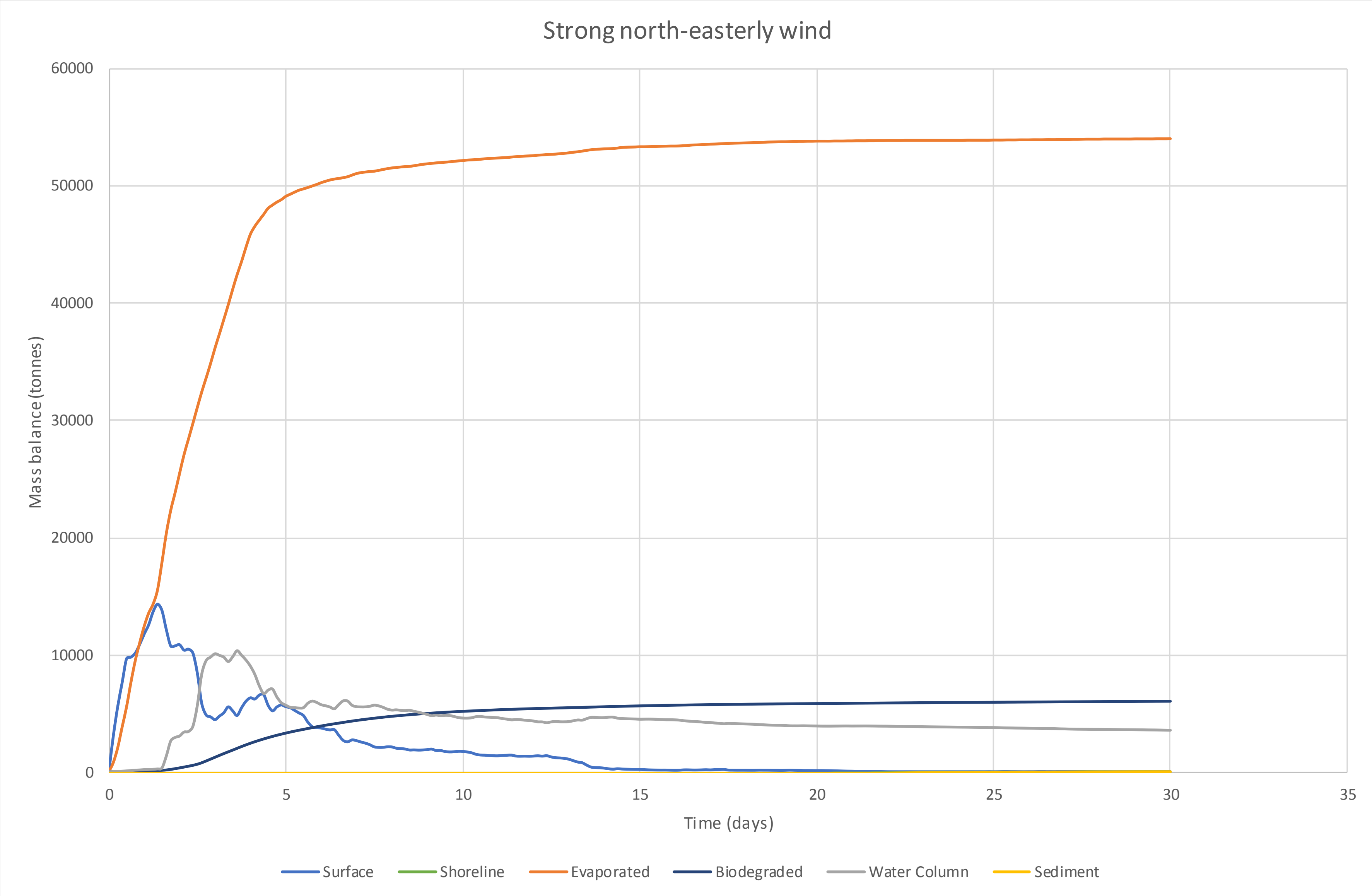
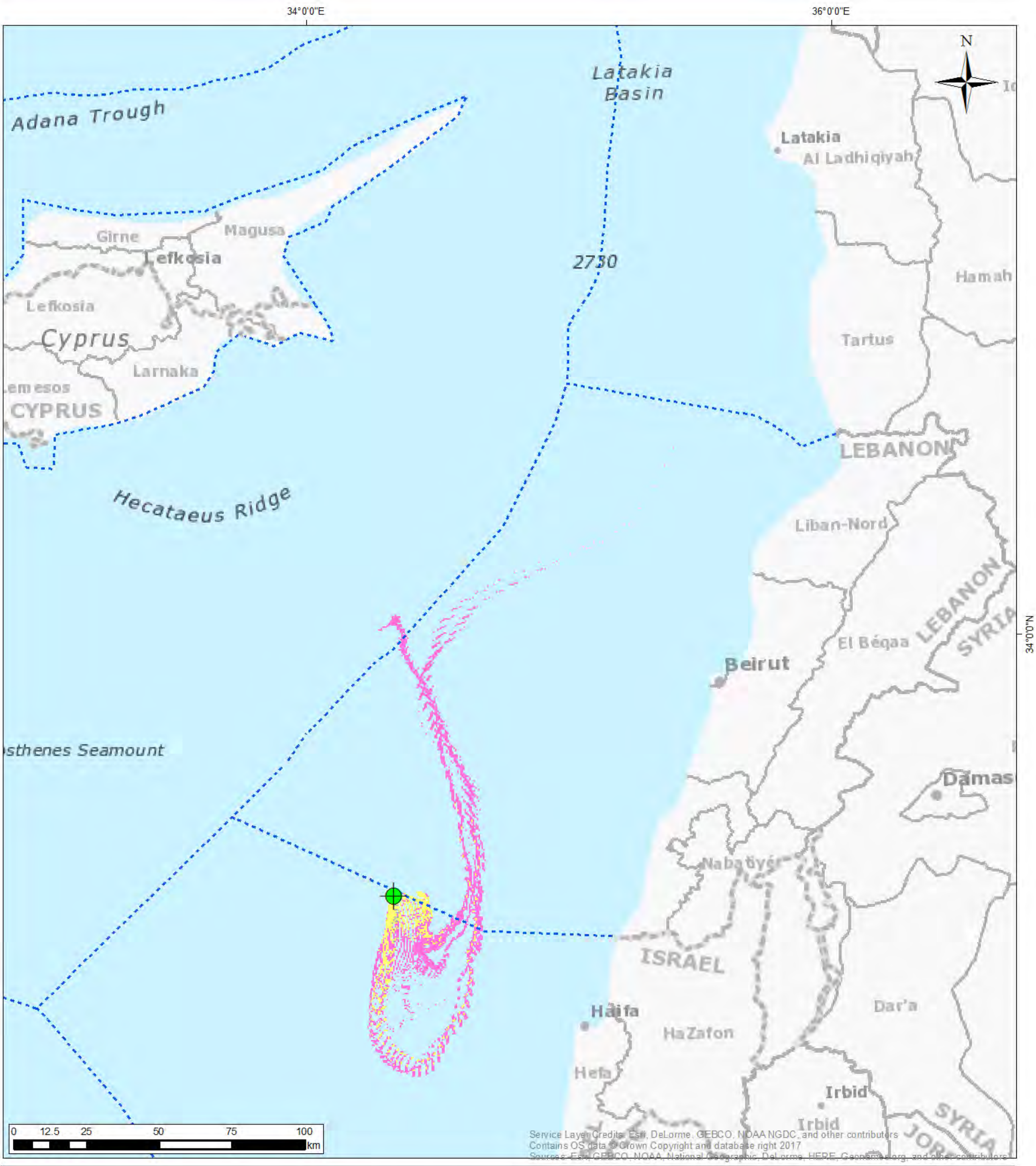


Figure 24: Mass balance plot for a strong north-easterly wind



Thickness (µm)

- 0.04 - 3 (sheen)
- 3 - 5 (rainbow sheen)
- 5 - 50 (metallic)
- 50 - 200 (discontinuous true colour)
- > 200 (continuous true colour)

KarishWell

Maritime Boundaries

PRODUCED BY: Oil Spill Response	DATA SOURCE: T04-Strong north-easterly wind (Spring and Autumn)	CLIENT NAME: Energean PROJECT CODE: GEOM0085	
	COORDINATE SYSTEM: WGS 1984 UTM Zone 36N		
CREATED BY: JKM DATE: 02/08/2017	DATA CREDITS: Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors Contains OS data © Crown Copyright and database right 2017 Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames.org, and other contributors	SURFACE THRESHOLD: 0.00004 mm SHORELINE THRESHOLD: 0.1 l/m2	EUROPE AFRICA

Figure 25: Overall area impacted for a strong north-easterly wind

4 RELIABILITY OF MODELLING RESULTS

Scenario 1 (Well Blowout) and scenario 2 (500,000 bbls released from an FPSO tank rupture) represent a highly unlikely worse case scenario. Whereas scenario 3 (25,000 bbls released from an FPSO tank rupture) is more indicative of a credible worst case. Furthermore, the oil spill modelling in this report does not include any response techniques. When used appropriately, response techniques would reduce the scale and severity of the impact to the environment.

Because of both the worst-case nature of the scenarios and the fact that no response techniques are simulated, the impact to surface waters and shoreline is almost certainly going to be less severe.

The modelling presented in this report is aimed at providing information so that that the merits of different response techniques and strategies can be assessed.

Determining the most appropriate response strategy is a complex decision-making process. The advantages and disadvantages of each response strategy should be considered in relation to not responding.[4] Considerations must be made for the type of oil spilled, the prevailing environmental conditions and the location of the spill.

Examples of response techniques are given below:

- Surface dispersant application could be used to reduce the impact of an oil spill from all scenarios. Further, subsurface dispersant application could be effective with the Well Blowout. Oil type, operating conditions and logistics of the operation should be considered, as well as approval from the relevant authorities. The viscosity of the oil determines dispersant effectiveness and there will be a window of opportunity where dispersant will be effective. The duration of this window will also vary per ambient sea and air temperatures as well as weather conditions.
- Offshore containment and recovery could also be an effective technique for all three scenarios. This technique is effective with most oil types, but can be constrained by weather conditions, encounter rates and vessel storage capacity.

To demonstrate the effectiveness of a response technique, a response simulation has been undertaken. The chosen scenario is the Summer scenario from the FPSO tanker spill (See Table 7: Summary of stochastic results for scenario 2). We re-ran the worst-case scenario that resulted in 4,700 MT of oil reaching the shoreline. This became our benchmark for the response strategy modelling.

We then simulated how effective a vessel equipped with a dispersant system would be and used shoreline impact as a measure of success.

This simulation is for guidance purposes only and not to be used for planning a response. For example, we have assumed that this oil is amenable to dispersant application which would need to be checked before considering a dispersant strategy. We have also not restricted

[4] http://www.oilspillresponseproject.org

where dispersant can be applied whereas dispersant is unlikely to be a viable strategy as the oil slick approaches the shore.

The figure below shows an idealised result of a response vessel armed with a dispersant spray system. It shows that the impact to the shore could be reduced by approximately 15 % if a dispersant system is mobilised.

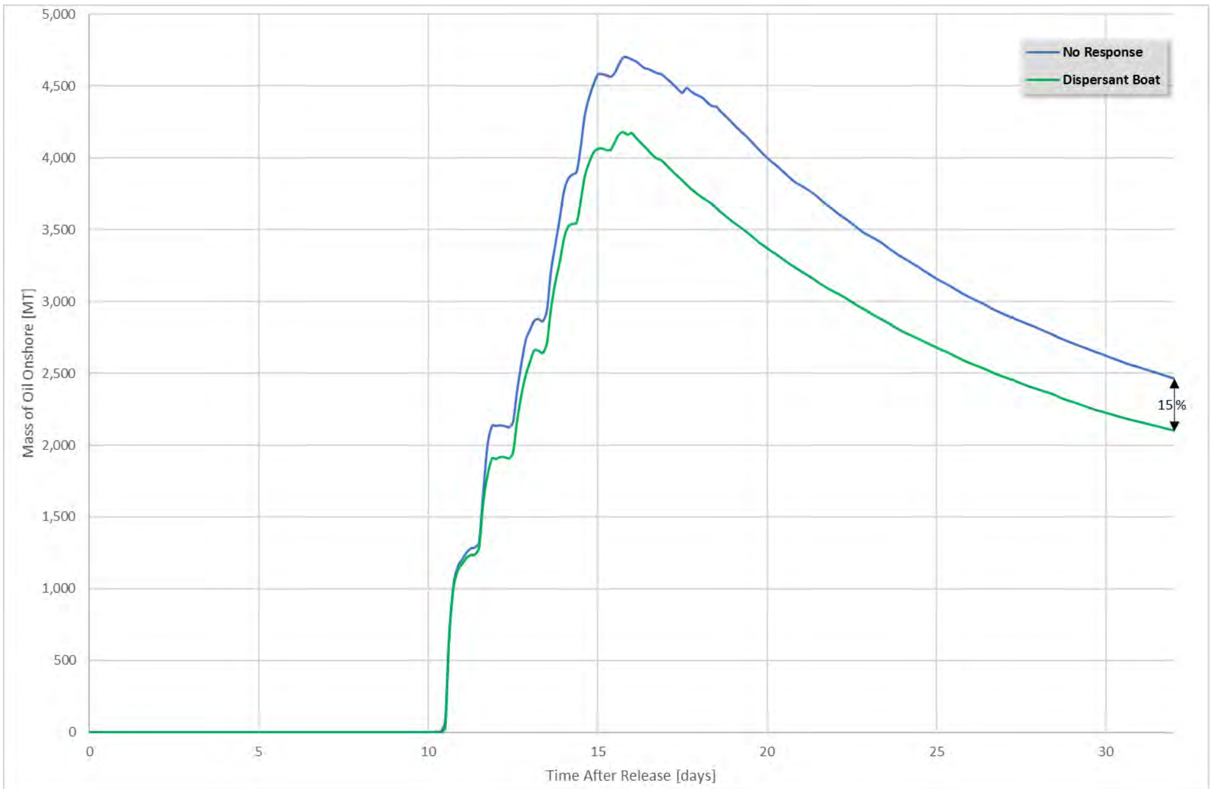


Figure 26: Response Strategy Modelling

This is just one example of the effectiveness of a response strategy. Whilst response strategies will not be 100 % effective, regardless of the number of assets, they do reduce the impact of a spill on the local environment.

5 CONCLUSION

Three scenarios were modelled at the Karish Well, offshore Israel. These were; a continuous release of 6,720 bbls/day for 90 days because of a Well Blowout for scenario 1; a phased release of 500,000 bbls as a result of an FPSO tank rupture for scenario 2 and a release from the FPSO of 25,000 bbls over 5 hours for scenario 3.

Shoreline impact

Light shoreline oiling along the coastline of Israel and Lebanon could occur following a well blowout from the Karish Tanin Well. Oil released during the larger FPSO rupture is most likely to result in shoreline oiling, and this oiling will be heaviest during the summer season. Lebanon is the country most likely to be affected by shoreline oiling, although Israel receives some heavy oiling during the tank rupture and Cyprus is impacted by light oiling.

Oil is likely to reach the shoreline quicker during the Tank Rupture than the Well Blowout. The coastline of Lebanon could see shoreline oiling within 5 days because of the larger Tank Rupture scenario; within 8 days because of the smaller Tank Rupture scenario, and within 9 days because of the Well Blowout scenario.

Only the larger FPSO Tank Rupture scenario resulted in heavy shoreline oiling (using ITOPF's recognition of shoreline oiling (See APPENDIX H)). This was recorded in Spring (6%), Summer (20%) and Autumn (16%). Most of the simulations resulted in no significant impact for both the Well Blowout scenario; with the highest percentage of oiling being light oiling which accounted for 177 out of 303 (58%) of simulations during the Well Blowout summer scenario, and the smaller Tank Rupture scenario. In this scenario, the highest percentage of oiling was light oiling (68 of 303 scenarios or 22%) although most of the scenarios results in no significant impact.

Surface impact

During the Well Blowout, metallic oil is likely to reach~64 km north of the well, with sheen oil reaching up to ~330 km north. During the larger FPSO Tank Rupture, metallic oil could reach ~280km north east, with sheen oil reaching ~184 km north east. The smaller FPSO Tank Rupture shows sheen oil reaching ~393 km north of the FPSO and metallic oil reaching ~200 km north east of the FPSO. Oil of a discontinuous true colour thickness (50-200µm) is unlikely to reach the shore in any of the scenarios.

Several country's waters are potentially affected by both scenarios, although the two that are impacted by every scenario are Lebanon and Cyprus.

APPENDIX A. MODEL SETUP

	Scenario 1	Scenario 2	Scenario 3
Scenario Reference	S01	S02	S03
Description	Well Blowout	FPSO Tank Rupture	FPSO Tank Rupture
Latitude	33° 13’ 55.2432” N	33° 12’ 15.1704” N	33° 12’ 15.1704” N
Longitude	034° 17’ 27.51” E	034° 17’ 24.842” E	034° 17’ 24.842” E
Time of Year	Dec – Feb Mar – May Jun – Aug Sep - Nov	Dec – Feb Mar – May Jun – Aug Sep - Nov	Jun – Aug
Release Depth	1,725 m	0 m (surface)	0 m (surface)
Release Rate	6,720 bbls/day	10,000 bbls/12 hours 6,000 bbls/12 hours 5,000 bbls/24 hours 4,000 bbls/47 hours	5,000 bbls/hour
Release Duration	90 days	4 days	5 hours
Duration After Cessation	28 days	28 days	28 days
Total Model Duration	118 days	32 days	28 days
API Gravity	55.0	55.0	55.0
Specific Gravity	0.759	0.759	0.759
Viscosity (cP)	1.0	1.0	1.0
Pour Point (°c)	-36.0	-36.0	-36.0
Wax (%)	0.01	0.01	0.01
Asphaltenes (%)	0.01	0.01	0.01
Diameter of Release Hole (m)	0.24	n/a	n/a
Gas to Oil Ratio (GOR, Sm^3/m^3)	12,720	n/a	n/a
Gas Density (kg/Sm^3)	0.8	n/a	n/a

APPENDIX B. METOCEAN DATA

Table 24: Current data – general description

Name	GEOM0085-Curr01		
Description	The physical component of the Black Sea Forecasting System (BS-Currents) is a hydrodynamic model implemented over the whole Black Sea basin. The model horizontal grid resolution is 1/36° in zonal resolution, 1/27° in meridional resolution (ca. 3 km) and has 31 unevenly spaced vertical levels. The hydrodynamics are supplied by the Nucleus for European Modelling of the Ocean (NEMO, v3.4). The model solutions are corrected by the variational assimilation (based on a 3DVAR scheme), originally developed for the Mediterranean Sea and later extended for the global ocean. The observations assimilated in the BS-Currents includes in-situ profiles, along-track sea level anomalies (SLA) and gridded sea surface temperature (SST) provided by the U.K. MetOffice Hadley Center and the Copernicus TACs.		
Reference	Sourced from COPERNICUS. The Mediterranean Forecasting System, physical reanalysis component, is a hydrodynamic model, supplied by the Nucleous for European Modelling of the Ocean (NEMO), with a variational data assimilation scheme (OceanVAR) for temperature and salinity vertical profiles and satellite Sea Level Anomaly along track data.		
Start Time	Jan 2009	**Spatial Resolution**	~7 km
End Time	Dec 2011	**Temporal Resolution**	Daily
Depth Levels [m]	2.5, 7.5, 12.5, 17.6, 22.7, 27.8, 33, 38, 44, 50, 56, 62, 70, 78, 89, 102, 118, 140, 170, 211, 266, 340, 438, 562, 716, 899, 1109, 1343, 1595, 1862, 2140		

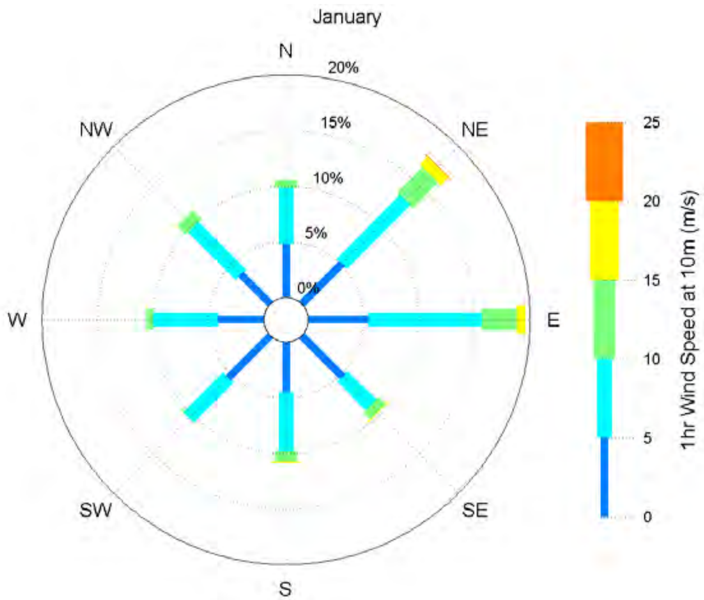
Table 25: Wind data – general description

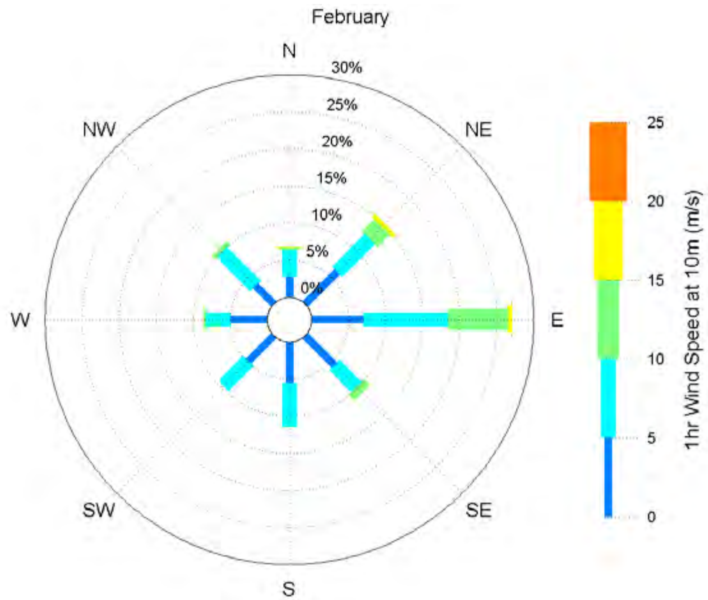
Name	GEOM0085-Wind01		
Description	The NCEP Climate Forecast System Reanalysis (CFSR) was designed and executed as a global, high-resolution, coupled atmosphere-ocean-land surface-sea ice system to provide the best estimate of the state of these coupled domains over the 32-year period of record from January 1979 to March 2011. It has been extended as an operational real-time product.		
Reference	The CFSR data was developed by NOAA's National Centers for Environmental Prediction (NCEP). The data for this study are from NOAA's National Operational Model Archive and Distribution System (NOMADS), which is maintained at NOAA's National Centers for Environmental Information (NCEI). Saha, S., S. Moorthi, H. Pan, X. Wu, J. Wang, and Co-authors, 2010: The NCEP Climate Forecast System Reanalysis. Bulletin of the American Meteorological Society, 91, 1015–1057, doi:10.1175/2010BAMS3001.1(link is external). Saha, S., ;S. Moorthi, X. Wu, J. Wang, and Co-authors, 2014: The NCEP Climate Forecast System Version 2. Journal of Climate, 27, 2185–2208, doi:10.1175/JCLI-D-12-00823.1(link is external). The CFS version 2 was developed at the Environmental Modelling Center at NCEP. It is a fully coupled model representing the interaction between the Earth's atmosphere, oceans, land and sea-ice. It became operational at NCEP in March 2011.		
Start Time	Jan 2009	**Spatial Resolution**	35 km
End Time	Dec 2011	**Temporal Resolution**	3 hours
Altitude Level	10 m		

APPENDIX C. WIND ROSE

The following diagrams illustrate the direction, probability and speed (m/s at a height of 10m) of the winds for individual months.

Please remember that wind direction is the direction the currents are travelling FROM, current direction is the direction the winds are travelling TOWARDS.


January
N
NE
E
SE
S
SW
W
NW
0%
5%
10%
15%
20%
1hr Wind Speed at 10m (m/s)
0
5
10
15
20
25


February
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NE
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SE
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SW
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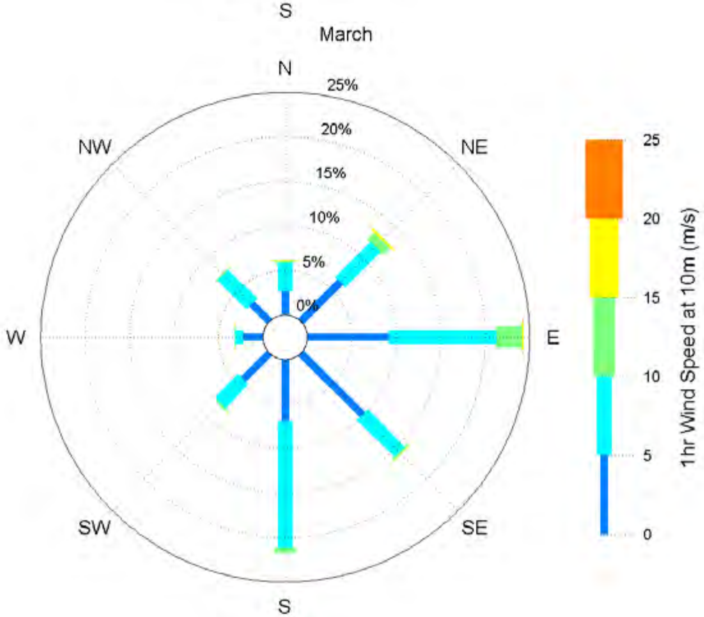
NW
0%
5%
10%
15%
20%
25%
30%
1hr Wind Speed at 10m (m/s)
0
5
10
15
20
25


March
N
NE
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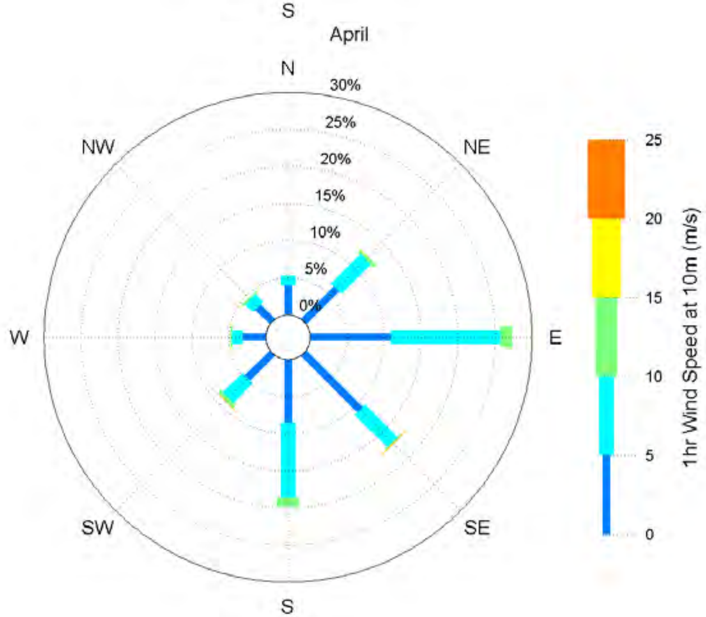
SW
W
NW
0%
5%
10%
15%
20%
25%
1hr Wind Speed at 10m (m/s)
0
5
10
15
20
25


April
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NE
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SE
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SW
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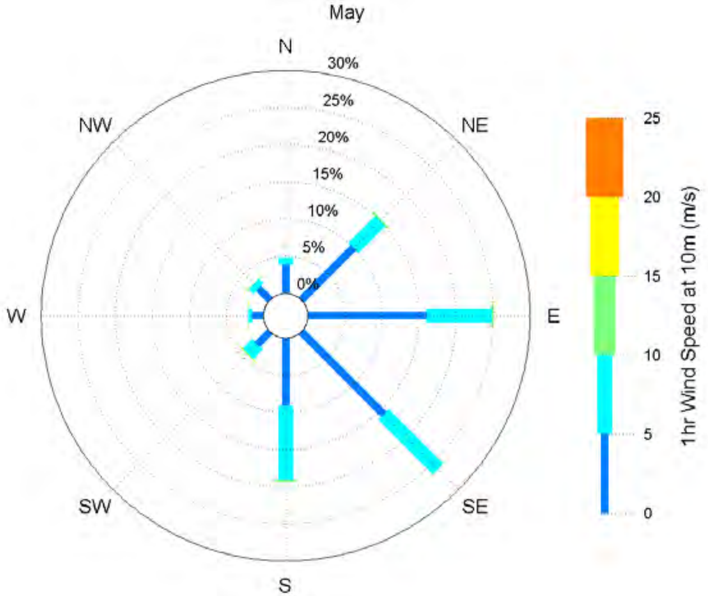
NW
0%
5%
10%
15%
20%
25%
30%
1hr Wind Speed at 10m (m/s)
0
5
10
15
20
25


May
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SE
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SW
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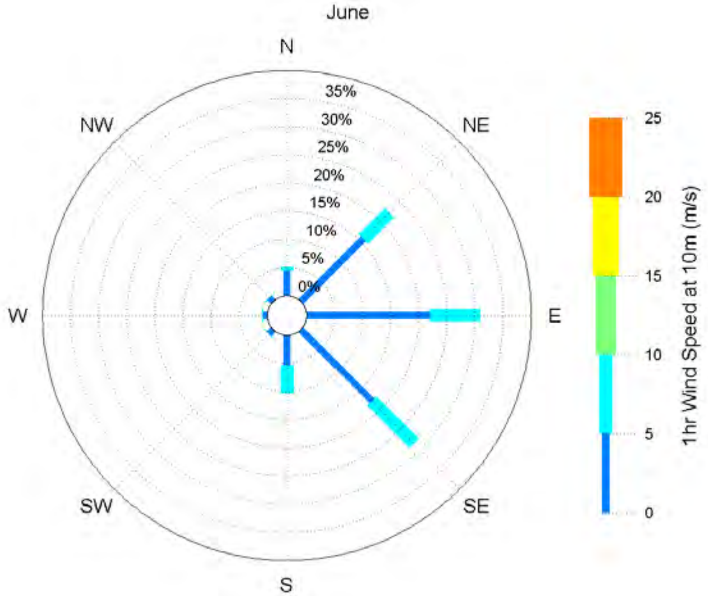
NW
30%
25%
20%
15%
10%
5%
0%
25
20
15
10
5
0
1hr Wind Speed at 10m (m/s)


June
N
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SE
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SW
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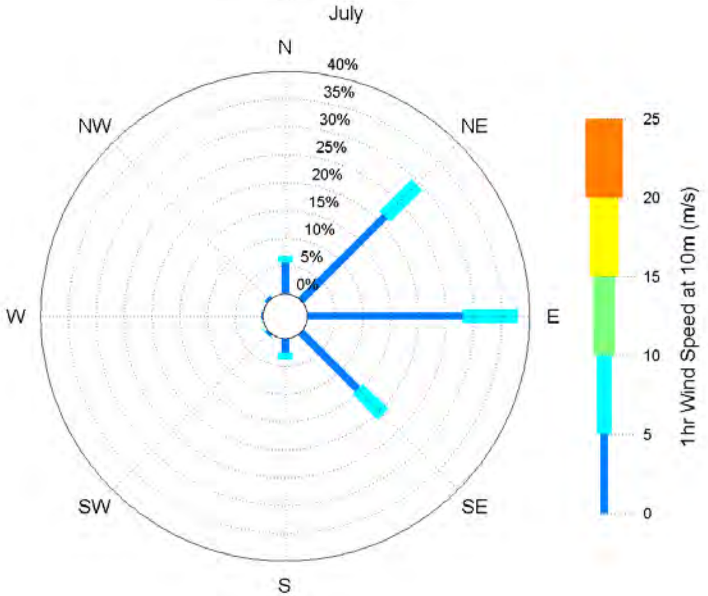
NW
35%
30%
25%
20%
15%
10%
5%
0%
25
20
15
10
5
0
1hr Wind Speed at 10m (m/s)


July
N
NE
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SE
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SW
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NW
40%
35%
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25%
20%
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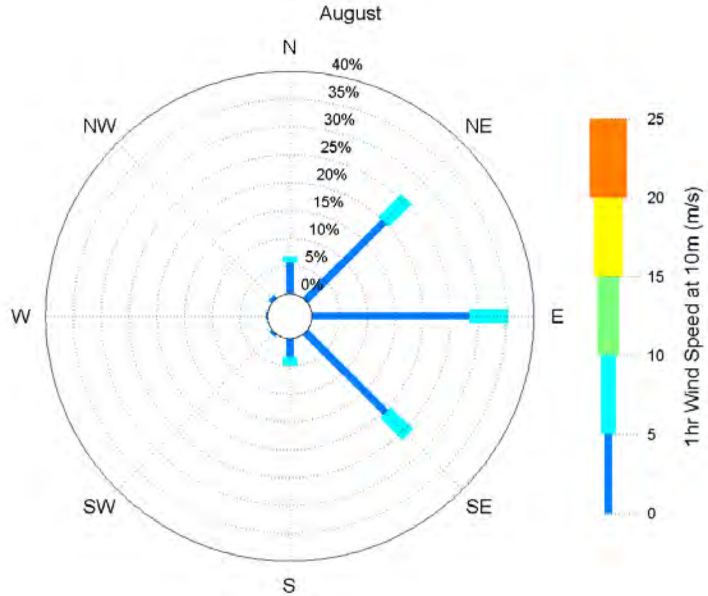
10%
5%
0%
25
20
15
10
5
0
1hr Wind Speed at 10m (m/s)


August
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NE
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SW
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NW
40%
35%
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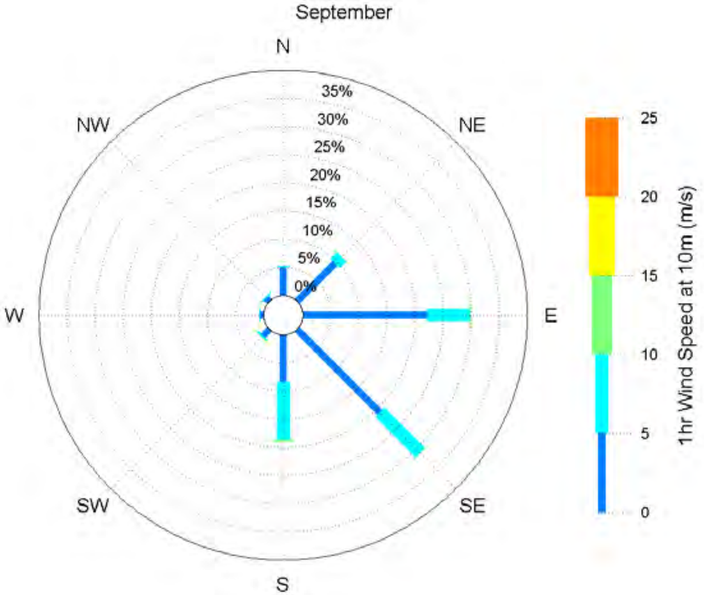
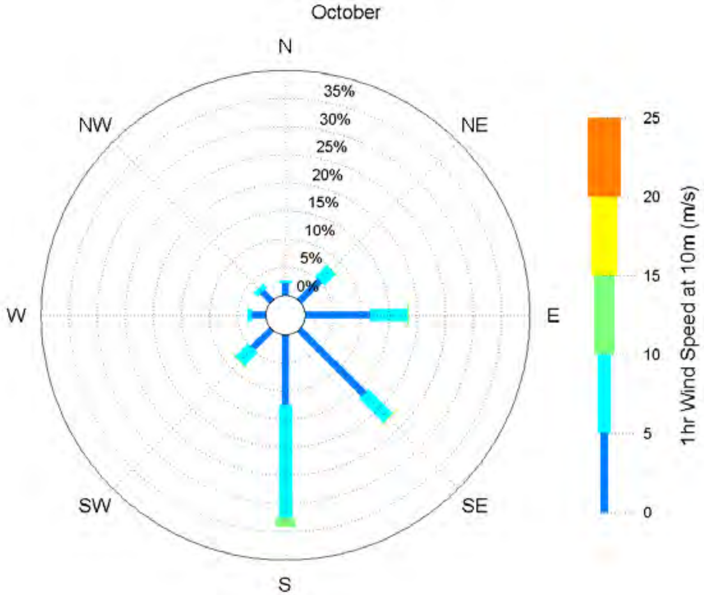
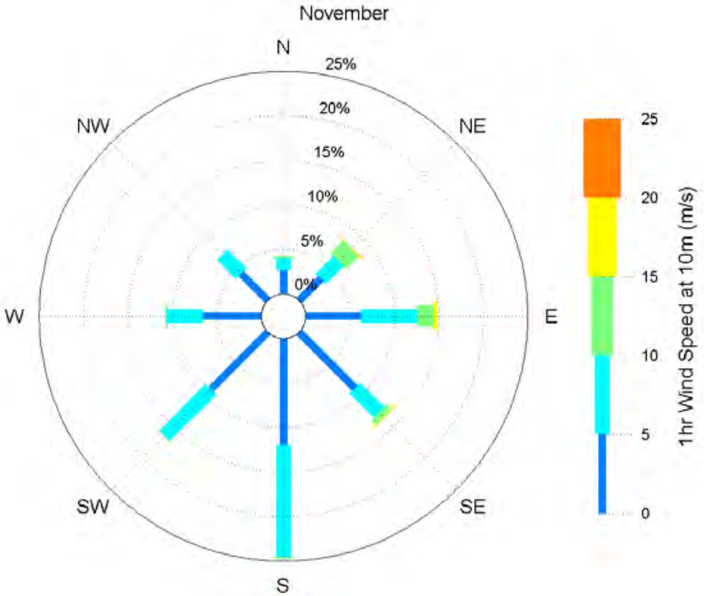
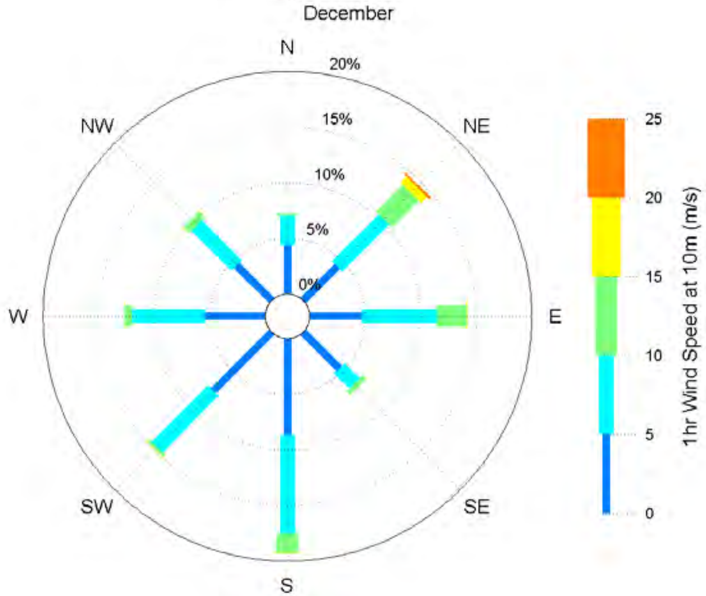
10%
5%
0%
25
20
15
10
5
0
1hr Wind Speed at 10m (m/s)


September
N
NE
E
SE
S
SW
W
NW
35%
30%
25%
20%
15%
10%
5%
0%
25
20
15
10
5
0
1hr Wind Speed at 10m (m/s)


October
N
NE
E
SE
S
SW
W
NW
35%
30%
25%
20%
15%
10%
5%
0%
25
20
15
10
5
0
1hr Wind Speed at 10m (m/s)

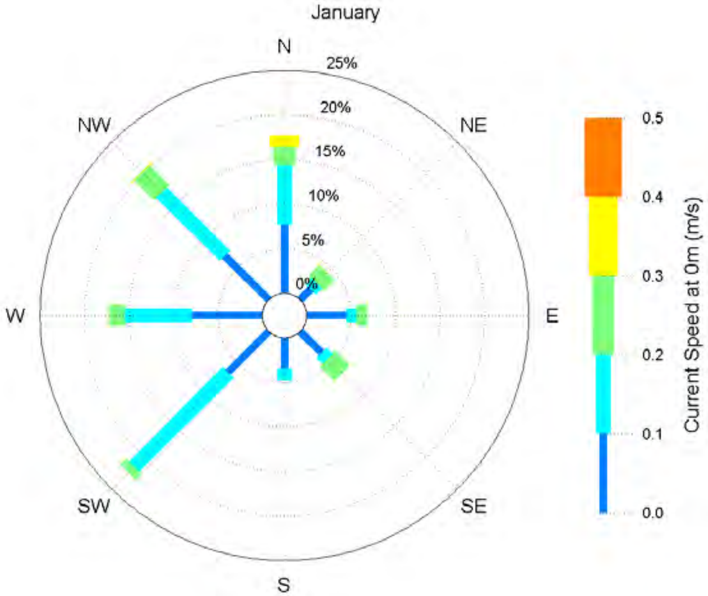

November
N
NE
E
SE
S
SW
W
NW
25%
20%
15%
10%
5%
0%
25
20
15
10
5
0
1hr Wind Speed at 10m (m/s)

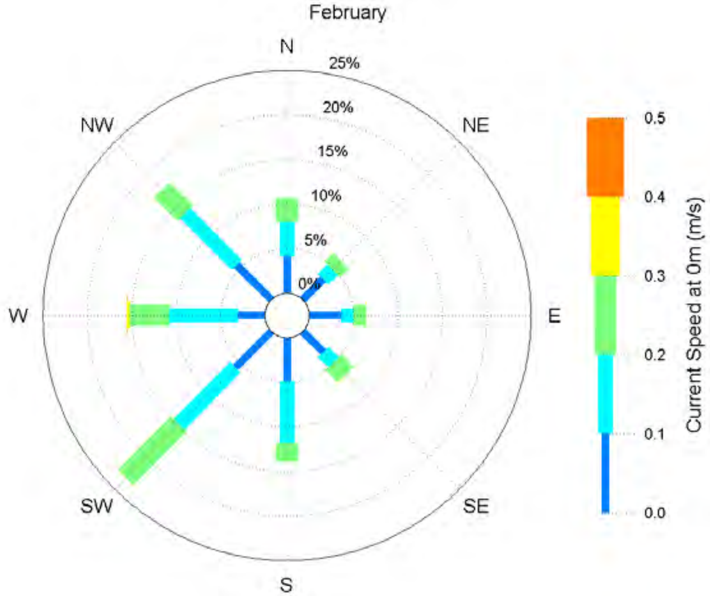

December
N
NE
E
SE
S
SW
W
NW
20%
15%
10%
5%
0%
25
20
15
10
5
0
1hr Wind Speed at 10m (m/s)

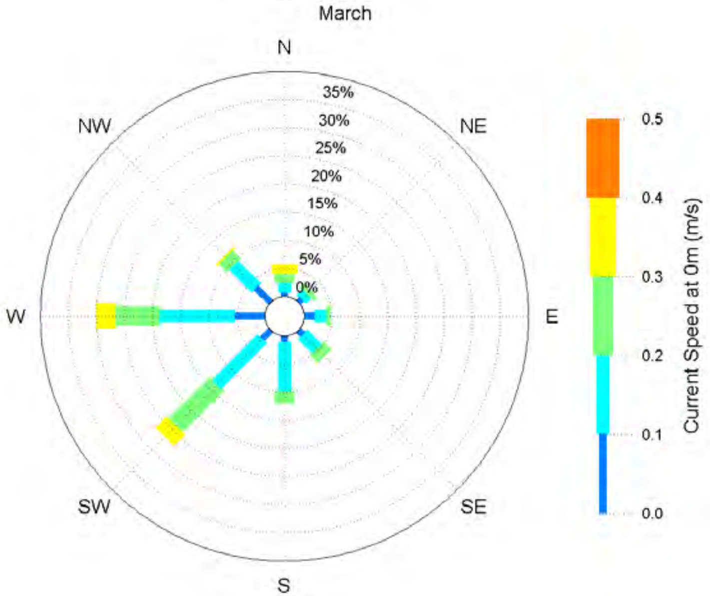
APPENDIX D. CURRENT ROSE

The following diagrams illustrate the direction, probability and speed (m/s) of the currents for individual months.

Please remember that current direction is the direction the currents are travelling TOWARDS, wind direction is the direction the winds are travelling FROM.


January
N
NE
E
SE
S
SW
W
NW
0%
5%
10%
15%
20%
25%
0.0
0.1
0.2
0.3
0.4
0.5
Current Speed at 0m (m/s)


February
N
NE
E
SE
S
SW
W
NW
0%
5%
10%
15%
20%
25%
0.0
0.1
0.2
0.3
0.4
0.5
Current Speed at 0m (m/s)


March
N
NE
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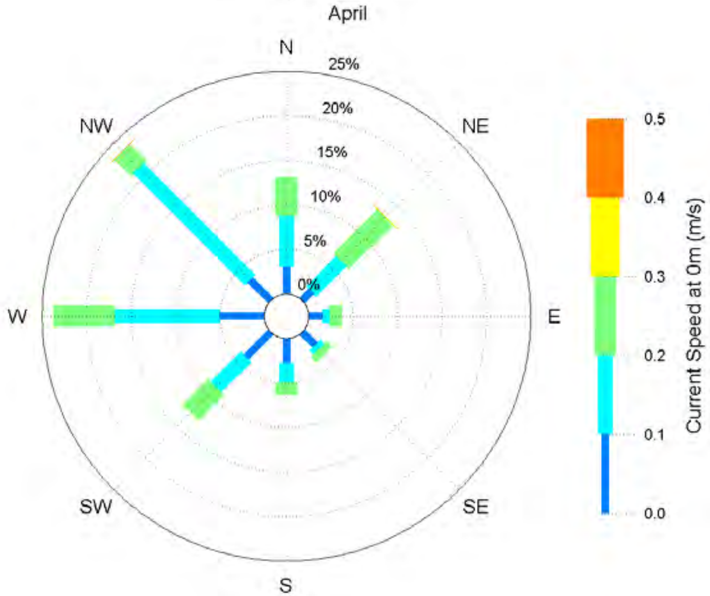
SE
S
SW
W
NW
0%
5%
10%
15%
20%
25%
30%
35%
0.0
0.1
0.2
0.3
0.4
0.5
Current Speed at 0m (m/s)


April
N
NE
E
SE
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SW
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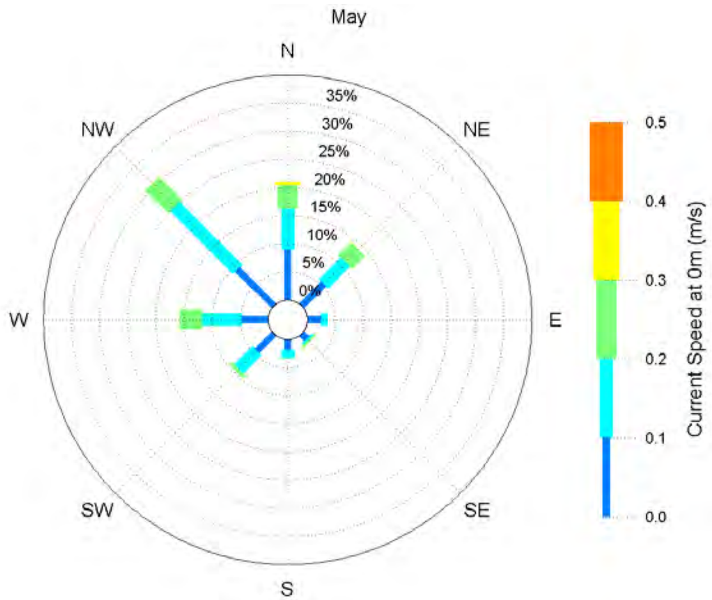
NW
0%
5%
10%
15%
20%
25%
0.0
0.1
0.2
0.3
0.4
0.5
Current Speed at 0m (m/s)


May
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NE
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SE
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SW
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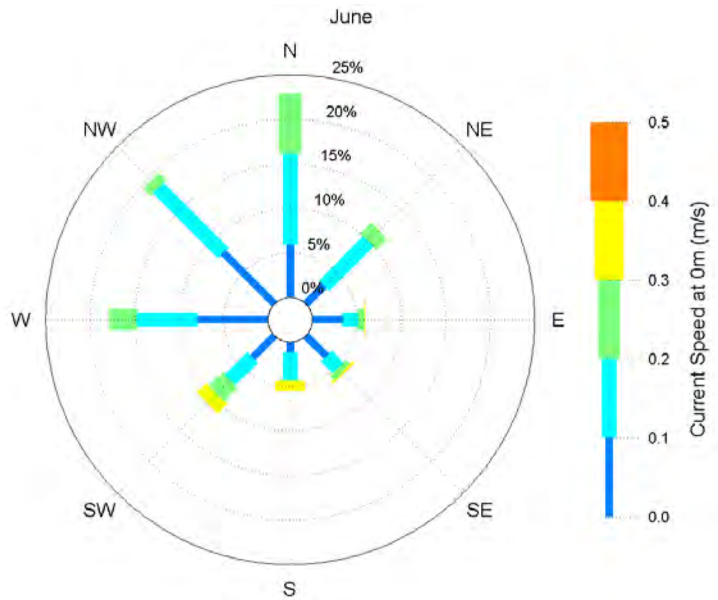
NW
35%
30%
25%
20%
15%
10%
5%
0%
0.5
0.4
0.3
0.2
0.1
0.0
Current Speed at 0m (m/s)


June
N
NE
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SE
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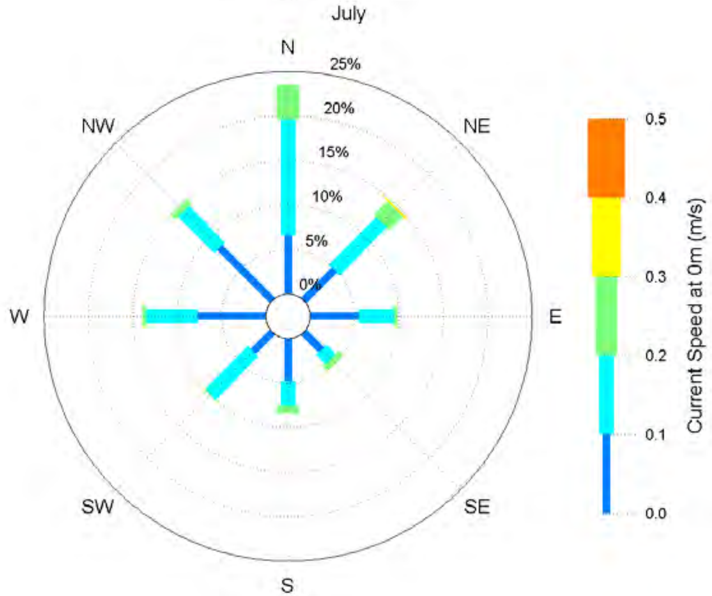
SW
W
NW
25%
20%
15%
10%
5%
0%
0.5
0.4
0.3
0.2
0.1
0.0
Current Speed at 0m (m/s)


July
N
NE
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SE
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SW
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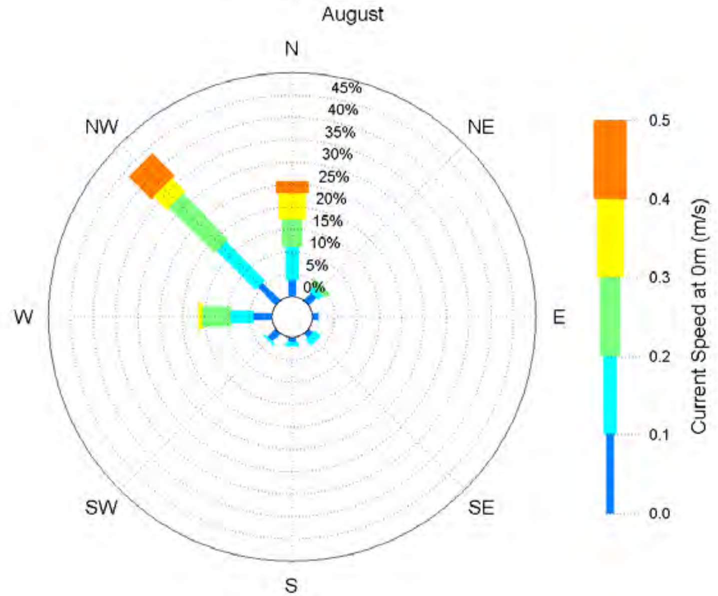
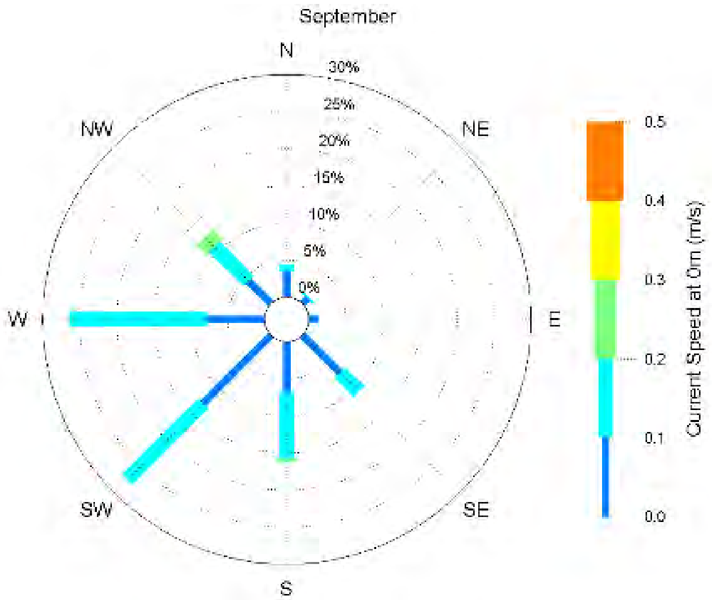
NW
25%
20%
15%
10%
5%
0%
0.5
0.4
0.3
0.2
0.1
0.0
Current Speed at 0m (m/s)


August
N
NE
E
SE
S
SW
W
NW
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
0.5
0.4
0.3
0.2
0.1
0.0
Current Speed at 0m (m/s)


September
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NE
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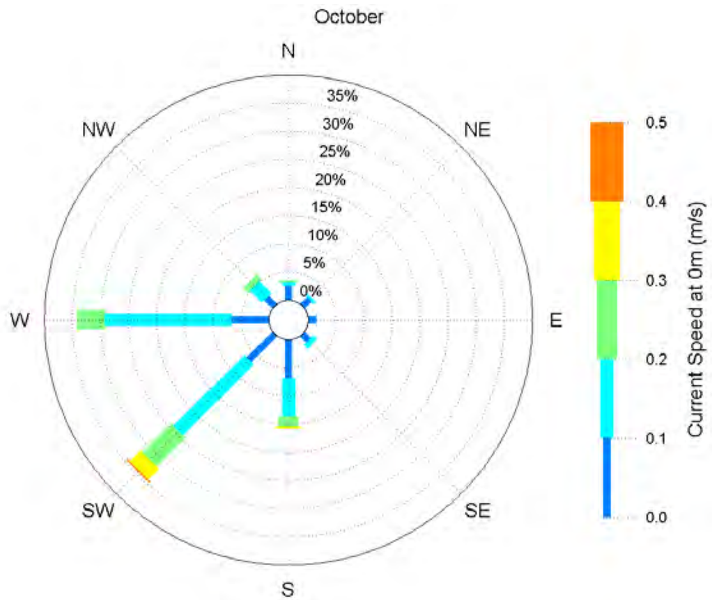
SW
W
NW
30%
25%
20%
15%
10%
5%
0%
0.5
0.4
0.3
0.2
0.1
0.0
Current Speed at 0m (m/s)


October
N
NE
E
SE
S
SW
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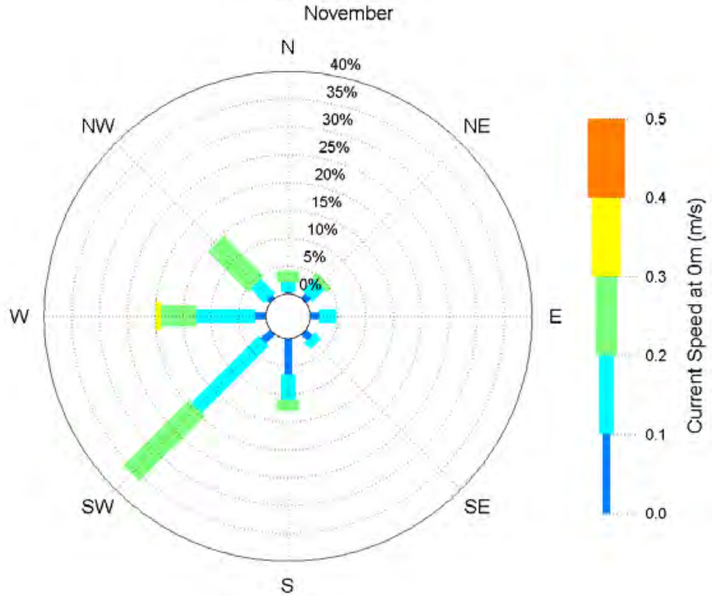
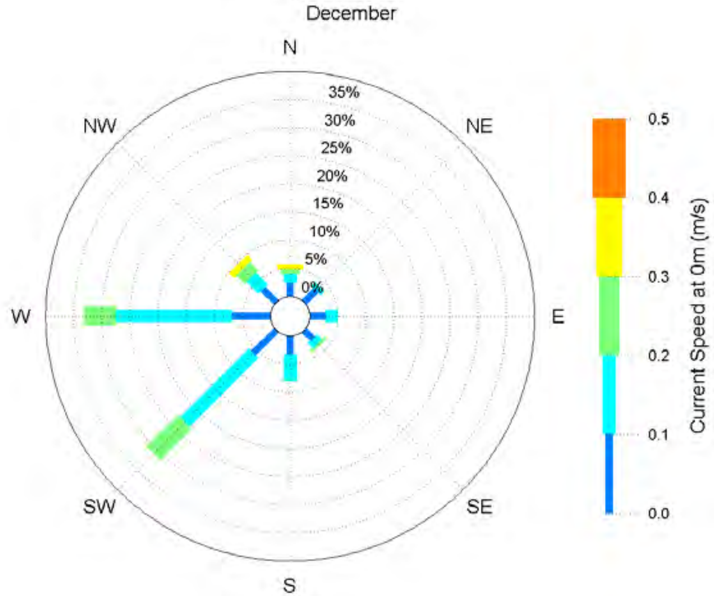
NW
35%
30%
25%
20%
15%
10%
5%
0%
0.5
0.4
0.3
0.2
0.1
0.0
Current Speed at 0m (m/s)


November
N
NE
E
SE
S
SW
W
NW
40%
35%
30%
25%
20%
15%
10%
5%
0%
0.5
0.4
0.3
0.2
0.1
0.0
Current Speed at 0m (m/s)


December
N
NE
E
SE
S
SW
W
NW
35%
30%
25%
20%
15%
10%
5%
0%
0.5
0.4
0.3
0.2
0.1
0.0
Current Speed at 0m (m/s)

APPENDIX E. HABITAT GRID

Table 26: Habitat domain details

Name	Domain Extent			
GEOM0085-S01-01 (Stochastics)	Bottom	Top	Left	Right
	30° 35' 19'' N	37° 15' 04'' N	025° 39' 59'' E	036° 30' 51'' E
	Number of Cells		Cell Resolution	
	East to West	North to South	East to West	North to South
	1000	740	1 km	1 km
	Domain Size			
	East to West		North to South	
	1,000 km		740 km	
Name	**Domain Extent**			
G0085-Trajectory-Grid (Trajectories)	Bottom	Top	Left	Right
	30° 54' 20'' N	37° 01' 48'' N	031° 35' 08'' E	036° 17' 16'' E
	Number of Cells		Cell Resolution	
	East to West	North to South	East to West	North to South
	430	670	1 km	1 km
	Domain Size			
	East to West		North to South	
	430 km		670 km	

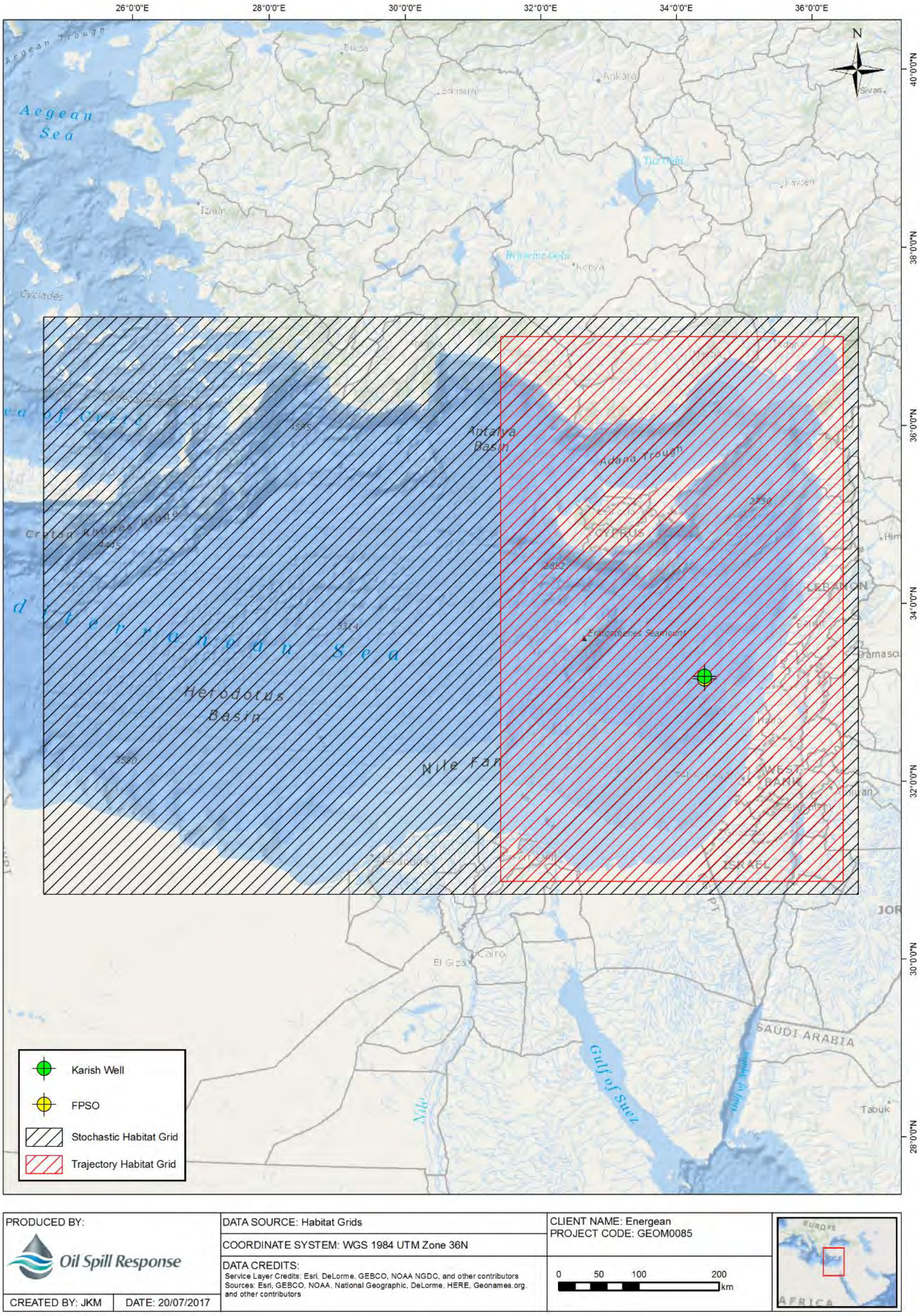


Figure 27: Extent of habitat grids used in this study

APPENDIX F. OIL CHARACTERISTICS AND BEHAVIOUR

The components found in crude oil are classified into two main groups: hydrocarbons and non-hydrocarbons (see Figure 30). If oil is rich in C1-12 alkanes, it is particularly light, as these are lighter components than the C25+ alkanes. Conversely, if oil contains high quantities of C25+ alkanes, resins and asphaltenes, it is heavy.

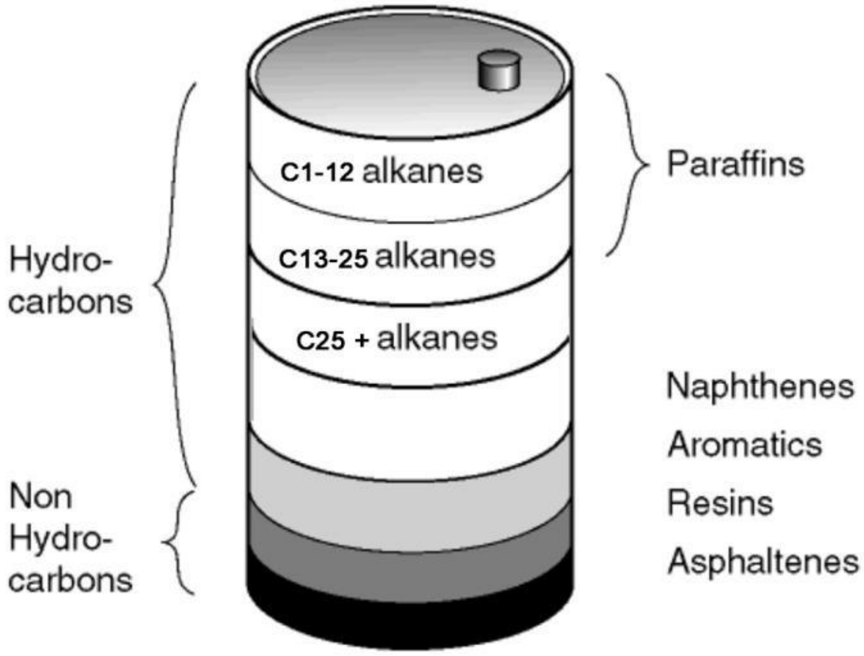


Figure 28: The chemical composition of crude oil

The chemical composition of oil is important when predicting how it will break down or weather. For example, oil containing mostly light components is likely to lose a greater volume to evaporation than heavy oil. Oils with carbon chains exceeding 15 (C15+) cannot evaporate, even during large storms. Long chains (for example, C25+ alkanes) take a long time to degrade in the water column. Asphaltenes can increase the stability of oil, allowing it to take up water but preventing the oil and water emulsion from breaking down.

As crude oil is a complicated mixture of organic compounds, its components must be analysed to characterise it successfully (LECO Corporation, 2012). The components of oil can be 'identified' and plotted using gas chromatography instruments which are coupled with mass spectrometers (see Bacher, 2014, for further information). The results of gas chromatography and mass spectrometry are converted into a list of 25 sub-components, as broken down in the OSCAR oil database. Each of the 25 sub-components is characterised by molecular weight, density, viscosity, boiling point, solubility in water, vapour pressure, and partition coefficient between oil and water.

The OSCAR Oil Database

A strength of the OSCAR model is its foundation on an observational database of oil weathering properties (maximum water content, viscosity, droplet size distribution, evaporation, emulsification and dispersion, which are measured in a wide range of conditions). The oil database contains complete weathering information for 340 crude oils and petroleum products. It also contains crude assay data for approximately 170 other crude oils (derived from the HPI database - HPI, 1987). But these oils have not been lab-tested so model estimates of the weathering process are used in place of observational data. This reduces the reliability of the model.

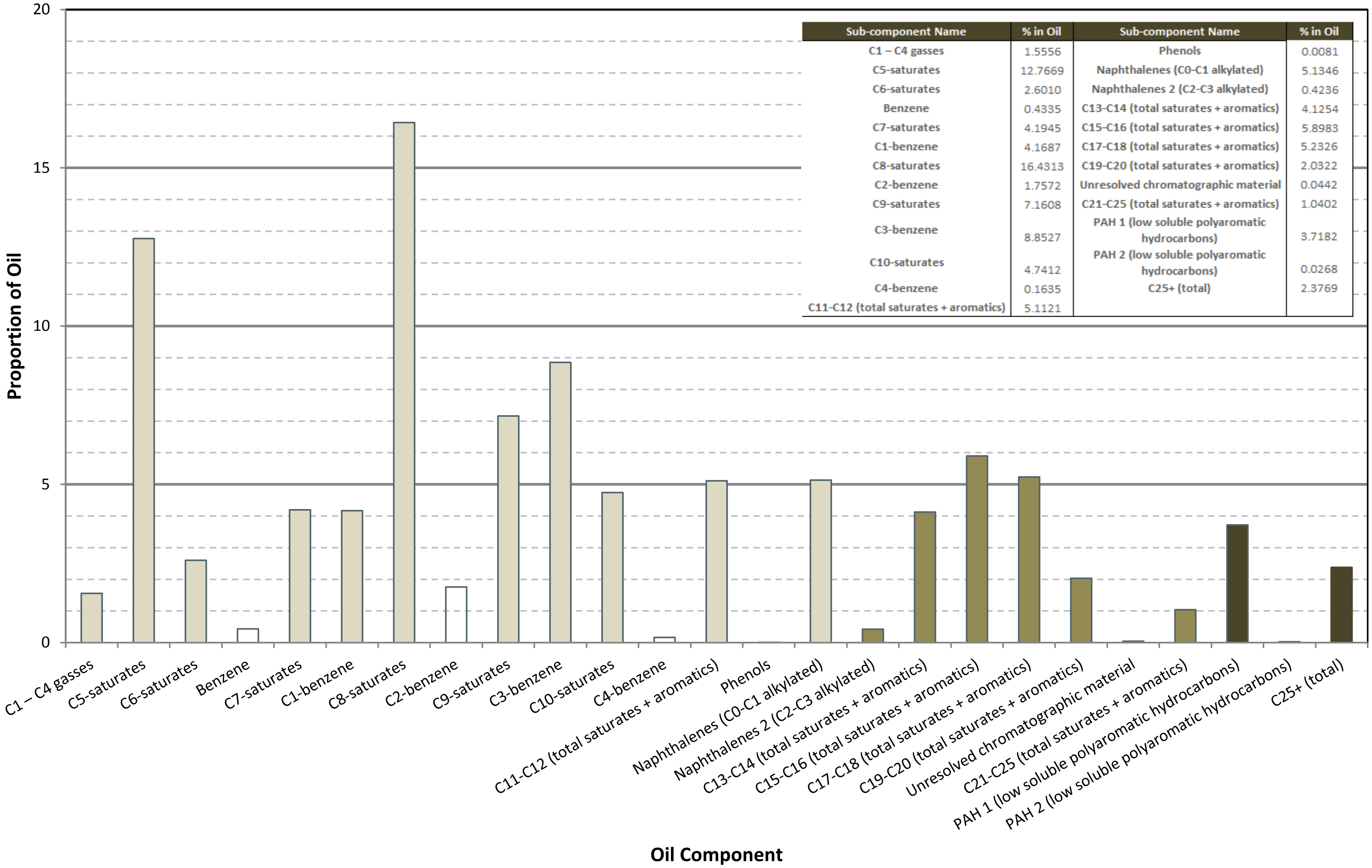
Oil Matching

A lab tested oil was selected for this modelling study based on the information provided by Energean Oil & Gas. The similarities between the client crude and the selected modelled oil are shown in Table 27. Figure 31 lists the sub-components of the modelled oil and their percentage fraction in the oil.

Table 27: Properties of the client crude and the modelled oil

Name	API	Specific Gravity	Viscosity (cP)	Pour Point[5]* (°C)	Wax Content (%)	Asphaltenes (%)
Client Crude	-	0.7048	0.6	-	0	0
Modelled Oil	**55.0**	**0.759**	**1.0**	**-36.0**	**0.01**	**0.01**

[5] Due to the algorithms in the model, Pour Point is of lesser importance when oil matching.



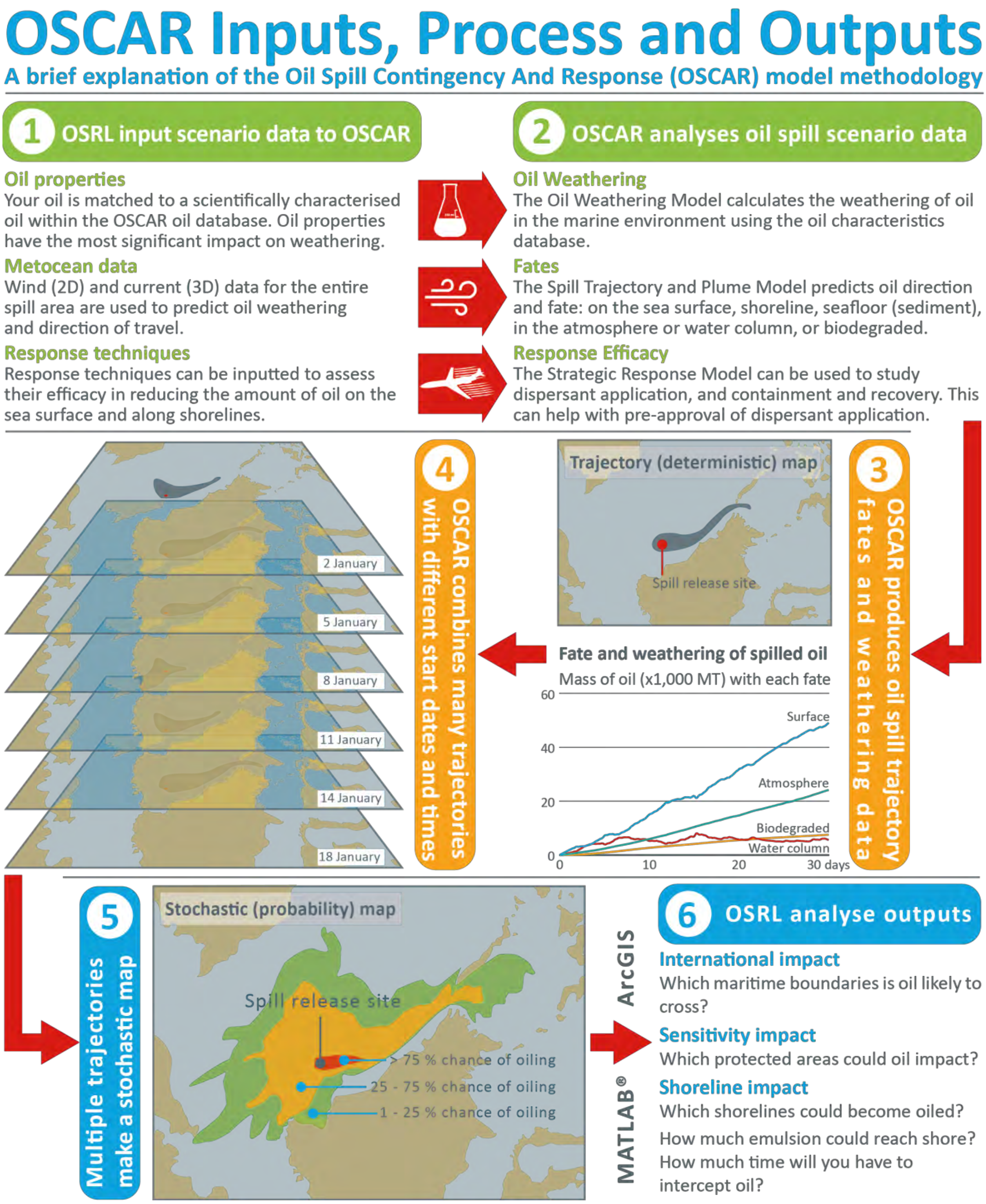
Sub-component Name	% in Oil	Sub-component Name	% in Oil
C1 – C4 gasses	1.5556	Phenols	0.0081
C5-saturates	12.7669	Naphthalenes (C0-C1 alkylated)	5.1346
C6-saturates	2.6010	Naphthalenes 2 (C2-C3 alkylated)	0.4236
Benzene	0.4335	C13-C14 (total saturates + aromatics)	4.1254
C7-saturates	4.1945	C15-C16 (total saturates + aromatics)	5.8983
C1-benzene	4.1687	C17-C18 (total saturates + aromatics)	5.2326
C8-saturates	16.4313	C19-C20 (total saturates + aromatics)	2.0322
C2-benzene	1.7572	Unresolved chromatographic material	0.0442
C9-saturates	7.1608	C21-C25 (total saturates + aromatics)	1.0402
C3-benzene	8.8527	PAH 1 (low soluble polyaromatic hydrocarbons)	3.7182
C10-saturates	4.7412	PAH 2 (low soluble polyaromatic hydrocarbons)	0.0268
C4-benzene	0.1635	C25+ (total)	2.3769
C11-C12 (total saturates + aromatics)	5.1121		

Figure 29: Chemical composition of the modelled oil

APPENDIX G. OIL SPILL MODELLING SOFTWARE AND METHODOLOGY

This project was completed using the version of OSCAR contained within the Marine Environmental Modelling Workbench (MEMW) 8.0, a model that has been fully validated and calibrated using various field observations from a number of experimental oil spills (Reed et al., 1995, 1996).

OSCAR predicts the movement of oil at the water's surface and throughout the water column. OSCAR consists of a number of interlocking modules that are activated as required. The following infographic illustrates the OSCAR modelling process.



APPENDIX H. GLOSSARY OF TERMS, ACRONYMS AND ABBREVIATIONS

°C	Degrees Celsius (1.0°C = 33.8° Fahrenheit)
µm	Micrometre (1.0 µm = 10^{-6} m)
API	American Petroleum Institute
API Gravity	API Gravity, like specific gravity, is a ratio between the densities of oil and water. Unlike specific gravity, API gravity is only used to describe oil, which it characterises as: • Light - API > 31.1 • Medium - API between 22.3 and 31.1 • Heavy - API < 22.3 • Extra Heavy - API < 10.0 API Gravity is converted to Specific Gravity using the following formula: *API gravity = (141.5/Specific Gravity) t 131.5* An API of 10 is equivalent to water, so oils with an API above 10 will float on water while oils with an API below 10 will sink. See also: *Specific Gravity, API*
ArcGIS	A geographic Information System (GIS) used to present OSCAR outputs on maps.
Asphaltene Content	The asphaltenes present the crude oil components that are (1) insoluble in n-heptane at a dilution ratio of 40 parts alkane to 1 part crude oil and (2) re-dissolves in toluene. The asphaltenes include the crude oil material highest in molecular weight, polarity and aromaticity.
bbls	Barrels of oil (a unit of volume). (1.0 bbls = 0.15899 m^3 and 1.0 m^3 = 6.2898 bbls) The conversion between mass and volume requires knowledge of the oil density. See also: *MT, API Gravity, Specific Gravity*
bbls/day	Barrels of oil per day (rate).
BONN Agreement	The BONN Agreement is an international standard and agreement on how to characterise and respond to pollution. Although aimed at pollution in the North Sea (Europe) many of the characterisation standards are internationally recognised.
FPSO	Floating Production Storage and Offloading - a floating vessel used for producing, processing and storing oil.
GOR	Gas to Oil Ratio - the ratio of volumetric flow of produced gas to the volumetric flow of oil. Although GOR is a ratio, the volume units must be known since gas and oil volumes are measured differently. GOR changes with temperature and pressure so the condition under which GOR is measured must be known.
ITOPF	The International Tanker Owners Pollution Federation Limited
km	Kilometres (1.0 km = 1,000 m) See also: *m*
m	Metres (1.0 km = 1,000 m) See also: …,*ukm*
MATLAB	Matrix Laboratory - a multi-paradigm numerical computing environment and programming language used in this study for the manipulation of data outputs from OSCAR.

MEMW	Marine Environmental Modelling Workbench - the modelling software package developed by SINTEF. The MEMW consists of three models: • **DREAM (Dose, Risk and Effects Assessment Model)** • **OSCAR (Oil Spill Contingency and Response Model)** • **ParTrack Model** When combined, these three models quantify the environmental effect of most chemical pollution activities. See also: *OSCAR, SINTEF*
MT	Metric Tonnes - this is a unit of oil mass. (1.0 MT = 1,000 kg) The conversion between mass and volume requires knowledge of the oil's API or Specific Gravity as follows: *Barrels per metric ton = 1/[(141.5/(API + 131.5) x 0.159]* See also: *bbls, API Gravity, Specific Gravity*
NOAA	National Oceanic and Atmospheric Administration – an American scientific agency focussed on metocean conditions
OSCAR	Oil Spill Contingency And Response A state of the art 3D oil spill model and simulation tool for predicting the fates and effects of oil released into the marine environment. Developed by SINTEF, it sits within the larger MEMW application. See also: *SINTEF, MEMW*
OSRL	Oil Spill Response Limited
Pour Point	The pour point of a liquid is the lowest temperature at which it shows flow characteristics. If ambient temperature is less than the liquid's pour point it will begin to solidify.
SCAT	Shoreline Cleanup Assessment Technique
SINTEF	SINTEF is an independent research organisation in Norway which develops the OSCAR model used in this study.
Specific Gravity	Specific gravity is a ratio of the density of one substance to the density of a reference substance, usually water. Specific gravity of oil is a ratio of the density of oil to the density of water. See also: *API Gravity, bbls, MT*
Stochastic	Stochastic (or probabilistic) results show the probability or likelihood of an event occurring. They provide statistical data that can be used to assess risk and identify worst-case scenarios. Stochastic results are achieved by combining many different trajectory simulations. See also: *Trajectory*
Trajectory	Trajectory or deterministic results show the impact of a single spill event over time. Can be used to assess different response options such as booms, skimmers and dispersant. See also: *Stochastic*
UTC	Coordinated Universal Time
Wax Content	Represents the crude oil components that are soluble in higher molecular weight normal alkanes (n-heptane) but are insoluble in lower molecular weight alkanes (n-pentane).

APPENDIX I. REFERENCES

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