DUQM LIQUID BULK BERTHS PROJECT

Report

Environmental Impact Assessment

SEZAD-DPTC-00-WP-EV-REP-3001-B2

22-Sep-2015

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DUQM LIQUID BULK BERTHS PROJECT
REPORT-ENVIRONMENTAL IMPACT ASSESSMENT

SYNOPSIS

This document presents the Report on the Environmental Impact Assessment study undertaken for the DUQM LIQUID BULK BERTHS PROJECT. The study and its outcome are summarised in the Executive Summary presented immediately after the Contents table.

PROJECT # 303060-00098 – REPORT-ENVIRONMENTAL IMPACT ASSESSMENT

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
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REVISION DESCRIPTION LIST

Rev.	Para.	Revision Description
A1		Issued for joint IDC/Client Review. Appendices not included. Will be included later.
B1		Approved for Use (Incorporated IDC and ICR comments)
B2		Approved for Use (Incorporated Client comments on Rev-B1)

Hold No.	Para.	Description of Hold

Executive Summary

Introduction

Duqm Petroleum Terminal Company LLC (DPTC), a joint venture company between Oman Oil Company (OOC) and the Port of Duqm Company (PDC), has been established to develop and operate the Duqm Liquid Bulk Berths (DLBB Project) Project Terminal, in Duqm Port, located in the Al Wusta Region of the Sultanate of Oman. The DLBB Project involves development of storage tanks and sheds for bulk liquid and solid products from Duqm Refinery, along with associated facilities, utilities, and jetties and berths for export of the refinery products. The products handled are Naphtha, Jet-A1, Diesel, High Sulphur Fuel Oil (HSFO), Pressurised Liquefied Petroleum Gas (PLPG), Pet Coke and Sulphur.

The Project lies on the Lee Breakwater (LBW) of the Port of Duqm, and thus lies within the Special Economic Zone Duqm (SEZD), which is administered by the Special Economic Zone Authority at Duqm (SEZAD). SEZAD was established as per the provision of the Royal Decree (RD) 119/2011 and subsequently RD 44/2014 redefined the land boundary. SEZAD is responsible for the management, regulation, and development of all economic activity in SEZD. With a land area of 1,745 km^2 and 80 km of coastline along the Arabian Sea, SEZD is the largest in the Middle East and North Africa region and ranks among the largest in the world.

Legislative Setting

A number of RD including RD 45/2014, place a number of unique powers to SEZAD including the power to issue environmental permits. Hence, SEZAD will be responsible for approval of this document and issue of Initial Environmental Permit. At the time of issue of this report SEZAD was yet to issue environmental regulations, guidelines and procedures; therefore, it was agreed with SEZAD that the methodology for this EIA would be in line with those issued by the Ministry of Environment and Climate Affairs (MECA) and international practices.

It should be noted that the DLBB Project entails the use of an offshore disposal area and offshore borrow area. These area lie beyond the SEZD boundary, and hence, MECA will be authority issuing permits for use of these areas. Legislations applicable to the Project are presented in Chapter 2.

Project Description

The present phase of the DLBB Project only involves developing a terminal along half the length of the current LBW (from the root of the LBW to half way towards the head of the LBW); the rest of the LBW is set aside for future development (see Figure 1, overleaf). It should be noted that the future development is excluded from the scope of the current EIA and the respective project proponent(s) will undertake the necessary project studies. The larger port operations including ship movement and navigation is being addressed in a separate operation phase EIA undertaken by PDC. It should also be noted that in addition to the activities and footprint within the port basin, the DLBB Project also encompasses activities and footprint at offshore borrow and disposal sites which have been addressed in this study.

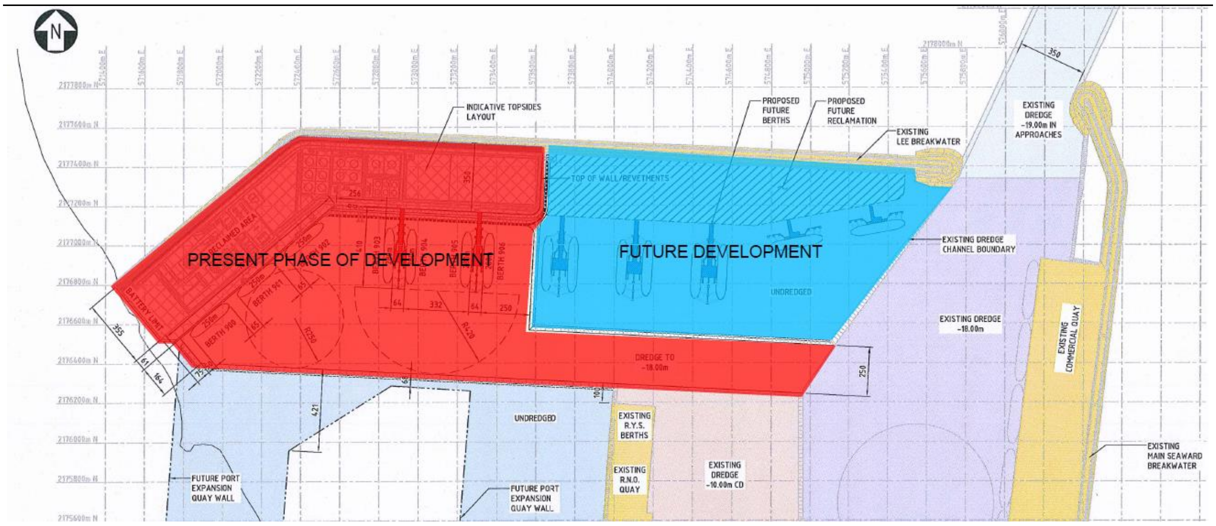

Figure 1: Sketch of Present and Future Developments

Salient features of the DLBB Project construction and operations, which are covered in this EIA, are:

- Dredging of the liquid bulk berth basin
- Reclamation to the south of the existing LBW including ground improvement and foundation to support equipment, buildings, tanks, pipeline, and other equipment (as required)
- Construction of the following berths:
    - Liquid product export berths (4 Nos)
    - Bulk solids export berth (1 No)
    - Spare berth (2 Nos)
- Installation of the following items on the berths:
    - Ship loading equipment
    - Pipelines
    - Tanks
    - Flare
    - Auxiliary equipment
    - Utilities
    - Equipment for control of loading and shipping operations
    - Access Road
- Housing up to 5,000 personnel in an existing construction camp for the peak construction

Associated facilities such as access roads, external pipelines, external drainage and power lines will be developed by third parties and will extend until the Project battery limit at the root of the LBW.

These facilities, though important for the construction and operation of the DLBB Project, have been excluded from the scope of this EIA. Separate EIA's for these ancillary facilities will be prepared by the respective third parties and submitted to the regulator for approval.

As part of the Project, a 150×350 m wide area will be reclaimed along the south of the LBW; and the area south of this reclamation area will be dredged to -18 m CD. As part of the DLBB Project, seven berths will be constructed. Table 1 presents a summary of berths.

Table 1: Summary of Berths

Berth	Use	Proposed Structure[a]
900	Dry Bulk Material Export Berth – Spare	Continuous Quay (Blockwork wall)
901	Dry Bulk Material Export Berth for Pet Coke and Sulphur	Continuous Quay (Blockwork wall)
902	Multi-purpose /Small Vessel Refined Product Export	Continuous Quay (Blockwork wall)
903 and 904	Liquid Refined Product Export Berth for Jet-A1 and Diesel	Double-sided Island Jetties (Concrete deck on steel piles)
905	Liquid Refined Product Export Berth for Naphtha and PLPG	Double-sided Island Jetties (Concrete deck on steel piles)
906	Liquid Refined Product Export Berth - Spare	Double-sided Island Jetties (Concrete deck on steel piles)

Note:

(a) The proposed structures listed are typical structures and the Contractors could modify the structures depending on field conditions

The operation of the terminal will consist of the following activities:

- Storing of Naphtha, Jet A-1 and Diesel in tanks at the terminal
- Loading of stored Naphtha, Jet A-1 and Diesel onto the vessels
- Loading HSFO and PLPG directly from the refinery onto the vessels
- Loading Diesel and Jet A-1 from storage tanks onto road trucks
- Loading of bulk Pet Coke and Sulphur onto the vessels

White products, i.e., Naphtha, Jet A-1 and Diesel will be pumped from the refinery to the Terminal Storage Tanks, through the pipeline network from refinery. Black products, i.e., HSFO and PLPG will be pumped from the refinery by pipeline directly to the ships – no storage facility will be built for the black products on the Project terminal. Duqm Refinery will be responsible for the construction and operation of the pipelines from the refinery to the terminal battery limit. The Pet Coke and Sulphur will be transported from the refinery to the terminal by trucks owned and operated by the Duqm Refinery. Table 2 presents the proposed storage at site.

Table 2: Tank Farm Capacity

Product	Type of Tank	No of Tanks	Tank Working Capacity (m^3)	Dimensions Di x H (m)	Tank Farm Capacity (m^3)
Naphtha	Floating Roof tanks with geodesic roof, Conical Base	2	41,500	41×35	83,000
		6	13,800	28×26	82,800
Jet A-1	Floating Roof tanks with geodesic roof, Conical Base	4	41,500	41×35	166,000
Diesel	Fixed Roof, Conical Base	6	41,500	40×35	249,000
HSFO(1)	Refinery by pipeline directly to vessels				
PLPG	Refinery by pipeline directly to vessels				
Pet Coke	In covered stockpiles (total storage 90,000 tons)				
Sulphur	In covered stockpiles (total storage of 60,000 tons)				
(1) HSFO export is anticipated to occur during the first 90 days after the initial Refinery start-up and then for short periods when the Delayed Coker Unit is shut down for maintenance					

Project Operation

Export of product from the facility will be in 4 modes as listed below:

- Loading of stored Naphtha, Jet A-1 and Diesel from the terminal onto vessels by loading arms
- Loading HSFO and PLPG pumped directly from the refinery by pipeline onto the vessels using loading arms
- Loading Diesel and Jet A-1 from storage tanks to road trucks
- Loading of bulk Pet Coke and Sulphur by conveyor system from storage on terminal onto the vessels

In addition to the tanks, storage sheds, pipelines, loading facilities, etc. the terminal will also house various control and admin structures. These are described in Table 3.

Table 3: Buildings at Site

Building	Comments
Admin Building/ Control Room/Amenities	• 3 storey RCC framed structure with blockwork infill • Plan area of about 1,200 m^2 in each floor i.e. 3600 m^2 • 50 users of admin building • 25 operators in control room
Parking area	• Open area, for admin building./control room • Additional parking facility in front of workshop (if required)

Building	Comments
	• Tarmac pavement will be provided
Substations / Local Equipment Room	• 2 storey, RCC structure • Number of substations 6 • Number of operators 10
Workshop	• Single floor • Steel framed structure • Number of users 20
Workshop	• Single floor • Steel framed structure • Number of users 20
Guard house	Guard House complex consisting of approach road, main gates, security gates, time office, speed breakers, traffic barriers and parking/waiting space – single storey building in protected air-conditioned environment
Warehouse	Warehouse for storage of miscellaneous material
Firewater Pump House	Pump house for storage of fire water

On arriving at the terminal, the vessels will undertake non-loading activities, such as manoeuvring, berthing, mobile loading arm hook-up/disconnect and administration and load their entire volumetric capacity of cargo. The responsibility for safe cargo handling operations is shared between the ship and the terminal and rests jointly with the Harbour Master and the Terminal Representative.

For quality assurance and safety reasons, simultaneous loading of two tanks with the same product will not be allowed. Therefore, filling the storage tanks from the refinery will be done in sequence, i.e., one tank at a time. Each tank is to be fitted with a High and Low level alarm and High-High level trip to close the tank inlet and send a signal/alarm to the Refinery to cease export. It should be noted that in order to avoid contamination each tank at the terminal will be dedicated to specific product.

The refinery will control the transfer pumps to the DLBB Project, whereas shut-off valves and emergency shutdown valves located at the DLBB Project will be controlled by DPTC. When a tank is filled, the refinery will be informed and the pumping to the tank will be stopped. The operator at the terminal will then make the next tank available for filling. The inlet valve will be closed to the filled tank and opened for the next tank. In the event that any of the tanks fill to its capacity an alarm will be raised at the DLBB Project control room and the refinery and closure of the emergency shutdown valve will initiate.

Pet Coke and Sulphur are delivered by road, by Duqm Refinery to covered storage facilities on the DLBB Project terminal. Pet Coke and Sulphur will not be loaded to vessels concurrently, but rather will be loaded in sequence. Loading of Pet Coke and Sulphur uses identical equipment and methods. Level control shut off will ensure that the hold will not overfill. The design of the equipment on the berth will be to contain potential spillage. Control of the system will be both local and remote, with the control centre being in communication with the local operator.

Table 4 presents a summary of resources consumed during the operation phase of the DLBB Project. Details on resource consumption during the operation phase are provided in Section 3.4.7.

Table 4: Summary of Resources Consumed During Operation Phase

Resource	Source
Fuel	• Marine refuelling managed by PDC • Land vehicles at the local fuel station • LPG for pilot flame through LPG cylinder (if any)
Power	From 300 MW power plant built by CUC
Water	Sea water intake and onsite RO plant
Chemicals	Licensed local suppliers

Table 5 presents a summary of important environmental releases expected during the operation phase. It should be noted that a complete list of releases are presented in Section 4.3.

Table 5: Summary of Important Operation Phase Environmental Releases

Release	Frequency of Release	Management
Fugitive emissions from storage tanks	Emissions of VOCs and Hazardous Air Pollutants (HAP)	BAT recommendations (Refer Section 5.5)
Pet Coke and Sulphur Dust during loading and unloading at DLBB Project terminal	Pet Coke and Sulphur particle	Covered storage, water spraying and use of covered conveyors
Emissions from emergency flaring	Occasional emission of CO_2, NO_X, SO_2, VOCs, and PM	Design of flare system and performance standards.
RO Rejects	Continuous discharge	Adequate dispersion as per MD 159/2005
Domestic wastewater	Continuous	The wastewater will be treated at site and reused for dust suppression.
Industrial wastewater from water spraying and cleaning	Intermittent	The wastewater will be treated at site and reused for dust suppression.
Clean runoff	Intermittent	Uncontaminated hence discharge to the environment through designated discharge
Domestic NHW	Intermittent	Collected and disposed in New Engineered landfill in Duqm. Attempt will be made to recover recyclables
HW	Intermittent	Will be sent to be'ah HW facility in Duqm Attempt will be made to recover recyclables
Noise	Intermittent	Compliance with MD 79/94 and MD 80/94
MARPOL Waste	Intermittent	Managed by PDC

Project Construction

The DLBB Project will have a 3 year construction period, extending between 2016 and 2019. In this period the dredging and reclamation will be the first activity completed between Q2 2016 and December 2018. After which the top-side facilities will be between Q1 2017 and Q1 2019. The construction contract will be divided into 3 Work Packages, which are:

- Work Package 1 – Dredging and Reclamation
- Work Package 2 – Marine Structures and Civil Works
- Work Package 3 – Topside Works

These three Work Packages will be awarded to two EPC Contractors – EPC1 (Marine side) and EPC2 (Topside). Work Package 1 will be included in the scope of the EPC1 Contractor, while Work Packages 2 and 3 will be included in the scope of the EPC2 Contractor.

Work Package 1

The liquid berths basin area is currently un-dredged, varying in elevation from approximately Chart Datum (CD) to the dredge level for the existing port at -18m CD. Figure 2 presents the area earmarked for dredging in the port basin.

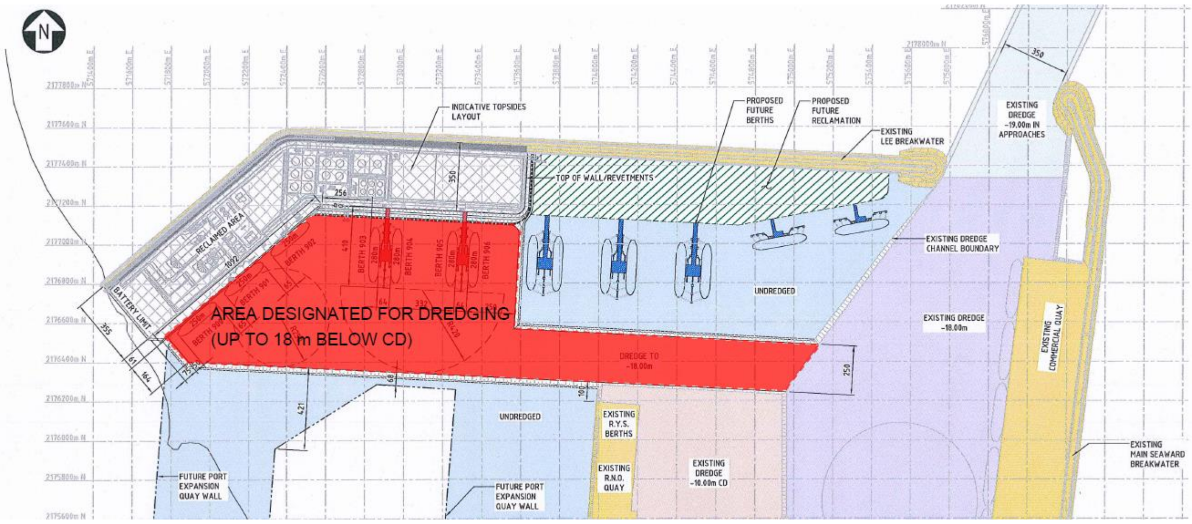

Figure 2: Sketch of Area Earmarked for Dredging in the Port Basin (Highlighted in Dark Red)

In all, the Project involves the dredging of about 27 million m^3 of soil from the port area and about 6.5 million m^3 of soil from the offshore borrow area.

In addition to the dredging, reclamation will need to be undertaken along the LBW for construction of tanks and other facilities along the LBW. Approximately 6.5 million m^3 of soil will be required to create 350 m wide reclamation along the LBW, which may be sourced from the offshore borrow area. Figure 3 presents the area earmarked for reclamation.

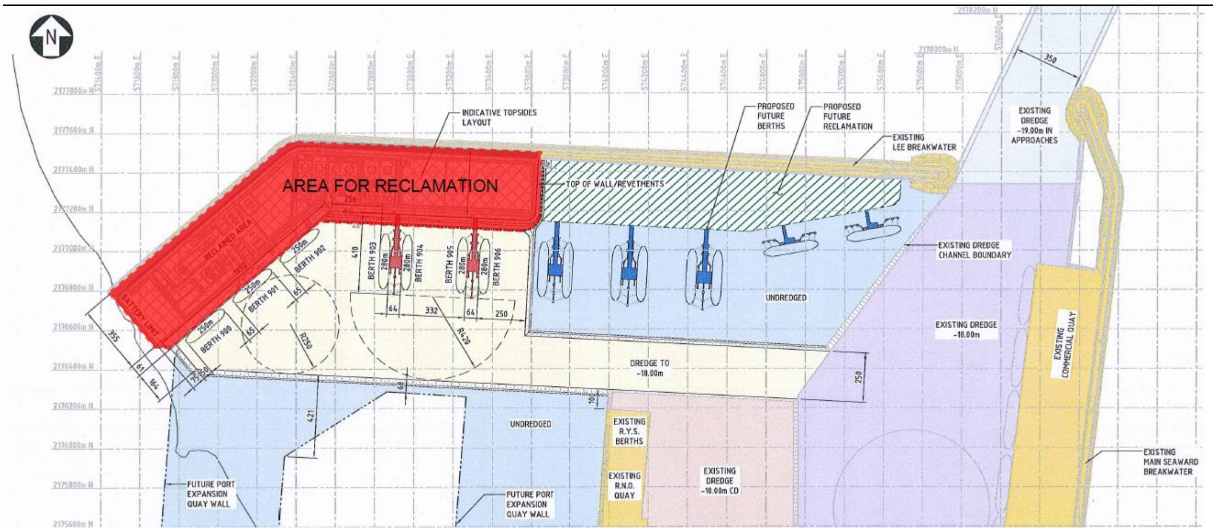

Figure 2: Sketch of Area Earmarked for Reclamation (Highlighted in Dark Red)

As mentioned above material for reclamation will be obtained from the offshore borrows area. The material dredged within the port is deemed unsuitable for reclamation and will be disposed offshore in an offshore disposal area. The dredging and reclamation are expected to extend for a period of 2.5 years. Table 6 presents the approximate volume of material for dredging and reclamation.

Table 6: Dredging and Reclamation Volume

Activity	Approximate Volume (million m^3)
Dredged in the basin	27
Material dredged from offshore borrow	6.5
Unsuitable material disposed offshore	27
Note: The volumes presented are preliminary and will be confirmed as the design progresses	

An overview of the dredging/borrowing and reclamation/disposal locations with respect to the Duqm Port is presented in Figure 3, overleaf.

It should be noted that the offshore borrow and disposal areas have been previously used for the development of the existing port.

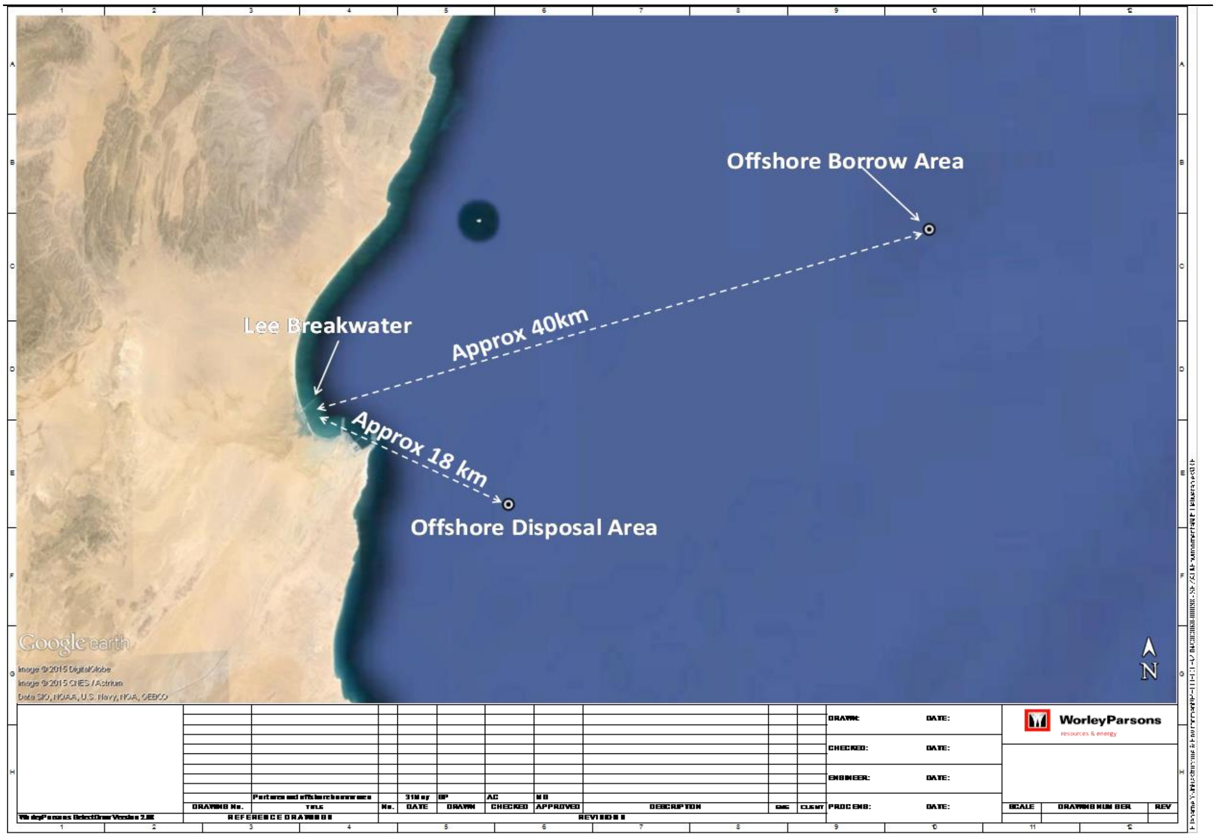

Figure 3: Offshore Borrow and Disposal Area

Work Package 2

As part of Work Package 2, seven berths will be constructed. Table 7 summarises details of the marine structures.

Table 7: Summary of Marine Structures

Berth	Expected Structure
900	Continuous Quay (Blockwork wall)
901	Continuous Quay (Blockwork wall)
902	Continuous Quay (Blockwork Wall)
903 and 904	Double-sided Island Jetties (Concrete deck on steel piles)
905 and 906	Double-sided Island Jetties (Concrete deck on steel piles)
Note: The Marine Structures will be finalised during the detailed design phase	

Berth 900 and 901 may be expected blockwork wall structures or other structure type which is suitable for a continuous quay. Details and information on typical blockwork wall construction is included herein although it is noted that the EPC Contractor may propose alternative structure types and construction methodologies to construct the continuous quay wall. They will be used as a spare berth, for bulk material loading and liquid product loading

Berths 903, 904, 905, and 906 will be constructed as a deck on steel piles. As the name suggests, the construction consists of installing steel piles, followed by laying a concrete deck on top of steel piles.

The method of piling proposed for the DLBB Project is rock socket piling, which involves drilling of a hole into which a pile is installed. It should be noted that the geotechnical investigations may permit other methods of installing piles such as driving the piles with a diesel (or similar) type hammer.

Work Package 3

At this stage of the DLBB Project detailed information on the construction methodology for the topside works was not available and a brief description has been provided. Construction of the topside is expected to include the following activities:

- Establishment of fencing and gates: All fencing and gates will be done in accordance with Project / Port of Duqm specifications
- Grading: The DLBB Project is located on the reclaimed area. The plot is developed with suitable soil fill material. The terrain is flat. Hence necessary site grading will be carried out by filling material as per the DLBB Project specification
- Piling: tanks and the buildings will be constructed on pile foundations. Hence extensive piling work is expected
- Construction of Roads: Asphalt roads will be provided within the terminal. Roads to and from the truck loading area will be designed for continuous heavy truck loads. Suitable drain system will be provided to collect the storm water from roads
- Construction of Superstructure: A variety of RCC and steel framed structures will be constructed at site
- Tanks Construction: will be constructed and installed using standard methodologies
- Laying Pipelines: various pipelines will be laid on the LBW to carry product to and from the tanks and to the vessels
- Non-Destructive Testing (NDT): will be undertaken to verify the integrity of the joints and seals hydrotesting and radioactive testing will be used for NDT

Construction Phase Land take

The construction phase of the DLBB Project will be associated with temporary land take around the Project area. It is estimated that 123,000 m^2 or 12.3 ha will be required during the construction phase for Work Packages 1 and 2. It is expected that a similar area of land will be required for Work Package 3. The land take for the DLBB Project will be within SEZD in an area demarcated by SEZAD and PDC. It is expected that during peak construction up to 5,000 staff will be employed at site.

Table 8, overleaf, presents a summary of resources consumed during the construction phase of the DLBB Project. Details on resource consumption during the construction phase are provided in Section 3.5.5.

Table 8: Summary of Resources Consumed During Construction Phase

Resource	Source
Fuel	• Marine refuelling in coordination with PDC • Land vehicles at the local fuel station or fuel storage at site
Power	Existing power plant in Duqm and diesel generators (DGs)
Water	Existing RO plant
Chemicals and material	Licensed local suppliers

Table 9 presents a summary of important environmental releases expected during the construction phase. It should be noted that a complete list of releases are presented in Section 4.3.

Table 9: Summary of Important Construction Phase Environmental Releases

Release	Frequency of Release	Management
Emissions from construction equipment vehicles and vessels	Intermittent release	Construction equipment and vehicles to be periodically maintained
Dust emissions from earthworks, vehicle movement, material stock piles and batching plant etc.	Intermittent emissions of PM	Water spraying may be used for suppressing dust. Preferably treated wastewater is to be used to supress dust
Industrial waste water from Hydro testing and washing/cleaning	Intermittent	Treatment and reuse
Domestic wastewater	Continuous	The wastewater will be treated at site and reused for dust suppression.
Potentially contaminated runoff from fuel storage area or chemical handling area	Intermittent	Collection in bunds followed by treatment and discharge
Clean runoff	Intermittent	Uncontaminated hence discharge to the environment through designated discharge
Domestic NHW	Intermittent	Collected and disposed in licensed landfill in Duqm. Attempt will be made to recover recyclables
HW	Intermittent	Initially stored at site, subsequently transferred to be'ah HW facility
Noise	Intermittent	Compliance with MD 79/94 and MD 80/94
Dredge material from port basin	During dredging operation	Offshore disposal

Project Interfaces

The DLBB Project has a number of interfaces as it is being developed as part of development of the Duqm Port which in turn is being developed as part of the SEZD. Table 10 presents a summary of key interfaces.

Table 10: Summary of Key Project Interfaces

Stakeholder	Primary Role	Primary Interface with DLBB Project
SEZAD	Development and regulation of the SEZD	• Financial commitment to the DLBB Project • Development of infrastructure in SEZD including Road No. 5 • Environmental Regulator for the DLBB Project • SEZAD will provide waste facilities for the operation phase
PDC	Developing the Port of Duqm and Regulating it	• Would manage MARPOL waste generated at the DLBB Project • Operation and regulation of the port • Managing ship movement in and around the port as well as the wider bay of Masirah
CUC	Provision of utilities to industries within the SEZD	• Establish flood control for the SEZD and train the wadi flowing to the north of the LBW • Construction of the power and desalination plant in SEZD • Developing the road for transport of Pet Coke and Sulphur from the refinery to the DLBB Project • Development of the utility corridor in which Duqm Refinery will lay and operate pipelines to transfer product from the Duqm Refinery to the DLBB Project
RAECO	Rural Areas Electricity Company	Laying power supply lines from the power generation plant to the DLBB Project terminal, designing and building main 33/11 kV substation at the beginning of the terminal facility and will subsequently supply power
Ministry of Environment and Climate Affairs	The environmental regulator for the areas outside SEZD	Permits for use of the offshore borrow and disposal area
Duqm Refinery & Petrochemical Industries Company LLC	Development of the Duqm Refinery	• The primary purpose of the DLBB Project is to provide facilities for export of the refined product from the Duqm Refinery. The DLBB Project will be linked to the refinery through a corridor built by CUC and operated and maintained by the Refinery. • The refinery will own the trucks used for transporting Pet Coke and Sulphur from the refinery to the terminal • The refinery will own the pipelines used to transfer refined products from the refinery to the terminal
Vessel owners	Transport of refined product from the DLBB Project	Loading of the refined product from the jetty to the vessels

Analysis of Alternatives

The IFC's Guidance Notes on Performance Standard on Environmental and Social Sustainability requires that 'the environmental and social impact assessment includes an examination of technically and financially feasible alternatives to the source of such impacts, and documentation of the rationale for selecting the particular course of action proposed'. In compliance with these requirements analysis of alternatives has been undertaken to document the major Project alternatives considered and the rationale behind their selection. Chapter5 presents the Analysis of Alternatives.

Environmental Baseline

The DLBB Project is located in the Al Wusta Region of the Sultanate of Oman. Al Wusta Governorate makes up 25.8 % of the land area of Oman, however only represents about 1 % of the population in the Sultanate with population density of 0.5 persons per square kilometre. The ecology in Al Wusta is diverse with many birds passing the Al Wusta region, and stopping over at Duqm coast for roosting and feeding, during their annual migration. On land, the climate, influenced by the annual autumn season in Dhofar, helps the growth of a variety of plants and rare mammals such as the Arabian Oryx and the Nubian Ibex. The waters off Al Wusta are home to marine cetaceans of conservation concern. The DLBB Project is a part of Port of Duqm, which in turn is a part of the Duqm Industrial Zone Master Plan. The Project is being developed on area earmarked for the terminal in the SEZD and Port master plan. Refer Chapter 6 for a detailed description of the environmental baseline.

Climate and Meteorology

The DLBB Project is located on the eastern coast of Oman and experiences average temperatures between 15.4 ºC and 40.8 ºC and sparse rainfall. The main weather systems that deliver rainfall to the region comprise:

- **Frontal systems:** originating in the Red Sea or Mediterranean Sea and occur late December to April. These are also known as the winter monsoons or *Shamal*. The winter monsoon is characterized by a relatively gentle and variable, dry northeast wind;
- **Cyclones:** Originating in the Arabian Sea during May, June and October-November, they are relatively infrequent, occurring once every 7 to 10 years; and
- **Summer Monsoon – '*Khareef*':** occurs annually between late June and September as wind, light drizzle and mists.

Analysis of the hind-cast wind data (CSFR) shows that winds are predominantly from the South-Southwest and Southwest directions. The maximum and average hourly wind speeds in the wind dataset under analysis are 21.2 m/s and 6.7 m/s, respectively. Winds from the north east, north-north east, south and west south west directions are also frequent but have lower wind speeds and percentages of occurrence compared to the prevailing south-south west winds. The hind-cast wind data also indicates that the most energetic winds occur during the summer months, peaking in June and July. Figure 4, overleaf, presents common occurring wind speeds/directions.

Earthquake and Tsunami

Oman is a part of the Arabian plate, which comprises the continent of Arabia as well as oceanic areas consisting of parts of the Red Sea, Arabian Sea, Gulf of Aden and Gulf of Oman. Along the north-eastern margin, the Arabian plate is in continental collision, which has given rise to the folded Zagros Mountains. The oceanic part of the Arabian plate is subducting along the Makran Trench. The destructive plate-margin of the Arabian plate along the Zagros and Makran is marked by intense earthquake activity. As the Arabian plate moves north-eastwards, parts of the plates are differentially deformed and periodic release of such stress accumulations causes earthquakes within the plate. The south of Oman has very low seismic activities. In contrast, the northern portion of Oman has a moderate to high seismic activity. The Middle East Seismic Hazard Map prepared by the Global Seismic Hazard Assessment Program (GSHAP) indicates a Low seismic hazard in the Project area.

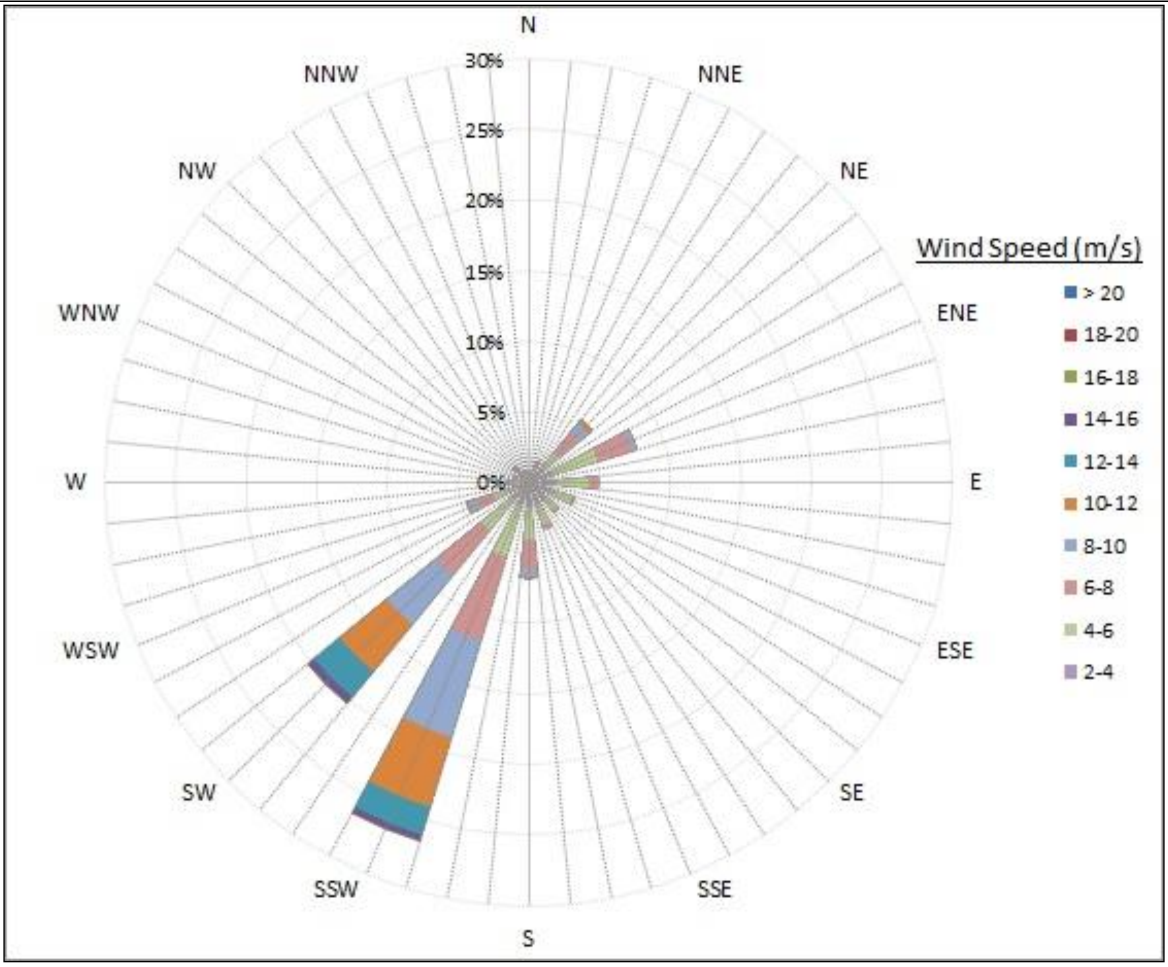

Figure 4: Annual Wind Rose (CFSR at WAVEWATCH Node 52567, 1979-2009)

Based on recorded earthquakes and tsunami events, the risk of a large tsunami reaching the DLBB Project site is considered medium to small since the site is relatively sheltered from the main tsunami generating areas, i.e., the Makran and the Sumatran subduction zones.

Topography

The DLBB Project is located in the Port of Duqm on the eastern coast of Oman approximately 7 km to the east of the Say village (also known as Al Duqm). The project involves development of the LBW, though reclamation of about 2.5 km of land along the LBW (reclaimed area 860,000 m^2). The area immediately around the root of the LBW is *sabkha* (salt flats). The *sabkha* comprised of several infra-littoral mud areas, intertidal sand and mud habitats, tidal and non- tidal lagoons, vegetated and non-vegetated dunes, and supra-littoral sand bars. These sand bars were broken through in areas, more so within the Port area than north of the LBW, with tidal inlets leading to tidal lagoons. North of the LBW are a series of non-tidal lagoons (otherwise known as '*khawrs*'), whereby the water has seeped underground to produce highly saline lagoons. The lagoons were then surrounded by a variation of sand and mudflats. On the whole the site topography is generally low lying and very flat, with the nearshore area fronting the port generally between 1 and 2 m above MSL.

Figure 5 presents a sketch of existing and future features around the Project area.

Figure 5: Sketch of Existing and Future Features

Landscape and Visual Amenity

The area around root of the LBW is a large salt flat, making the LBW visible from Highway #32, which passes through Say village. It should be noted that SEZAD has earmarked the salt flats between the LBW and Highway #32 for development into an industrial zone. Plastic and other litter is spread across the area near the root of the LBW. This litter is a result of wadis flow carrying waste from its catchment and depositing around the project site. Other sources of litter are fishermen operating in the area and locals using the LBW for recreational fishing.

Geology

The DLBB Project lies in the Huqf area and contains the best outcrop of the Al Khlata reservoir, a huge but massively complex formation that serves fields including Marmul and Nimr which form the bedrock of Petroleum Development Oman's production in south Oman.

Soil Quality

In most of Oman the effective rainfall is very limited and soils are very dry most of the time. Soil formation is therefore very slow and weak. The General Soil Map prepared by the Ministry of Agriculture and Fisheries and Food and Agriculture Organisation of the United Nations identifies the DLBB Project area is mostly composed of tidal flats, with poor soil unsuitable for agriculture. Past analysis of soil in the region has found no evidence of hydrocarbon contamination without any evidence of industrial contamination.

Hydrology

The DLBB Project lies within the Huqf hydrologic area. In the Al Wusta region groundwater discharge is in the dune fields of Ar Rub al Khali in the west and Huqf in the east, where highly fractured pre-Tertiary basement outcrops borders the Arabian Sea. The main regional aquifer in the area is the Umm ar Raduma (UAR) formation. Groundwater in the area is saline and unfit for human consumption.

Ambient Air Quality

Ambient air quality studies undertaken for the region found that parameters are within the United States Environment Protection Agency (USEPA) National Ambient Air Quality Standards (NAAQS), excluding O_3 at one location, where the ozone level is marginally above the USEPA NAAQS limit. Measurements of dust in the area also showed compliance with the USEPA NAAQS.

Noise

A review of noise levels in the study area found levels to be within the limit prescribed in MD 79/94 for industrial areas.

Terrestrial Ecology

The Duqm region is important from the perspective of biological diversity which needs to be conserved for its productivity, regulation of climate and ecosystem services. The flora in the study area is dominated by halophyte plant community. However this was limited to a few patches. The flora in the study area is not rare or endemic to the region.

Duqm plays a vital role for migratory and wintering shorebirds in Oman along the East-African – Central Asian Migratory Flyway and the Ghubbat Quwayrat bay (i.e., Port of Duqm site) at Duqm is designated as an Important Bird Area (IBA) by Birdlife International due to the presence of overwintering and passage waterfowl. Essentially all the birds at Duqm are migratory. The importance of Duqm as well as Bar Al Hikman to the north and Khawr Ghawi to the south lies in their value as stop-over sites during spring and autumn migration as well as wintering grounds.

The terrestrial faunal elements in the study area were not observed directly at the time of site survey but indirect observation of their pugmarks, dropping, and burrows indicated presence in the study and were listed as Least Concern by IUCN. Refer Section6.16.

Marine Baseline

No protected areas are located in close proximity to the Project Area. The closest protected area, Ras Madrakah, is located 70 km to the southeast followed by Barr al Hikman located 90 km to the northeast and Masirah Island 100 km in the same direction. All other marine protected areas are located over 300 km from the proposed Project

Aside from the visible presence of the Port's infrastructure there is further evidence of the effects of the Port. Nearshore depths were greater inside the shipping channel due to dredging work undertaken to accommodate vessel drafts. Dissolved oxygen levels were reduced in the bottom layers of the Port and this influence has spread to bottom waters outside of the Port and close to the mouth. Turbidity levels were elevated inside the Port and remained high in the nearshore areas adjacent to the Port. Chemical water quality was good throughout the study area, with only very minor exceedances of some adopted guideline values for copper and zinc outside of the Port

The majority of the benthic habitat within the Port was found to be unconsolidated sediments of fine sand with no epifauna or flora cover. Outside the Port, the benthic habitat was homogenous unconsolidated sand with no epifauna or flora. The disposal area revealed evidence of past disposal with rock rubble visible with fine sand sediment.

The DLBB Project area is also known to support marine species that are rare and of international importance and value. Of particular note is the presence of numerous cetacean species. The resident humpback whale population is of great significance as this is a unique population of small numbers and is of very high international importance. As noted above, this population is listed as 'Endangered' by International Union for Conservation of Nature and Natural Resources (IUCN) and is known to be one of the rarest baleen whale populations in the world.

Turtles have been shown to nest and feed on the coastline to the north of the Port, and certain cetacean and turtle species are known to transit through waters offshore from the Port, on route to breeding and feeding grounds in the region. However, these species are not known to concentrate in the nearshore area that the Project will operate in.

Socio Economic

The DLBB Project is located on the LBW within Duqm Port and the nearest inhabited village is the Say village located on the banks of Wadi Say. The name Say village is often used in synonym with Duqm Town and is the administrative headquarters of Duqm Wilayat.

Majority of the population within the Al Wusta region lives in the coastal zone in small towns or villages. The Governorate is divided into four Wilayats, viz., Mahout, Al Jazer, Duqm and Haima (in the order of the population number). Traditionally, during the monsoon season, when the coastal area along Duqm is too rough for fishing, the local populace migrates to villages south of the mountain ranges, mainly in the Adam, Sinaw and Mudhaibi areas. There they live in palm-frond shelters (*rishah*) and stay there for the date harvest. Many have invested in date palms and collect their crops for storage to supply their families and livestock through the upcoming winter. Locals also derive income from livestock growing (goats, sheep and camels) and by working in government and the private sector. Some families receive financial support from the Ministry of Social Development.

The local people rely heavily on fishing for its income. However, a number of Government-planned initiatives for industrial and tourism developments in Al Wusta are expected to supplant the traditional reliance on agriculture and fisheries.

The development of the DLBB Project is a part of the Duqm Port development and the larger SEZD development of Duqm. As part of the DLBB Project there will be no relocation or displacement of the local population, however it is understood that access of locals to the DLBB Project area will be restricted as consequence of operations of the Duqm Port and hence the DLBB Project. Additionally the local community could be impacted as a result of influx of migrant labour and accidents.

During constructive discussion in Wali office, many representatives of institutions as well as community members, raised questions about the storage tanks safety and firefighting measures, types of liquid and bulk materials to be handled, whether risk assessment was conducted for the

DLBB Project, whether H_2S gas will be generated in this facility, environmental study of the projects, type of contractors to be mobilized for DLBB Project and employment opportunities, materials to be processed in refinery and how they will be transferred to vessels. Participants highlighted previous (smaller) projects when they were not consulted in advance but could have provided good advice. Overall response was positive and participants were pleased that these consultations were carried out to inform them about the upcoming project. A summary of the discussion with institutions are presented below:

- Institutions see the upcoming developments in Duqm as highly positive for overall economic and social development in Duqm
- They expect / require from companies coming to the SEZD to provide job opportunities for people of Duqm in the long term and more contracts to be awarded to Duqm companies. These requirements were imposed to authorities in Duqm already by local population.
- They expect / require more information about the upcoming developments, promotion of industry requirements in order to plan education curricula for young generation to match the local professional requirements. This should involve education authorities
- Participants expect development and upgrade of all city facilities, infrastructure, utilities and services
- The challenge of the development will be not to impact environmental quality and to protect the fish wealth and fish stock
- By law, SEZAD is going to take over all municipal competencies in Duqm. Municipality will help during hand over and will remain in charge for municipal area out of Duqm
- Fishing and animal growth has been impacted since construction of port started (last seven years). Fishery people are upset by frequent change of available location for fish landings on the coast
- It is expected that government will compensate for the loss of grazing land to the affected population and that vulnerable families will be supported
- The institutions are concerned about overall safety once the massive expat labour force moves in. To prepare for this, the Royal Omani Police (ROP) is going to move into new office. Safety wise, the ROP requires companies to organize induction programs for expats about living in the interior of Oman and about local culture and customs, and to prevent interference to local culture, etc.
- No complaints were recorded on environmental quality in Duqm
- Institutions have neither specific expectations nor potential conflicting issues from DLBB Project. Overall expectations and some recorded issues are related to the whole development in SEZD.
- The opinion about the overall development in Duqm is positive and the projects are very welcome, and

- be'ah did not express any expectations from this particular Project related to the waste management (industrial or communal) nor has identified any advantages / issues/challenges in this context that might result from the upcoming development.

Archaeology

As the DLBB Project will be established on reclaimed/backfilled land within the existing port it is unlikely the DLBB Project will interact with any archaeological resources. However, should any archaeological resources be identified during the construction phase, the same will be reported to SEZAD and the Ministry of Heritage and Culture.

Impact Assessment

Impacts have been assessed as planned and unplanned impacts. Planned environmental impacts are those which result from routine operation and maintenance, while unplanned are those which will result from accidents or non-routine operation and maintenance. Planned impacts have been rated considering the duration of the impact, the area of influence and the intensity of the impact, while unplanned impact have been assessed considering their likelihood and severity. Section 7.2 discusses the methodology used to assess planned and unplanned impacts. The tables below summarises planned and unplanned impacts during construction and operation phase of the Project.

Table 11: Summary of Planned Impacts – Construction Phase

Impact to	Area of Influence	Duration	Intensity	Significance
Soil quality from land take and earthworks	Local Spread	Long term	Low	Medium Impact
Hydrology from Storm water runoff and waste management	Local Spread	Short to Medium term	Low	Slight to Low Impact
Terrestrial ecology from land take and light and noise	Local Spread	Medium to Long term	Moderate	Medium Impact
Air quality from combustion emissions and dust	Local to Moderate Spread	Short to Medium term	Low	Low to Medium Impact
Ambient noise level from construction activity	Local Spread	Medium Term	Low	Low Impact
Soil quality from waste management	Local Spread	Medium Term	Low	Low Impact
Marine ecology from marine construction	Moderate Spread	Medium Term	High	Medium Impact
Marine water quality from marine construction	Moderate Spread	Medium Term	High	Medium Impact
Socio-economical from DLBB Project construction	Moderate Spread	Medium Term	Moderate	Medium Impact

Table 12: Summary of Unplanned Impacts – Construction Phase

Impact from Accidental	Likelihood	Severity	Significance
Release of hydro test water	Unlikely	Localised	Medium Impact

Spill of chemical – fuel during transport	Unlikely	Major	Medium Impact
Spill of chemical – fuel on land	Unlikely	Major	Medium Impact
Spill during marine refuelling	Unlikely	Major	Medium Impact

Table 13: Summary of Planned Impacts – Operation Phase

Impact to	Area of Influence	Duration	Intensity	Significance
Land use from land take	Local Spread	Long term	Low	Medium Impact
Air quality from VOC emissions, fugitive dust and combustion emissions	Local to Moderate Spread	Short to Long term	Low	Low to Medium Impact
Ambient noise from operation	Local Spread	Long Term	Low	Medium Impact
Soil quality from waste management	Local Spread	Long Term	Low	Medium
Terrestrial ecology from light and noise	Local Spread	Long Term	Moderate	Medium Impact
Marine ecology from operation	Local Spread	Long Term	Low Intensity	Medium Impact
Marine water quality from operation	Local Spread	Short Term	Low Intensity	Medium Impact
Socio-economic	Overall positive impact			

Table 14: Summary of Unplanned Impacts – Operation Phase

Impact from Accidental	Likelihood	Severity	Significance
Leak from tanks	Unlikely	Major	Medium Impact
Spill of Pet Coke and Sulphur	Unlikely	Minor	Medium Impact
Oil spill	Modelling is ongoing hence assessment could not be completed		

Detailed discussion on the impact assessment is presented in Chapter 7, additionally discussion on impacts from associated developments is presented in this section.

Environmental Management Plan

The environmental management plan presents mitigation measures ensure that negative impacts are reduced to ALARP, and meet relevant Omani national laws and regulations, and internationally acceptable standards. Chapter 8 details the purpose and scope of the EMP, the process adopted and its organisation, the mitigation measures for each phase and the scope of the supporting monitoring and management plans. EPC Contractors are responsible for the preparation of detailed site specific management plans, prior to outset of any activities. All plans shall be approved by DPTC.

Climate Affairs

The GHG emissions from the DLBB Project will be reported to the regulator during the construction and operation phases. It should be noted that during the construction phase the major source of GHG emissions will be attributed to the movement and operation of the various construction equipment, while during the operation phase the major source of GHG emissions will be from the operation of the emergency flare. Being a coastal project the DLBB Project is in particular vulnerable to sea-level rise and in order to mitigate this, a sea level rise (SLR) of 5 mm/y is applied to the DLBB Project. This equates to an allowance of 0.25 m over a 50 year design life.

Conclusion

The Project area is surrounded by wetland area/*sabkha*. The nearest inhabited village is the Say village located about 5.5 km south west, with a fish landing area located 4 km north. The predominant wind direction is towards north east away from these population centres. The social baseline survey conducted as part of this EIA study indicated that the local population supports the ongoing developments in Duqm and is looking for an improvement in their quality of life as result of the developments. The terrestrial and coastal environments around the DLBB Project are sensitive on account of the terrestrial area adjoining the DLBB Project being designated an IBA and the presence of the Arabian Sea Humpback Whale which is endemic to the region and endangered. It should be, however, noted that the study area on the whole is undergoing major development as part of the SEZD development and all stakeholders will contribute to environmental impact in the region.

The impacts from the DLBB Project have been rated from slight to medium significance and through the implementation of mitigation measured the impact is considered to be ALARP, supporting the case for the development of the Project.

Abbreviations and Definitions

ANZECC	Australian and New Zealand Environment Conservation Council
BAT	Best Available Technique
BPD	Barrels Per Day
BREF	BAT Reference Document
BS	British Standard
CD	Chart Datum
CSD	Cutter Suction Dredger
CSR	Corporate Social Responsibility
CUC	Centralized Utilities Company LLC
DCU	Delayed Coker Unit
DG	DGs
DIVSR	Dutch Intervention Values for Soil Remediation
DO	Dissolved Oxygen
DPTC	Duqm Petroleum Terminal Company LLC
DWT	Deadweight Tonnage
ECOLEX	Information Service on Environmental Law
EHS	Environment Health and Safety
EIA	Environmental Impact Assessment
EIPPCB	European IPPC Bureau
EMP	Environmental Management Plan
EPC	Engineering Procurement and Construction
ESDV	Emergency Shutdown Valve
FAO	Food and Agriculture Organisation
FEED	Front End Engineering Design
GHG	Green House Gas
HPD	Hearing Protection Devices
HSEMS	Health, Safety, and Environmental Management System
HSFO	High Sulphur Fuel Oil

HW	Hazardous Waste
IBA	Important Bird Area
IFC	International Finance Corporation
IMO	International Maritime Organisation
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
LBW	Lee Breakwater
LPG	Liquefied Petroleum Gas
MARPOL	Marine Pollution
MD	Ministerial Decisions
MECA	Ministry of Environment and Climate Affairs
MSDS	Material Safety Data Sheets
MW	Mega Watt
NAAQS	National Ambient Air Quality Standards
NGO	Non-Governmental Organization
NHW	Non Hazardous Waste
O&M	Operation and Maintenance
ODC	Oman Dry Dock
ODS	Ozone Depleting Substance
OOC	Oman Oil Company
PDC	Port of Duqm
PM	Particulate Matter
PMC	Project Management Consultant
PPE	Personal Protection Equipment
PRG	Preliminary Remediation Goals
RD	Royal Decree
RO	Reverse Osmosis
ROP	Royal Oman Police
ROPME	Regional Organisation for the Protection of the Marine Environment

SEZAD	Special Economic Zone Authority Duqm is the authority designated by RD119/2001 responsible for the management, regulation, and development of all economic activity in the SEZD.
SEZD	Special Economic Zone at Duqm represents the land area demarcated in Royal Decree (RD) 119/2011 and subsequently RD 44/2014
STP	Sewage Treatment Plant
TSHD	Trailer Suction Hopper Dredger
TSP	Total Suspended Particulates
ULCC	Ultra-Large Crude Carriers
UNEP	United Nations Environment Program
USEPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VOC	Volatile Organic Compounds
WorleyParsons	WorleyParsons Oman Engineering LLC

1 INTRODUCTION

1.1 Overview

Duqm Petroleum Terminal Company LLC (DPTC), a joint venture company between Oman Oil Company (OOC) and the Port of Duqm Co. (PDC), has been established to develop and operate the Duqm Liquid Bulk Berths (DLBB Project) Project terminal, in the Duqm Port. WorleyParsons has been retained by DPTC for the Consultancy Services for Project Definition, Front End Engineering Design (FEED) and Supervision of the New Liquid Bulk Berths in the Port of Duqm. The DLBB Project involves development of storage tanks and sheds for bulk liquid and solid products from Duqm Refinery, along with associated facilities, utilities, and jetties and berths for export of the refinery products. The products handled are Naphtha, Jet-A1, Diesel, High Sulphur Fuel Oil (HSFO), Pressurised Liquefied Petroleum Gas (PLPG), Pet Coke and Sulphur. Table 1-1 summarises the products use.

Table 1-1: Product Use

Product	Use
Jet-A1	A type of aviation fuel designed for use in aircraft by gas turbine engines
Naphtha	low-octane gasoline product used as a feedstock be the chemicals industry, as a feedstock for catalytic reforming and in the production of hydrogen
Diesel	A commonly used fuel product used in automotive and rail road industries
HSFO	These are used in large industrial boilers, in power stations, e.g.,, and to raise steam to drive turbines on ships
PLPG	Pressurised Liquefied Petroleum Gas, consisting primarily of propane and butane, is used as a fuel and as an intermediate in manufacturing petrochemicals
Pet Coke	After gasoline, jet fuel and lubricating oils are manufactured from crude oil, the remaining material goes through additional processing called coking. It is understood the refinery will be producing green Pet Coke meaning unprocessed material which will need to undergo additional processing prior to use. The end product can be used as a fuel or as anodes depending on metal content.
Sulphur	Sulphur is a relatively cheap commodity, which is used in the manufacture of fertilizer

1.2 Project Setting

DLBB Project is located in the Al Wusta Region of the Sultanate of Oman. The Al Wusta Governorate is located to the south of the Governorate of A'Dakhiliyah and A'Dhahirah Governorate. It is flanked on the east by the Arabian Sea, on the west by The Empty Quarter, and on the south by Dhofar Governorate. Al Wusta comprises of four Wilayats, viz., Ad-Duqm, Mahout, Al-Jazer and Haima. The Project is located within the Ad-Duqm Wilayat. Al Wusta Governorate makes up 25.8 % of the land area of Oman, however only represents about 1% of the population in the Sultanate with population density of 0.5 persons/km^2. The ecology in Al Wusta is diverse with many birds passing the Al Wusta region during their annual migration. On land, the climate, influenced by the annual autumn season in Dhofar, helps the growth of a variety of plants and rare mammals such as the Arabian Oryx and the Nubian Ibex. The waters off Al Wusta are home to marine cetaceans of conservation concern. Figure 1-1 on pg. 46 presents the Location Map.

The Special Economic Zone Authority Duqm (SEZAD) was established as per the provision of the Royal Decree (RD) 119/2011 and subsequently RD 44/2014 redefined the land boundary. SEZAD is responsible for the management, regulation, and development of all economic activity in the Special Economic Zone at Duqm (SEZD). With a land area of 1,745 km^2 and 80 km of coastline along the Arabian Sea, the SEZD is the largest in the Middle East and North Africa region and ranks among the largest in the world. Figure 1-2 on pg. 47 demarcates the SEZD as defined in RD 44/2014.

The SEZD is composed of zones, which are:

- Port of Duqm
- Industrial Area
- New Town
- Fishing Harbour
- Logistic Centre
- Tourist zone
- Education and Training Zone

Figure 1-3 on pg. 48 presents the master plan for the SEZD. All these zones are supported by a multimodal transport system that connects it with nearby regions (e.g., the Arabian Gulf countries, Middle East, East Africa and Southeast Asia). These zones are described further below.

1.2.1 Port of Duqm

PDC manages the Port of Duqm. PDC is a 50:50 joint venture between the Omani Government and the Consortium Antwerp Port. PDC is responsible for the development of the port and overseeing its operation (Refer Figure 1-3 and Figure 1-4 pp. 48 and 49). Additionally, PDC is responsible navigation within and around the Port, as well as the wider bay of Masirah.

The first phase of the port handles containers, general, and bulk cargo. The inner basin is 18 m deep and has commercial quay (2.25 km by 350 m) which can accommodate 8 vessels or more vessel (dependent on the size). Moreover, a 1 km Government quay is also present, which will accommodate the Royal Navy, Coast Guard, and potentially Oman's fast ferries. The bunker terminal for the storage of diesel, gasoil, fuel oil and military naval fuels is developed by Oman Oil Marketing Company SAOG, located on the commercial quay is a part of the first phase of the port.

The Oman Dry Dock Company (ODC) also operates within the port. The ODC operates two docks that are 10 m deep, one of which is 410 m × 95 m and the other is 410 m × 80 m, Furthermore there is a 2.8 km of quays available for additional ships to be repaired. Depending on the size up to ten ships can be repaired at the same time, including largest tankers in the world such as ultra-large crude carriers (ULCCs) at capacities up to 600,000 dead weight tonnage (DWT).

The DPTC is located on the Lee Breakwater (LBW) of the Port and represents the second phase of the port development.

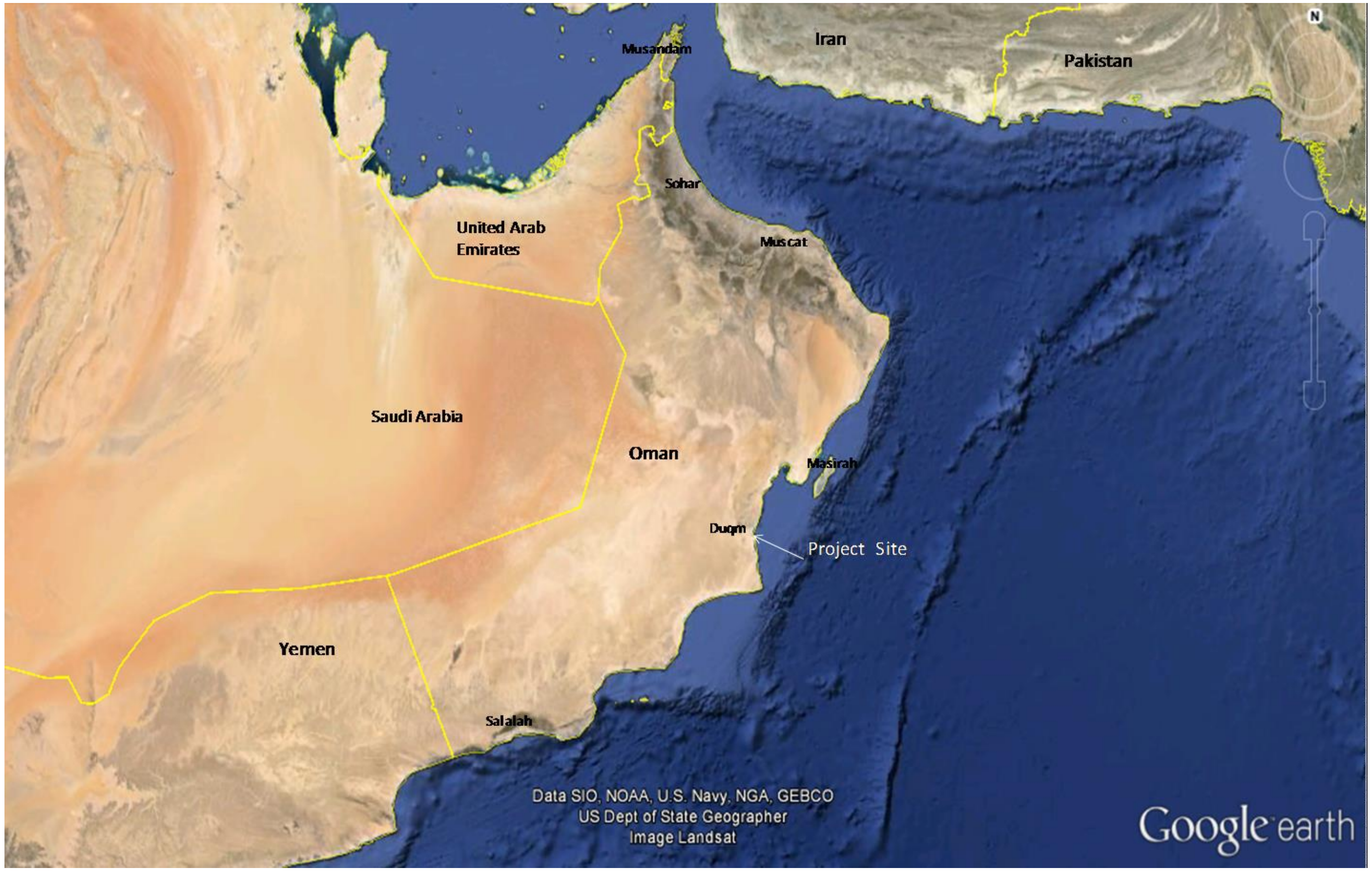

Figure 1-1: DLBB Project Location Map

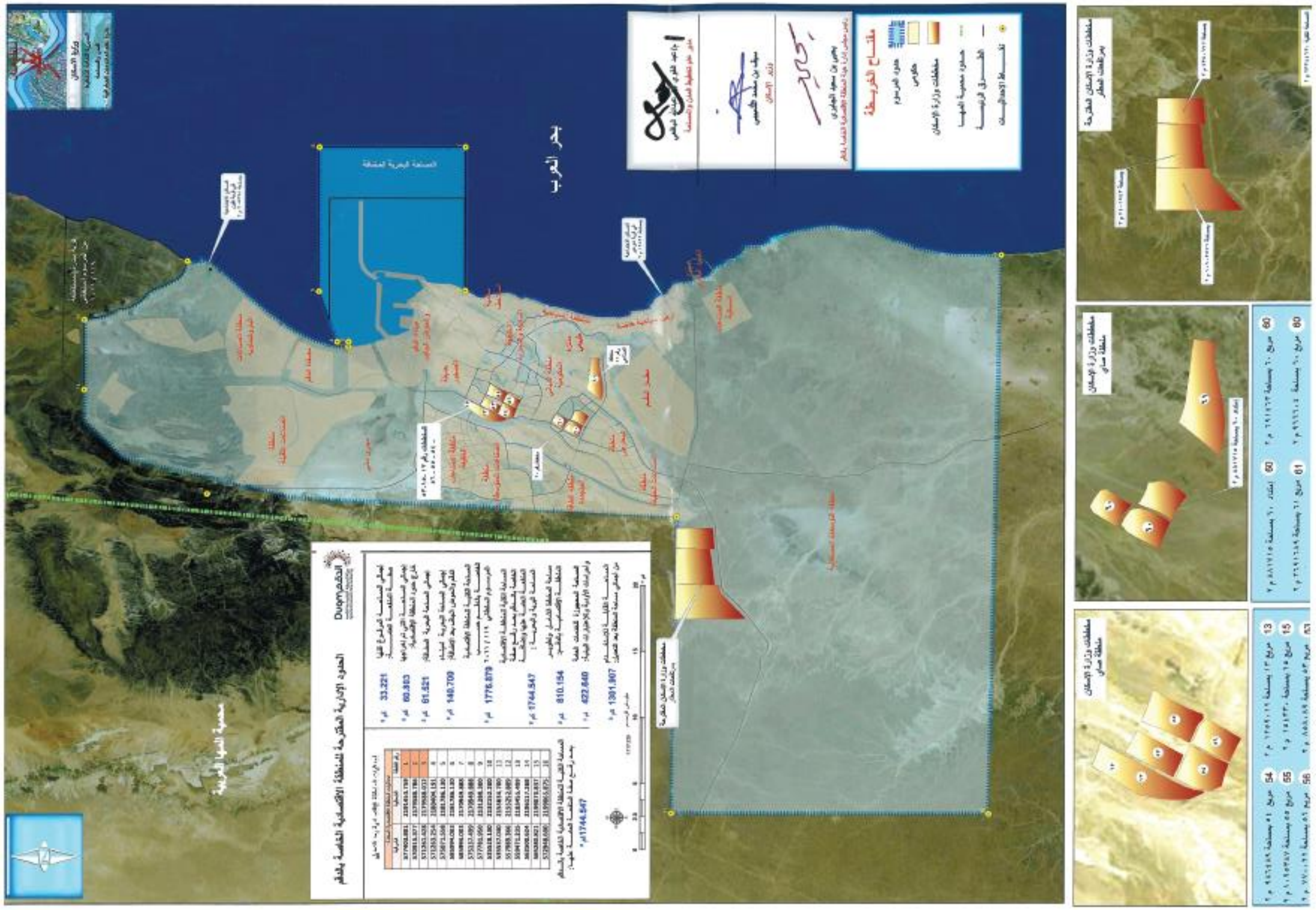

Figure 1-2: SEZD as defined by RD 44/2014

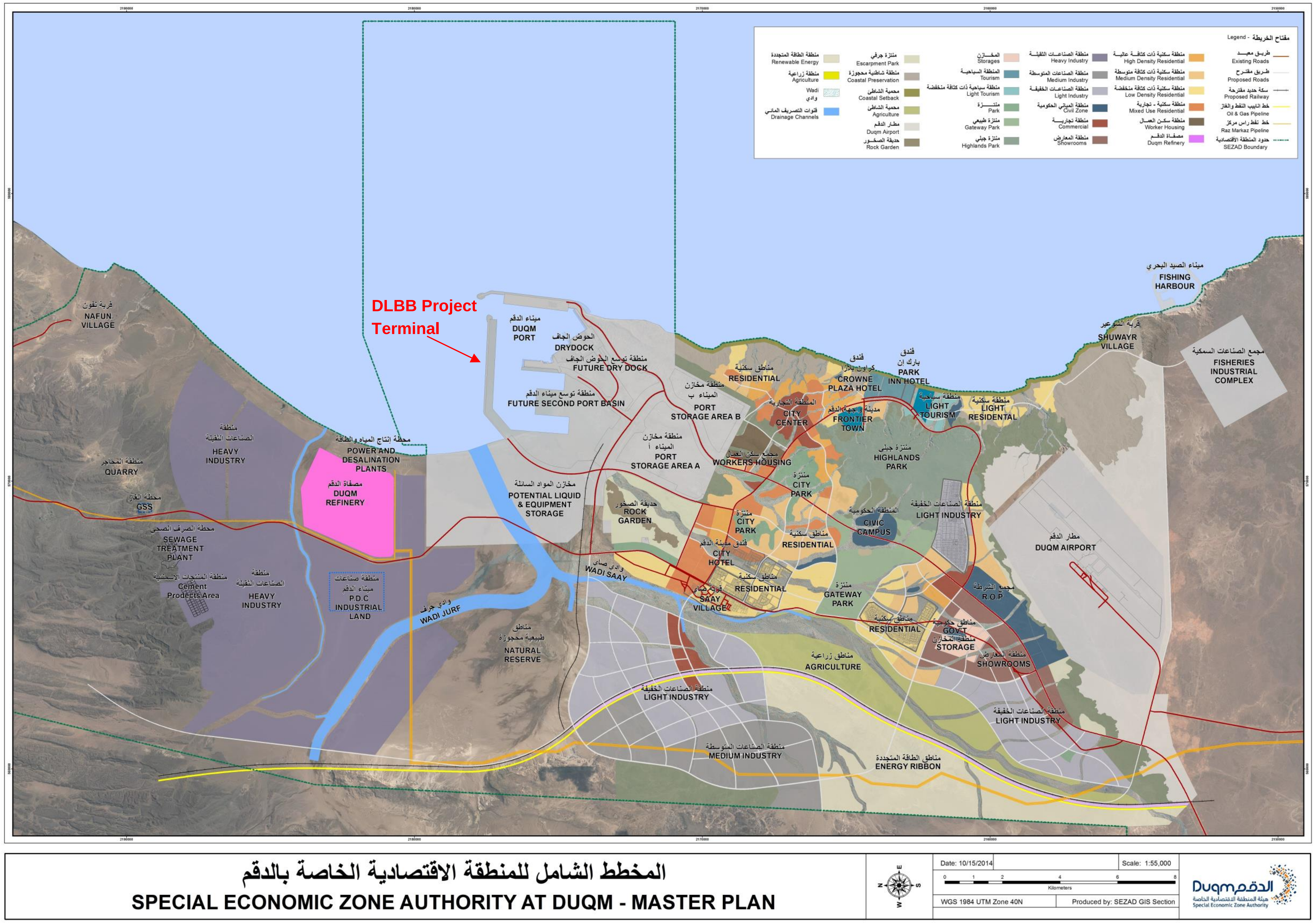

Figure 1-3: The DLBB Project relative to the SEZD Master Plan

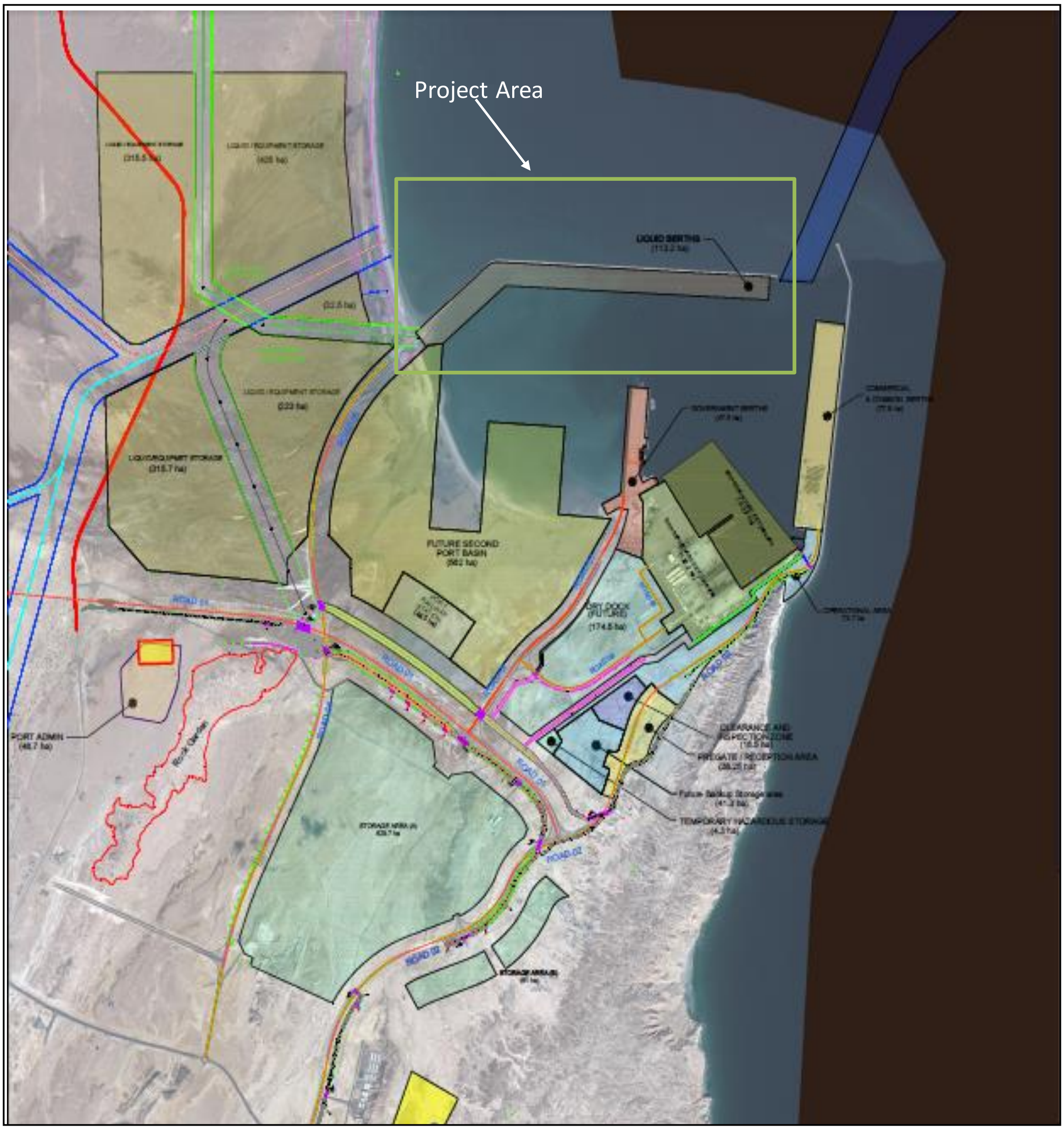

Figure 1-4: Duqm Port Master Plan showing the DLBB Project Area

1.2.2 Industrial Area

A comprehensive 365 km^2 have been allocated for industrial and logistics use, which will be near the port, main roads, airport, and future railway. The industrial strategy prepared for the industrial area targets petrochemicals, building materials, minerals and inorganic chemicals, fishery and aquaculture, food manufacturing, clean technologies, life sciences and allied businesses.

The Duqm Refinery is at the heart of the industrial area oil refinery with a potential capacity of 230,000 bbl per day (bpd). The refinery will export product through the DLBB Project. Cured oil for the refinery will be transferred by pipeline from the Oman Tank Terminal Company LLC (OTTCO) at Ras Markaz approximately 70 km to the south of Duqm. The proposed OTTCO facility will have a storage capacity of 200 million bbl of crude oil.

1.2.3 New Town

An area of 23 km^2 has been designated in the master plan for the new frontier town at SEZD. This will be the backbone of the development area and initially it is proposed that it will accommodate up to 67,000 people with further provisions to extend it to 110,000 residents. It is planned that the new town of SEZD will be a sustainable community a model of contemporary urban planning with due consideration given to Omani culture and the local environment and will catalyse the envisioned urbanization and commercialization of the Wusta governorate

A variety of indoor and outdoor sport facilities and a youth stadium are proposed in and around SEZD. The proposed town centre will boast a regional hospital, a business district, administrative offices parks and a public library, as well as malls and other high profile facilities, and social amenities.

1.2.4 Fishing Harbour

The Arabian Sea is rich with fisheries resources which include different varieties of fish in addition to favourite Omani crustaceans’ species, all of which are in great demand in neighbouring countries as well as Europe. Efforts are made to exploit this lucrative comparative advantage of Duqm’s traditional affinity to fishing activities and developing an integrated cluster fishery based activities in the fishing northern part of SEZD. This will encompass

a. A fishing harbour at 6 m water depth with all facilities required to accommodate small and medium size fishing boats

b. Retail, wholesale and export markets

c. Allocating enough land area to house fish processing, canning, fish oil and animal feed industries

d. Fish and shrimp farming

e. A marine research centre and training centre

f. An international standards quality assurance centre for fresh and processed fish export

1.2.5 Logistic Centre

A state-of-the-art airport, busy commercial seaport and world-class infrastructure, combined with SEZD’s strategic location on a busy, East-West trade route, create unique logistical warehousing, distribution and re-export business opportunity.

The master plan of SEZD provides for qualifying the zone as, multi model transportation hub which includes land, air, sea and future railway transportation network to connect Duqm with the rest of Oman as well as the other Gulf Cooperation Countries, and the world at large. The government of Oman is in the process of finalizing the natural rail way master plan which will connect in its first phase UAE with the capital city Muscat and extend the connection to Duqm and Salalah in second phase. The construction of two main roads is complete:

- The first is a 36 km primary dual-carriageway with three lanes in each direction. This road will connect the port, airport, and tourist areas with local residential and social amenities
- The second is a 35 km, 4-lane road beltway around the city that will connect the residential areas within the city with the beach

In addition, another 200 km of primary and secondary roads will be constructed to serve the various parts of the city, and to connect it with the development site around it.

1.2.6 Tourist Zone

The designated tourist area occupies 26 km^2 and includes an 18 km stretch of beach on the pristine Arabian Sea. Duqm's elaborate plans also include a relatively large public beach area offering a variety of water sports to accommodate residents and tourists recreational interests.

1.2.7 Education and Training Zone

At present, Duqm has several government educational facilities providing basic education in Arabic to the existing Omani population. In the future, private educational institutions will be invited to provide multilingual schools that meet international standards and address the needs of expatriates as well as local residents. As part of Duqm's vision of creating a viable local community, institutions for higher education and vocational training as well as research and development centres will be established.

The two major objectives of the educational institutions will be to:

a. Provide local manpower with skills required to qualify for jobs in future industries and services

b. Provide engineering and troubleshooting services to local industries

Emphasis will be placed on advanced IT and communications, green technologies, marine sciences, and business administration. An advanced Marine Research Centre is planned that will conduct cutting-edge studies and provide technic support for the local fishing industry.

In addition to the public health care provided by government hospital in Duqm, private sector medical practitioners and specialists are expected to take advantage of area's demographics and corporate clienteles to augment the scope of medical services provided by the Ministry of Health.

1.3 Objectives of the Environmental Impact Assessment

The Environmental Impact Assessment (EIA) process examines the environmental consequences of projects prior to their execution. The main goal of this process is to facilitate planning for sustainable development and to aid decision-making, as well as to anticipate and manage the negative effects, risks and consequences of development proposals.

It is not the purpose of the EIA to impede economic development or to serve as the principal means for preserving undisturbed natural settings. EIAs are designed to alert decision makers, regulatory agencies and the public to the environmental consequences of projects so that these projects can be modified, if need be, to prevent or mitigate environmental deterioration, and to enhance project benefits. In the long term, EIAs can lead to positive gains for the public, developers and the environment by promoting environmentally sound and sustainable economic development.

Specifically the objectives of this EIA are to:

- Describe the physical, biological, and socio-economic environment baseline information of the DLBB Project
- Identify the environmental and social impacts of the DLBB Project during construction, operation and maintenance and well as decommissioning so that they can be addressed in the appropriate planning and decision making process
- Present the various environmental alternatives considered as part of the DLBB Project development
- Present mitigation measures and monitoring plan proposed to minimise the potentially adverse impacts from the DLBB Project, and
- Support the application for the Initial Environmental Permit (IEP)

1.4 Project Schedule

Key Project activities are scheduled as below:

- FEED Design: Q3-2014 to Q1-2016
- Award of Engineering Procurement and Construction (EPC)-1 contract for dredging and reclamation and marine works: Q1-2016
- Dredging and Reclamation and marine works: Q2-2016 to Q4-2018
- Award of EPC-2 contract for topside facilities construction: Q3-2016
- Construction of topside facilities: Q1-2017 to Q1-2019
- Commissioning: Q4-2018 to Q2-2019
- Operation: Q2-2019 onwards

1.5 EIA Scope and Methodology

A number of Royal Decrees (RDs) including RD 45/2014, the latest RD issued in relation to the SEZAD, place a number of unique powers to the SEZAD including the power to issue environmental permits. Hence, SEZAD's Environmental Department will be responsible for approval of this document and for issuing the IEP. At the time of issue of this report SEZAD was yet to issue regulations, guidelines and procedures. Hence, it was agreed with SEZAD that the methodology for this EIA would be in line with those issued by Ministry of Environment and Climate Affairs (MECA) and international practices.

The EIA study methodology is conducted in accordance with the MECA's 'Guidelines on Environmental Impact Assessment' and approved EIA Scoping report. The scope of the study included the following major work elements:

- Project details such as description, flow diagrams, layout, utilities, Project schedules, etc., provided by Project Definition and FEED were reviewed to gather relevant information on the facility configuration, air emissions (if any), wastes generated and their storage, wastewater treatment and disposal methods, locations of lay-down areas, manpower requirement, etc.
- Environmental baseline information was compiled based on the desktop review of existing environmental studies in the Duqm Port, results of direct environmental field monitoring and modelling conducted for this EIA and site walkthrough
- The DLBB Project activities were considered with respect to their potential to interact with an environmental or social receptor. Potential environmental impacts from the DLBB Project are identified using standard environmental checklists and matrices. Both qualitative and quantitative assessments techniques are used to determine the magnitude of these impacts. The significance of each impact is determined based on area of impact, duration, intensity and type of impact (adverse, beneficial)
- Environmental Management Plans (EMP) is developed as tools to be used to mitigate adverse environmental impacts to acceptable levels, and
- Assessment of DLBB Project climate impacts due to Ozone Depleting Substance (ODS) intended to use and greenhouse gas emissions were carried out as per MECA guideline

The EIA methodology is based on the MECA's Guidelines on EIA. The Climate Affairs Department in MECA has additionally promulgated guidelines (on 24-Nov-2010) on the extent of information on greenhouse gas emissions and ozone depleting substances emissions that are to be provided in the EIA report. This guideline will also be adhered to during the present EIA study.

The EIA addresses the construction, operation and decommissioning phases of the DLBB Project. The EIA process in general incorporates a number of key steps which are summarized in Figure 1-5 below.

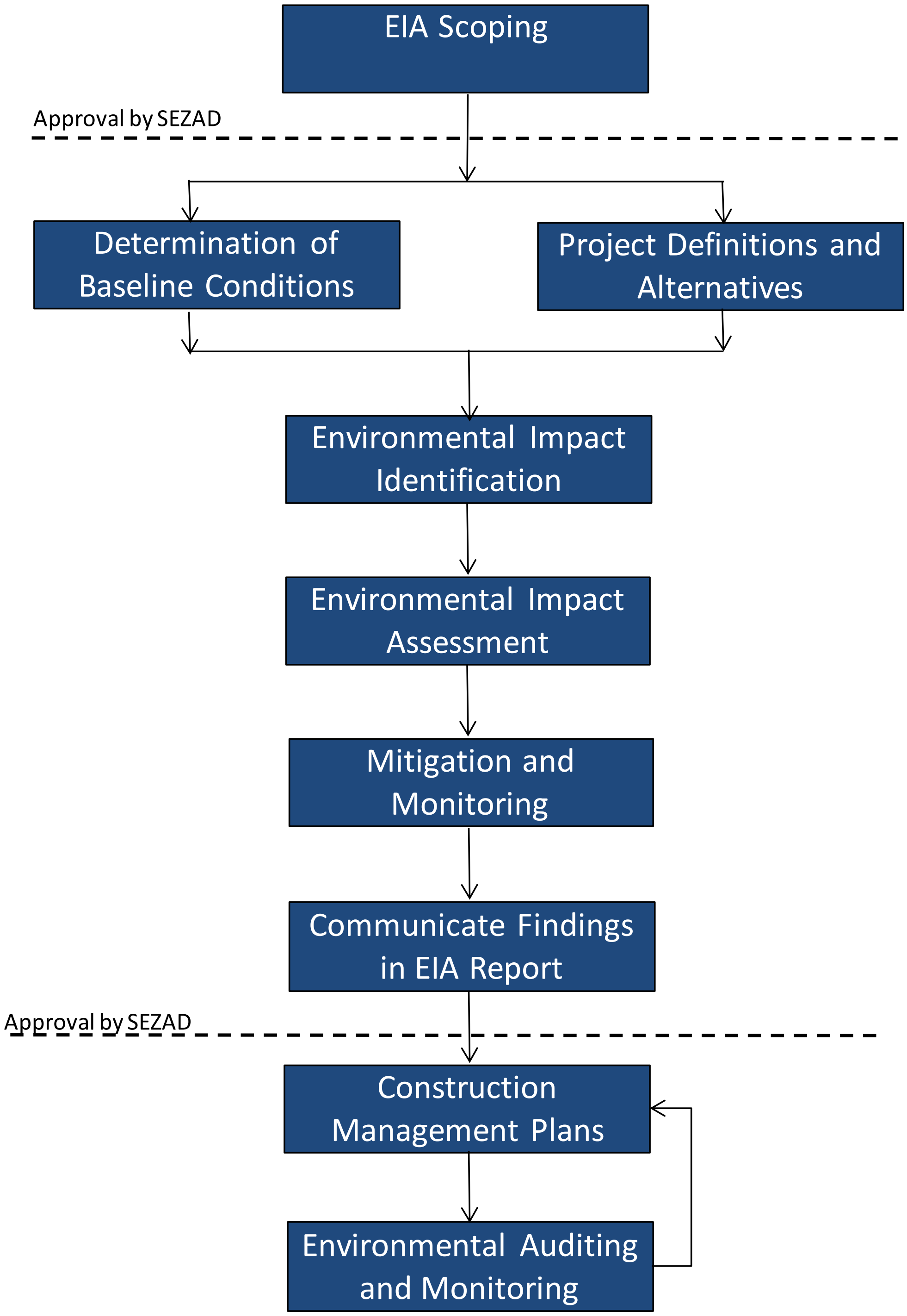

Figure 1-5: Typical EIA Methodology

The study thus includes the following:

- Assessment of various operations of the DLBB Project with regard to environmental compliance.
- Identification and characterization of potential environmental releases from the DLBB Project construction and operation phases through review of available construction philosophies, operating manuals, process flow diagrams, etc.
- Assessment of current environmental quality at site by conducting site surveys, marine surveys and modelling, assessment of soil and groundwater pollution scenarios and review of available published information on the area.
- Identification of impacts to the environment from construction, operation and decommissioning activities.
- Assessment of identified environmental impacts using qualitative method, i.e., using impact assessment matrix.
- Identification and assessment of the influence/contribution of the DLBB Project towards climate change and to assess vulnerability of the DLBB Project to changes in climate, and
- Development of a framework for the EMP

1.6 Project Proponent

DPTC is the DLBB Project proponent, and their contact details are presented below:

Duqm Port Terminal Company LLC

PO Box 261, Post Code 118, Sultanate of Oman

Tel: 2457 3100, Fax: 2457 3101 Contact

Person: Ahmed Al Amry, Project Director

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WorleyParsons Oman Engineering LLC is the Environmental Consultant for the DLBB Project, and their contact details are below:

WorleyParsons Oman Engineering LLC

PO Box 81, Postal Code 133, Al Khuwair, Sultanate of Oman

Tel: 24473421, 92984638; Fax: 24483908

Contact Person: Dr. C Radhakrishnan, Business Sector Manager – Infrastructure & Environment

Email: Radhakrishnan.C@WorleyParsons.com

1.7 Report Structure

This chapter provides a brief introduction to the DLBB Project and lists objectives of the report with subsequent sections arranged as below:

- Chapter 2: Legislative Review – Presents a list of regulations of relevant to the DLBB Project
- Chapter 3: Project Description – Describes the DLBB Project and its operation;
- Chapter 4: Releases – Presents the releases from the DLBB Project;
- Chapter 5: Analysis of Alternatives - Discusses the alternatives considered while establishing the DLBB Project;
- Chapter 6: Environmental Baseline Setting – Presents a description of environmental baseline and sensitivities in and around the DLBB Project site;
- Chapter 7: Impact Assessment – Identifies and assesses the potential impacts resultant from the DLBB Project;
- Chapter 8: Environmental Management Plan – Presents the framework environmental management plan for the DLBB Project;
- Chapter 9: Climate Affairs – Estimates the Green House Gas (GHG) emissions from the DLBB Project and discusses the vulnerability of the DLBB Project to climate change; and
- Chapter 10: Conclusion – Presents conclusion and recommendations to the EIA study.

2 LEGISLATIVE REVIEW

2.1 Overview

In identifying and assessing the impacts from a project, a number of environmental regulatory requirements and guidelines are required to be taken into consideration. The term "environmental" is therefore used in the broadest sense and besides standard biophysical factors is extended to include social issues related to the general population.

2.2 Relevant Environmental Regulations

Omani environmental law has two main legal instruments, viz., Royal Decrees (RDs) and Ministerial Decisions (MDs). Typically, an RD provides a general framework relating to a particular area in need of statutory control, while MDs provide specific regulation using the framework provided in the RD.

Where Omani environmental regulations and standards are not available, acceptable international environmental regulations and standards will be referenced. Additionally, the applicable Best Available Technique (BAT) Reference (BREF) documents published by the European Integrated Pollution Prevention and Control Bureau (EIPPCB) will be referred.

The Omani and international environmental laws and regulations particularly applicable to the DLBB Project are presented in Table 2-1.

Table 2-1: Omani and International Environmental Regulations Applicable to the DLBB Project

#	Aspects	Reference Number / Dates / Agencies	Title
OMANI ENVIRONMENTAL LAWS, REGULATIONS AND STANDARDS			
1	General	RD 114/2001	Conservation of the environment and prevention of pollution
	Permitting	MD 209/95	Obligating industrial and commercial organisations and others to apply environmental regulations as stated in environmental permits
		MD 187/2001	Issuing regulations for organizing obtaining environmental approvals and final environmental permit
		MD 71/2002 and MD 68/2004	Amendments to MD 187/2001
2	Special Economic Zone at Duqm (SEZAD)	RD 119/2011	Establishing Special Economic Zone Authority Duqm and issuing its regulations
		RD 79/2013	Issuing the regulation of the Special Economic Zone at Duqm
3	Water Resource	RD 29/2000	Law of protection of water resources
		RD 115/2001	Law on protection of potable water sources from pollution
		OS 8/2012	Omani standard for drinking water
4	Biodiversity	RD 6/2003	Law on nature reserves and wildlife conservation
		RD 8/2003	Law on grazing land and animal resources

#	Aspects	Reference Number / Dates / Agencies	Title
		MD 128/1993 Amended by MD 169/2000	Ban on Cutting Green Trees
		MD 101/2002	Ban on hunting, killing or trapping of wild animals and birds
		MD 110/2007	Regulations of the law on nature reserves and wildlife conservation (implements RD 6/2003)
5	Quarries And Earth-Moving	MD 4/87	Regulation on the issuance of quarries and mines licences
		MD 200/2000	Regulations for stone crushers, stone quarries and transport of sand from coasts, beaches and wadis
6	Marine Environment	RD 34/74	Law on marine pollution control
		MD 39/2004	Regulations on marine environmental management permits (includes permit for dredging)
		MD 159/2005	Regulations for the discharge of liquid effluents to the marine environment
7	Coastal Setback	MD 20/90	Regulations regarding coastal setback
8	Air Pollution Control And Prevention	MD 118/2004	Regulations for air pollution control from stationary sources
9	Noise Pollution Control And Prevention	MD 79/94	Regulations for noise pollution in public environment
		MD 80/94	Regulations for noise pollution in working environment
10	Chemicals Management	RD 46/95	Law on handling and use of chemicals
		MD 248/97	Regulations for registration of chemicals substances and relevant permits
		MD 20/99	Fees for import and handling of chemicals substances
		MD 316/2001	Banning the use of some hazardous chemical substances
		MD 317/2001	Regulations for packaging and binding conditions / stipulations and putting information and labels on the hazardous chemical substances
		MD 25/2009	Regulations for organisation of handling and use of chemicals
11	Radioactive Material	MD 21/99	Fees for granting permits for the import, transportation, storage and use of radioactive substances
		MD 249/97	Regulations for control and management of radioactive materials and substances
		MD 281/2003	Amends MD 249/97
12	Waste Management	MD 17/93	Regulations for the management of solid non-hazardous wastes
		MD 57/2002	Amends MD 17/93

#	Aspects	Reference Number / Dates / Agencies	Title
		MD 18/93	Regulations for the management of hazardous wastes
		MD 56/2002	Amends MD 18/93
13	Wastewater Management	MD 145/93	Regulations for wastewater reuse and discharge
		MD 55/2002	Amends MD 145/93
		MD 421/98	Regulations for septic tanks, soak-away pits and holding tanks
14	Climate Affairs	MD 243/2005	Control and management of ozone depleting substances
		MD 18/2012	Regulations for management of climate affairs
		Guidance from Directorate General for Climate Affairs 2007	Guidance addressing climate change, including instructions for addressing climate change in EIAs
15	National Heritage	RD 116/2001	Law for Protection of National Heritage
INTERNATIONAL ENVIRONMENTAL GUIDELINES, LEGISLATIONS AND STANDARDS			
16	Best Available Technique (BAT)	European IPPC Bureau	BAT Reference (BREF) Document on Emissions from Storage
			BREF Document on Waste Treatment Industries
17	International Guidelines and Standards	International Finance Corporation	General Environment Health and Safety (EHS) Guidelines
			EHS Guidelines for crude oil and petroleum products terminal
			EHS Guidelines for ports, harbours and terminals
		United States Environment Protection Agency (USEPA)	National Ambient Air Quality Standards (NAAQS), 2011
		Netherlands Ministry for the Environment	Dutch Intervention and Target Values for soil and groundwater, 2000
		Australian and New Zealand Environment Conservation Council (ANZECC)	Fresh and Marine Water Quality Standards, 2000
		Government of Dubai	Harbour Water Quality, 2010
18	Significant International Convention	ROPME	Regional Organisation for the Protection of the Marine Environment (ROPME)
		MARPOL	International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978
Sources:			

#	Aspects	Reference Number / Dates / Agencies	Title
(1) The Omani Environment Over Three Decades, Ministry of Regional Municipalities, Environment and Water Resources November 2005 (2) ECOLEX the gateway to environmental law, FAO, UNEP and IUCN. Accessed on 2-Oct-2014			

The requirements contained in the above applicable regulations have been reviewed during the EIA study and the potential environmental impacts from the facility will be assessed taking into account the requirements of such laws and regulations. The subsequent section elaborates select legislation with particular relevance to the Project.

2.2.1 RD 114/2001 – Law for the Conservation of the Environment and Prevention of Pollution

This Royal Decree is composed of 43 articles. Terms and definitions are given in article 1.

- Article 3: The environmental inspectors and the persons designated by a decision from the Minister of Justice by agreement with the Minister, shall have judicial powers in respect of enforcement of this law and its implementing regulations and decisions;
- Article 7: It is not allowed to use Oman environment for the disposal of environmental pollutants in such quantities and types that may adversely affect its intactness and its natural resources or nature conservation areas and the historical and cultural heritage of the Sultanate. No pollutants shall be disposed of in the natural ecosystems unless in accordance with the regulations and conditions issued by a decision from the Minister;
- Article 13: The owner shall immediately inform the Ministry in writing of any discharge that contravenes this law or its implementing regulations and decisions or the issued environmental permit. He shall also inform the Ministry of any incident leading to pollution or damage of the environment. The owner shall specify reasons and nature of the incident or the incompatible discharge together with the measures taken to rectify the situation and the time required. The owner shall keep records containing quantities, types and methods of discharge. The Ministry shall have the right to examine these records at any time; and
- Article 17: The Ministry shall have the right to take the necessary measures to monitor and control the ecosystems, the natural processes and wildlife species, in the light of which environment conservation policies and methods shall be re-assessed.

2.2.2 MD 209/95: Requiring application for Environmental Permits

MD 209/95 is composed of 3 articles:

- Article 1 states that every industrial, commercial or other kind of establishment is obliged to abide by the stipulations outlined in the environmental permit issued for it;
- The General Director of Environmental Affairs, the General Director of Environment of the Governorate of Dhofar, and the Directorate of Environmental Affairs in the Directorate General of Regional Municipalities (now MECA) in the regions and the Environmental Inspectorate, are to enforce the provisions of this Decision; and

- Anyone who hinders their carrying out the obligations of their duties or opposes them is to be banned. Those who contravene the environmental stipulations of article 1 are to be punished by a fine of 100 Omani Riyals (OR). If, after 25 days, the violator continues to contravene, he will be fined 50 OR a day for a period not exceeding 3 weeks, after which the establishment is to cease operations until the cause of the violation is dealt with. If there is danger to the environment or harm to public health, the Ministry can remove the violation at the expense of the violator.

2.2.3 MD 187/2001 and Amended by MD 68/2004- Issuing the Regulations for Organizing the Issuance of Environmental Approvals and the Final Environmental Permit

This regulation is composed of 8 articles.

- Article 1: The conditions on preliminary and temporary environmental approvals, Environmental permit to Infrastructure projects and final environmental permit are discussed;
- Article 2: The establishments, subject to the provisions of these regulations, shall be classified into categories according to the materials used in production, production capacity and the degree of their impact on the adjacent environment as indicated in the attached annex. Every category stated in the said annex shall have its own environmental conditions according to the level of environmental impact arising from its construction and operation;
- Article 3: The owner of an establishment shall apply to the Ministry on the form approved by the Ministry and in addition enclose an environmental impact study prepared by a consulting office approved by the Sultanate, if required by the Ministry;
- Article 4: The Ministry official shall as a preliminary step toward issuance of the environmental approval inspect the proposed sites to determine the environmental conditions that must be fulfilled; and
- Article 5: The owner of the establishment shall be bound to implement the required conditions and shall inform the Ministry of the same and after ensuring that all conditions were implemented prior to issuance of environmental approval or final Environmental Permit.

2.2.4 RD 119/2011 – Establishing Al-Duqm Special Economic Zone Authority and Issuing Its Regulations

This Regulation is composed of 18 articles. Terms and definitions are given in article 1.

- Article 2: The Authority's objective is to supervise the implementation of the project of the development of Wilayat Al-Duqm and administering, improving and developing the Zone while adhering to the regulations of the Zone in order to contribute to the achievement of comprehensive economic and social development;
- Article 3: Issuing environmental permits and taking the necessary action for the protection of the environment, the prevention of pollution and protection of potable water resources from pollution pursuant to the laws in force (Clause 11); and

- Article 6: The projects licensed to be established within the Special Economic Zone at Al-Duqm shall not be nationalized except by virtue of the law and in consideration of fair compensation. The monies of such projects may not be confiscated, come under custody or adjudicated except by virtue of a judicial verdict.

2.2.5 RD 79/2013 – Issuing the Regulation of the Special Economic Zone at Duqm

This Regulation is composed of 31 articles. Terms and definitions are given in article 1.

- Article 5: The use of land by the projects located in the Zone for all purposes shall be subject to a payment of a fee, and for a period up to fifty years, renewable for similar periods. The usufruct rights shall be according to rules established by a decision from the Board without prejudice to clause (11) of article (5) of the regulation of the Special Economic Zone Authority at Duqm issued by Royal Decree number (119/2011). The Authority cannot annul or terminate the Usufruct Agreement except in the case of violation of the terms of the Agreement by the projects or the relevant rules issued by the Board or the terms of the licenses issued to such, or for considerations of public utility projects and in accordance with the provisions of the laws in force in the Sultanate. Project are not permitted to undertake any form of alienation or transfer of the usufruct rights accorded to them, except for other similar projects, subject to the prior approval of the Authority;
- Article 7: Except the goods that are banned by law to be imported, the projects have the right to import all kinds of goods to the Zone without permission, license or prior approval, except if the products are classified as an explosive or chemical material, in which case must follow the rules on importation of such materials that are laid down in the related Laws and regulations in the Sultanate; and
- Article 20: Projects may agree among themselves on the transfer or assignment of workers among themselves without restrictions, in accordance with the rules established by a decision issued by the Board.

2.2.6 RD 29/2000 – Water Resources Protection Law

RD 29/2000 is composed of 4 articles and an attached Law. These are as follows:

- The attached Law is made up of 8 Articles. Article 1 defines the words and expressions referred to in the Law. Article 2 declares water to be a national asset.
- The Ministry is permitted to define water protection zones and prohibited activities within the zones. The Ministry may also regulate governing digging and maintenance of wells and use of their water, as well as the construction and use of aflaj (irrigation channels).
- Article 5 prohibits activities that adversely affect aquifers regardless of who owns the land in which the aquifer lies. No work is to be carried out that may alter aflaj routes without obtaining a permit from the Ministry.
- Under article 7, the Minister shall issue a decision fixing the fees payable by companies for permits for well digging, maintenance, deepening or widening as well as replacement or installation of pumps or desalination units on such wells.

- Article 8 defines the punishment for violations the provisions of article 2 or 5. Repeated offenders will receive double penalty.

2.2.7 RD 115/2001 - Issuing Law On The Protection From Pollution Of Sources Of Potable Water

RD 115/2001 consists of 3 articles, an attached Law and four Appendices. These are listed below:

- Article 1 states that the provisions of the attached Law shall have effect on protection of sources of potable water from pollution.
- The Minister of Regional Municipalities, Environment and Water Resources (now MECA) shall issue the regulations and decisions implementing this Law. Until then the current regulations and decisions shall remain applicable in such a manner that shall not conflict with the provisions of this law (Article 2).
- The attached Law states that the Ministry shall, in coordination with concerned bodies, specify zones of protection of sources of potable water from pollution, and the activities prohibited to be practiced within such zones, which may pollute water and its source (Article 3).
- Construction of septic tanks connected to holding tanks or soakaway shall be allowed to serve institutions and houses discharging domestic effluent waste water according to attached Appendix No. 2. Large institutions shall be served by sewage treatment plants according to attached Appendix No. 1(Article 7).
- Articles 9-11 deal with waste, landfills and solid non-hazardous waste.
- No hazardous substances or waste or other water pollutants shall be discharged in aflaj and their channels, surface watercourses, wadis or places of underground water recharge (Article 16).
- Articles 17-20 deal with violations to the law.
- Appendix No. 1 provides conditions for treatment, re-use, and discharge of wastewater.
- Appendix 2 gives provisions and conditions for septic tanks, holding tanks and soakaways
- Appendix 3 gives standards for discharge of non-household liquid waste into sewage system; and
- Appendix 4 provided guidelines for location, design and operation of sanitary landfills for non-hazardous solid waste.

2.2.8 MD 128/1993 Amended by MD 169/2000– Ban on Cutting Green Trees

This Ministerial Decision is composed of 3 articles. Article 1 bans the cutting of green or live trees. It also forbids the gathering or transportation of dry wood (firewood) without a permit issued by the Regional Council. Such permits are also obtainable from the Directorate General for the Protection of Nature in Muscat Governorate, the Directorate General of Environment in the Governorate of Dhofar, or from the Directorate General for Regional Municipalities and Environment for the Al Battinah Region (art. 1). A 200 Omani Riyal fine will be imposed on all who cut green trees, or gather and transport dry wood without a permit. Those who disobey the conditions of the permit are also subject to a fine of 50 Omani Riyals. Fines are increased if the transgressor has previously been fined (art. 2).

MD 169/2000 amends MD 128/1993 on the ban to cutting green trees and the organization of logging. It exempts trees and shrubs within the borders of private property or agricultural tenure from the mentioned ban

2.2.9 MD 101/2002 – Ban on killing, hunting, or trapping of wild animals or birds.

This Ministerial Decision is composed of 5 articles. Article 1 bans the killing, hunting, or trapping of wild animals or birds. Exceptions to this ban include animals or birds that bear or cause disease or which pose a danger to individuals or property. The Ministry should in these cases catch and kill them or offer a permit to the parties concerned. Article 2 requires a permit from the Ministry for the taking of specimens of animals or birds for the purpose of science, education or studies on the life of animals or plants. The aforementioned permits must include name, duration of permit, place and species and the size of these specimens. Violators are to be punished according to article 33 of the Law of Environmental Protection and Prevention of Pollution (Royal Decree No. 114 of 2001).

2.2.10 MD 200/2000 - Regulations for crushers, quarries and transport of sand from coasts, beaches and wadis

This Regulation is composed of 12 articles. Terms and definitions are given in article 1.

- Article 2: It is prohibited to use crushers or quarries' sites without obtaining an environmental permit to ensure that the project requesting a permit is sound from an environmental point of view and according to the approved standards. The permit shall be issued by the Ministry after application is made on the prescribed form and required documents enclosed and approvals issued by the competent authorities, particularly the following:
  a. The Ministry of Commerce and Industry approval for establishment of the project together with site coordinates shown on the map.
  b. Environmental impact study to projects requiring such.
  c. Relevant project's plans, drawings and production processes flow diagrams.
- Article 4: It is not permitted to use radioactive or chemical sources or equipment containing radioactive sources unless after obtaining the prescribed permit from the Ministry; and
- Article 8: It is not permitted to make any excavations or remove sand from coasts, beaches or wadis other than places determined by the Ministry. In addition, it is not permitted to excavate any part of a hill without obtaining the necessary permit issued by the concerned authority.

2.2.11 RD 34/1974 – Marine Pollution Control Law

This Decree is composed of 7 Chapters: General provisions (I); Application of the Law (II); Particular defences (III); Registration, notification and insurance conditions (IV); Management and execution (V); Liability for costs and damages (VI); Entry into force of this Law (VII).

Chapter II prohibits any person or ship to drain any hazardous substance in pollution-free areas (articles 1- 4). Article 6 addresses matters related to liability of the captain of the ship. Offences and penalties are contained in (articles 7-11).

Every ship registered in the Sultanate shall conserve the Oil Register (article 1), and every ship which receives or delivers oil into the Territorial Sea of Oman and is not registered in the Sultanate shall conserve the Oil Register (article 2). All owners of ships who carry or load pollutants shall present to the Minister a financial liability certificate (article 6). Pollution Control Officers shall have the right to inspect the ships (article 5). The Minister or any Pollution Control Officer has the authority to confiscate the ship (article 8). The Minister shall issue additional laws, provisions and rules necessary for the implementation of this Law (article 16).

2.2.12 MD 159/2005- Discharge to Marine Environment

This Regulation is composed of 17 articles. Terms and definitions are given in article 1.

- Article 3: The government authorities are exempted from the license fees, also exempted are the parties or individuals discharging for research or scientific purposes;
- Article 4: Environmental inspectors concerned may enter, inspect and monitor any liquid waste discharge in order to execute their assignments;
- Article 5: No liquid waste shall be directly or indirectly discharged in the marine environment without obtaining a prior Permit;
- Article 7: Permit applicant undertakes to reuse or recycle the liquid waste, or destroy the hazardous contents of such waste, or mitigate it by using proper environmental treatment. The Ministry may refuse awarding the Permit if it considers it possible to reuse, recycle or treat such waste without causing any hazard to the human or environment health;
- Article 11: Presents the requirements for the discharge point;
- Article 14: It is prohibited to destroy any seabed marine life within 300 meters radius from the discharge outlet in the initial mitigation area; and
- Article 15: Facilities and equipment should be provided and maintained in accordance with the Ministry’s requirements to take samples and analyse seawater and liquid materials. Other parties may carry out similar analysis after the Ministry’s approval of such parties’ laboratories.
- Article 16: The liquid effluent from ships, stable or floating dredging rig and other structures have to be discharged according to the Agreement of MARPOL (by the International Maritime Organization - IMO) and its protocols and attachment within the limits clarified in attachments (2) to (7).
- Attachment 1 presents the controls for discharging liquid effluent into the marine environment

2.2.13 MD 118/2004 - Air Pollution from Stationery Sources

MD 118/2004 is composed of 3 main articles, an attached Regulation and an Annex. The significant Articles from the Regulation are presented below:

- Article 1 of the Regulation specifies definitions of terms used in the MD.
- Article 2 the attached Regulation requires the owner to use scientific means to prevent direct or indirect emissions of toxic and hazardous gases and particulates from a site, and to treat such gases and particulates appropriately to render them harmless and to comply with the Ministry's standards as specified in the attached Annex
- The owner must also monitor the particulate and gas emissions from time to time, carry out any necessary alterations to the stacks or the sources of generation, and report the results of emission monitoring to the Ministry (Article 1).
- Article 5 bans emissions of dark smoke from the chimney of any building, industrial/commercial premises, or any other site. No construction or operation can start before the Ministry approves the height of the chimney which shall be sufficient to prevent smoke, grit, dust and gases emitted from the chimney causing injury to health or nuisance.
- Minimum stack heights (from ground level) are given for different kinds of installation (Article 6).
- The MD does not specify the height or the emission standard that flares operating at oil terminals need to meet. However the MD does specify standard related to flaring in oil field s and refinery, which is presented in Table 2-2 below.

Table 2-2: Standard for Flaring in Oil Fields and Refinery

Parameter	Standard
Carbon monoxide	0.050 g/m^3
Sulphur dioxide	0.035 g/m^3
Nitrogen dioxide	0.150 g/m^3
Carbon dioxide	5 g/m^3
Unburnt hydrocarbon	0.010 g/m^3
Particulates	0.100 g/m^3

2.2.14 MD 79/94 - Noise Pollution Control in Public Environment

- Article 2 classifies sources of external noise into 4 categories: (a) industrial plants and public works, (b) road traffic, (c) airports and (d) airborne operations of commercial and general aviation;
- Article 3 defines public noise;
- The regulation distinguishes 3 time periods: workday's day time, workday evenings, and holidays/nights. Noise limits for each of the time periods are given in the table found in Articles 7 to 10, with each article focusing on a category referred to in Article 2. Further differentiation is made according to location, with acceptable noise limits higher in industrial and commercial zones than in rural residential and recreational zones and is presented in Table 2-3; and

- Article 13 requires that measurements of noise are made according to the International Standard ISO 1996-1.

Table 2-3: Ambient Noise Standards (from Industrial Sources)

Type of District	Maximum Permissible Noise Level [as L_{eq} in dB(A)]		
	Day time (7 am to 6 pm) workdays	Evening Time (6 pm to 11 pm) workdays	Night Time (11 pm to 7 am) on workdays and all times on holidays
Rural residential and recreational	45	40	35
Sub-urban residential	50	45	40
Urban residential	55	50	45
Urban residential with some workshops or business city hub	60	55	50
Industrial and commercial	70	70	70

Table 2-4: Ambient Noise Standards (from Roads Traffic)

Type of District	Maximum Permissible Noise Level [as L_{eq} in dB(A)]		
	Day time (7 am to 6 pm) workdays	Evening Time (6 pm to 11 pm) workdays	Night Time (11 pm to 7 am) on workdays and all times on holidays
Rural residential and recreational	60	55	50
Sub-urban residential	65	60	55
Urban residential	65	60	55
Urban residential with some workshops or business city hub	65	60	55
Industrial and commercial	70	65	60

2.2.15 MD 80/94 - Noise Pollution in Working Environment

This Ministerial Decision is composed of 6 articles and attached Regulations.

- Environmental Permits which are issued to new industrial projects shall include noise abatement measures in accordance with the attached Regulations (Article 3).
- Article 5 defines that the employer will provide the employee exposed to noise level 85 dB (A) during normal working conditions with suitable means of noise abatement. Ear protectors shall be provided by the employer to an employee exposed to noise levels exceeding 85 dB (A). The attenuation of such protectors shall be at least equal to the amount by which the noise level exceeds 80 dB (A).

- The employer, according to the Ministry request, must provide a competent person to carry out a qualified noise assessment and to substantiate that the regulations are complied with (Article 9).

2.2.16 RD 46/1995 – Law on handling and use of chemicals

This Royal Decree is composed of 13 articles. Terms and definitions are given in article 1.

- Article 2: Manufacture, import, transport, storage, handling, and use of any chemical shall comply with the provisions of this Law, and the Regulations and Decisions issued thereof;
- Article 5: The committee shall convene at least biennially at the request of the chairman and whenever necessary, and a quorum shall be the attendance of two thirds of the members. The committee can seek the assistance of experts who may be invited to attend by not vote; and
- Article 11: The user of hazardous chemicals shall be committed to dispose of hazardous chemical waste empty containers and any substance in violation of the Law, at this expense and under the supervision of the Ministry, as the regulations in force.

2.2.17 MD 248/97 – Handling Hazardous Substances and Fees

- Article 2 – Any juridical or physical person intending to trade with hazardous chemical materials (importation, exportation, fabrication, transportation, storage, circulation, use and treatment) shall register this materials at the Ministry to obtain the Environmental license after paying the fixed fees; and
- Any person dealing with hazardous chemicals shall maintain a valid environmental permit and chemical safety data, and shall keep copy of the permit and the data in a safe place as far from where the chemical is kept or transported (Article 4).

2.2.18 MD 20/99 – Fees for Granting Permits for the Trade in Hazardous Chemical Substances

This Ministerial Decision is issued by the Ministry of Regional Municipalities and Environment and Water Resources (now MECA). It consists of 2 articles and 2 attached tables. Fees for granting permits for the trade in hazardous chemical substances are prescribed in accordance with the attached tables (Article 1). Table 1 lists import fees, which vary according to tonnage. Table 2 refers to other permits, with fees varying according to the activity type such as use, sale, manufacture, payment and export.

2.2.19 MD 317/2001 - Issuing the Regulations for the packing, packaging, and labelling of Hazardous Chemicals

- Article 2: All such relevant hazardous chemical warning symbols as depicted in the attached Appendix of MD 317/2001, shall also be drawn on, or fixed to, each container;
- Article 3: Without prejudice to the provisions of Article (13) of the Law on Handling and Use of Chemicals, and in accordance with the provisions stated in Article (4) therein; any violating

activity concerning chemicals, or any violation the provisions of these Regulations shall cause the offending person to cease to be allowed to practice his activity; and

- Article 4: The provisions of these regulation are not be applicable to the following:

  a) Pharmaceuticals and medical drugs

  b) Explosives as stated in Royal Decree No. (82/77)

  c) Radioactive materials.

2.2.20 MD 25/2009 - Chemical Handling and Use

This Regulation is composed of 8 articles. Terms and definitions are given in article 1.

- Article 3: The user of any chemical substance stated in Annex (1) shall submit the academic qualifications of the technical working team supervising its use to the Department; shall be committed not to exceed the quantity specified in the permit issued to him and not to sell it in the local market;
- Article 4: Handling and use of any chemical substance stated in Annex (2) is prohibited; and the user is committed to notify the Department of any stock during two months from the date of enforcement of this decision, and to be disposed of in accordance with the conditions and procedures specified by the Ministry;
- Article 5: The user of chemical substance shall be committed to prepare a contingency plan to deal with it within and outside the establishment, and shall train the authorized staff within the establishment in the mechanism of its application; and
- Article 8: Offenders of the provisions of these Regulations shall be liable to penalties stated in the referred to Law of Handling and Use of Chemicals. In the event the violation continued for more than one month from the date of offense, the Ministry may stop the offender from practicing his activity in accordance to the procedures stated in Article (4) of the referred to Law of Handling and Use of Chemicals, and not to permit him to handle or use chemicals until the removal of the causes and impacts of the violation at his own expense.

2.2.21 MD 281/2003 - Regulations on the Control and Management of Radioactive Substances

This Regulation is composed of 28 articles. Terms and definitions are given in article 1.

- Article 3: The Organization shall, after the Ministry's approval, provide qualified persons to monitor and control radioactive materials and ensure that the provisions of these regulations are complied with;
- Article 5: The Organization shall identify the "Controlled" and "Supervised" areas within which dose levels as indicated in the permit or as per the terms of the Guidelines are complied with;
- Article 8: Any Organization dealing with radioactive materials shall establish an internal management system including; staff structure with well-defined responsibilities, written

procedures of work, quality assurance procedures, staff training and emergency procedures so as to meet the Ministry's requirements;

- Article 10: All classified workers must receive adequate training on their field of work, before dealing with radioactive materials. This shall be suitably recorded; and
- Article 25: Liquid radioactive waste shall be disposed of in drains in accordance with the Ministry's regulatory conditions.

2.2.22 MD 17/93 Amended by MD 57/2002 – Management of Solid Non-Hazardous Waste

This Regulation is composed of 19 articles.

- Article 2: Occupants of premises used for residential, commercial, industrial, agricultural or other purposes shall store or dispose of solid non-hazardous waste;
- Article 5: The user of commercial, industrial, agricultural or any other sites, which produce solid non-hazardous waste except domestic waste, shall collect this waste and transport it in a safe manner to a site established by the Concerned Authority;
- Article 7: According to the request of the applicant, the Ministry shall issue a license for the establishment of solid non-hazardous waste treatment facilities and sanitary landfills;
- Article 8: The Concerned Authority shall inspect the sites to ensure the environmental protection;
- Article 10: The operators of solid non-hazardous waste treatment facilities and sanitary landfills shall keep such records of daily operation;
- Article 13: No solid non-hazardous waste shall be mixed with any category of hazardous waste at any time; and
- Article 18: Importation of solid non-hazardous waste shall be prohibited unless previously authorized by the Ministry.

MD 57/2002 amends Regulations on the management of solid non-hazardous waste by replacing the text of article 7 with the following: "The Ministry issues licenses for establishing sanitary or treatment locations for burying waste and licenses for dumping solid non-hazardous waste in Omani waters. In return for the issuance of these licenses a fee of 200 baizas per ton is payable where the total load is less than 50,000 tons. Where the load exceeds 50,000 tons, a fee of 100 baizas is payable".

2.2.23 MD 18/93 Amended by 56/2002 - Management of Hazardous Waste

This Regulation is composed of 16 articles. Terms and definitions are given in article 1.

- Article 2: The application submitted for the hazardous waste license shall be compatible with the standard format developed by the Ministry and the applicant shall explain and describe how the waste generator will apply the best available technology relevant to his production and operational practices to minimize the generation of hazardous waste, including the application of any practicable recycling procedures covered by Article (7) of these Regulations;

- Article 5: Every hazardous waste generator shall complete a consignment note for each category of hazardous waste before the hazardous waste leaves his land or premises;
- Article 7: Hazardous waste or its components may be recycled according to this Regulation;
- Article 8: Every hazardous waste generator shall store hazardous waste in approved storage facilities on his land or at his premises until its removal in accordance with the terms of the license issued by the Ministry;
- Article 9: Hazardous waste shall be transported by transporters licensed by the Ministry to collect, handle, store and dispose hazardous waste outside the waste generators premises. This license will be issued with conditions after the approval of Royal Oman Police; and
- Article 12: The owner of any site for the pre-treatment of hazardous waste shall apply to the Ministry for a license for the site prior to starting his activities. He shall not receive any hazardous waste other than the conditions included in the issued license which is accompanied by the consignment note(s).

This MD 56/2002 amends Regulations on the Management of Hazardous Waste by adding the following new paragraph to article 10: "In return for issuing this license, a receipt for 15 Omani Riyals should be obtained".

2.2.24 MD 145/93 - Wastewater Treatment and Discharge

- Article 2: Drainage of sewerage waters and sludge without the ‘Permit to Discharge’ issued by the Ministry shall be prohibited;
- Article 5: The treated wastewater quality shall at all times comply with the standards mentioned in Table 1 as they relate to the permitted method of discharge or as may be modified and supplemented by any other limits that might be included in any specific Permit to Discharge;
- Article 6: The soil on which sludge may be applied shall be tested by the owner for the metals listed in Table (2), and for pH value, prior to any initial application and the sludge quality and application constraints shall at all times be within the limits that are set out in Table (2) as they relate to the permitted method of sludge re-use, or as may be modified and supplemented by any other limits that might be included in any specific permit to discharge.
- Article 11: Transportation of sewerage waters and sludge shall not be carried out without a previous authorization of the Ministry;
- Article 12: The Ministry may inspect any treatment station and collect samples from water, soil and sludge; and
- Standards for sewerage waters (maximum and minimum limits) are given in Annex I, Annexes II and III deal with the recycling of sludge for agricultural purposes, and the recycling of sewerage waters.

2.2.25 MD 243/2005 - Regulations on the Control and the Management of Substances that Deplete the Ozone Layer

The purpose of these Regulations is to prevent emissions of substances that result in depletion of the stratospheric ozone layer. The import or export of controlled substances such as, restored or blended materials shall be accompanied by a license from the Ministry. The import of these substances from or their export to countries which are not part of Montreal Protocol is forbidden. The Regulations set forth specifications for the import, export, use and recycling of products, and equipment containing substances that may result in depletion of the stratospheric ozone layer.

The Regulations include 3 Annexes: Annex 1 lists the substances responsible for the depletion of the ozone identified in the Montreal Protocol; Annex 2 concerns the disposal of these substances according to the Montreal Protocol; Annex 3 concerns licensing fees.

2.2.26 MD 30/2010 – Guidance Addressing Climate Change in EIA

This Regulation is composed of 10 articles. Terms and definitions are given in article 1.

- Article 2: The directorate general in the ministry is the national authority to evaluate and approve the projects;
- Article 3: The project owner/developer shall apply to the directorate general requesting approval for the project, using the pre-prepared form and enclosing the required documents;
- Article 7: The project owner/developer undertakes to collect and maintain the data, reports and information relating to the project. The ministry inspectors shall have the right to enter the project site at any time for inspection and review of the records; and
- Article 10: Without prejudice to any stronger punishment stipulated in the said Environment Protection an Pollution Control Law, or any other law, any violator of these bylaws shall be fined by not more than Omani Rial five thousand.

2.2.27 RD 6/1980 – The Natural Heritage Protection Law

This Regulation is composed of 50 articles. Terms and definitions are given in article 1 and article 2.

- Article 5: The Minister may-whether at his own discretion or at the instance of the landlord or in response to a request raised by the appointed supervisor –decide that a certain monument is of special historical, artistic or scientific importance and must accordingly be duly registered;
- Article 9: Anyone who may damage, demolish, move, maim, vandalise, alter or tamper with any registered monument or cause the same to be lost or displaced will be liable to a fine not exceeding OMR 200 and/or a maximum of one year imprisonment penalty;
- Article 26: In all cases involving excavation under official permission by the Ministry, excavation works must be carried out under supervision of the government department concerned; and
- Article 28: It is strictly prohibited to export any mobile cultural property without obtaining an official written permission duly issued by the Ministry that must take the form of an Export

License exhaustively outlining the tiniest details of the mobile cultural property intended for export.

2.2.28 Port of Duqm Regulations

The Port of Duqm prepared the Port Rules and Regulations in September 2012. These regulations are applicable to all tenants of the port. The regulation is divided into 11 Sections, as listed below:

- Section 1: Definitions Applicable to the Project
- Section 2: General Provisions
- Section 3: Arrival Stay and Departure of Vessels (Not *Dhow*s)
- Section 4: Port Operations
- Section 5: Safety of the Port
- Section 6: Port Security
- Section 7: Environmental Protection
- Section 8: Special Regulations for Tankers
- Section 9: RO-RO Vessels and Passenger Vessels
- Section 10: Dows
- Section 11: Miscellaneous

Section 2.13 prohibits the boat mooring and landing of launches and *dhows* in the port without permission from the harbour master. Section 2.14 prohibits fishing or placing of fishing gear in the port, without permission of the port authorities.

Section 7 provides guidance on environmental protection measures and covers the management of MARPOL waste and provides broad guidance on collection of such waste. Additionally, this section states that charges will be levied for waste collection from vessels. Also, the section places restriction on hull maintenance and engine usage while at berth. Lastly, the port requires vessel to maintain insurance to cover clean-up as a result of any accident or spillage.

It should be noted that as presently these regulations were under review for update and modification. The updated regulations are expected to be published during Oct-2015.

2.3 International Environmental Guidelines

2.3.1 Best Available Techniques

The EIPPCB organises and co-ordinates the exchange of information between Member States and the industries concerned on Best Available Techniques (BAT). The EIPPCB produces BAT reference documents (BREF) and BAT conclusions. BAT is defined in the EIPPCB as:

- Best – Most effective in achieving a high general level of protection of the environment as a whole

- Available - Developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions
- Techniques - Both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned

While BREF or 'BAT reference document' are drawn up for defined activities and describing, in particular, applied techniques, present emissions and consumption levels, techniques considered for the determination of best available techniques as well as BAT conclusions and any emerging techniques, giving special consideration to the criteria listed in Annex III to Directive 2010/75/EU.

The BREFs considered relevant to the DLBB Project are:

- Emission from storage
- General principles of monitoring

It should be noted, Omani regulation requires the implementation of BAT for establishment and operation of industries in Oman, however does not make specific reference to what constitutes BAT or the European BAT.

2.3.2 IFC EHS Guidelines

The EHS Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP), as defined in International Finance Corporation's (IFC's) Performance Standard 3: Resource Efficiency and Pollution Prevention. IFC uses the EHS Guidelines as a technical source of information during project appraisal activities, as described in IFC's Environmental and Social Review Procedures Manual.

The EHS Guidelines contain the performance levels and measures that are normally acceptable to IFC, and that are generally considered to be achievable in new facilities at reasonable costs by existing technology. For IFC-financed projects, application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets with an appropriate timetable for achieving them. The environmental assessment process may recommend alternative (higher or lower) levels or measures, which, if acceptable to IFC, become project- or site-specific requirements.

When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects will be required to achieve whichever is more stringent. If less stringent levels or measures than those provided in the EHS Guidelines are appropriate in view of specific project circumstances, a full and detailed justification must be provided for any proposed alternatives through the environmental and social risks and impacts identification and assessment process. This justification must demonstrate that the choice for any alternate performance levels is consistent with the objectives of Performance Standard 3.

The following EHS guidelines are applicable to the project:

- General EHS Guidelines
- Crude oil and petroleum product terminals

2.3.3 USEPA – National Ambient Air Quality Standards

In the absence of any local ambient air quality standards the USEPA National Ambient Air Quality Standards (NAAQS) have been referred to.

Table 2-5: USEPA- National Ambient Air Quality Standard

Pollutant [final rule cite]		Primary (P)/ Secondary (S)	Averaging Time	Level	Form
Carbon Monoxide [76 FR 54294, 31-Aug-2011]		P	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead [73 FR 66964, 12-Nov-2008]		P and S	Rolling 3 month average	0.15 $\mu g/m^3$ NOTE-1	Not to be exceeded
Nitrogen Dioxide [75 FR 6474, 9-Feb-2010] [61 FR 52852, 8-Oct-1996]		P	1-hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		P and S	Annual	53 ppb NOTE-2	Annual Mean
Ozone [73 FR 16436, 27-Mar-2008]		P and S	8-hour	0.075 ppm NOTE-3	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particle Pollution 14-Dec-2012	$PM_{2.5}$	P	Annual	12 $\mu g/m^3$	annual mean, averaged over 3 years
		S	Annual	15 $\mu g/m^3$	annual mean, averaged over 3 years
		P and S	24-hour	35 $\mu g/m^3$	98th percentile, averaged over 3 years
	PM_{10}	P and S	24-hour	150 $\mu g/m^3$	Not to be exceeded more than once per year on average over 3 years
Sulphur Dioxide [75 FR 35520, 22-Jun-2010] [38 FR 25678, 14-Sep-1973]		P	1-hour	75 ppb NOTE-4	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		S	3-hour	0.5 ppm	Not to be exceeded more than once per year

Notes:

(1) Final rule signed 15-Oct-2008. The 1978 lead standard (1.5 $\mu g/m^3$ as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.

(2) The official level of the annual NO_2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.

(3) Final rule signed 12-Mar-2008. The 1997 ozone standard (0.08 ppm, annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years) and related implementation rules remain in place. In 1997, USEPA revoked the 1-hour ozone standard (0.12 ppm, not to be exceeded more than once per year) in all areas, although some areas have continued obligations under that standard ("anti-backsliding"). The 1-hour ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1.

(4) Final rule signed 2-Jun-2010. The 1971 annual and 24-hour SO_2 standards were revoked in that same rulemaking. However, these standards remain in effect until one year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.

2.3.4 Dutch Intervention and Target Values for Soil and Groundwater

Dutch Environmental Quality Standards (EQS), the New Dutch List of 2000, for water, soil, and sediment standards for pollutant reference values (i.e., concentrations in environmental medium) are used in environmental remediation, investigation and clean-up.

Barring a few exceptions, the target values are based on an environmental risk analysis wherever possible and apply to individual substances. In most cases, target values for the various substances are related to a national background concentration that was determined for the Netherlands.

Groundwater target values provide an indication of the benchmark for environmental quality in the long term, assuming that there are negligible risks for the ecosystem. For metals a distinction is made between deep and shallow groundwater. This is because deep and shallow groundwater contains different background concentrations. An arbitrary limit of 10 m has been adopted. The target values are for 'shallow' groundwater, 0 to 10 m depth.

The soil remediation intervention values indicate when the functional properties of the soil for humans, plants and animals is seriously impaired or threatened. They are representative of the level of contamination above which a serious case of soil contamination is deemed to exist. The target values for soil are adjusted for the organic matter (humus) content and soil fraction <0.2 µm (lutum - Latin, meaning "mud" or "clay"). The values are calculated for a 'Standard Soil' with 10 % organic matter and 25 % lutum.

2.3.5 ANZECC – Fresh and Marine Water Quality Standards

The Australian National Water Quality Management Strategy (NWQMS) aims to achieve the sustainable use of Australia’s and New Zealand’s water resources by protecting and enhancing their quality while maintaining economic and social development. The guidelines are designed to help users assess whether the water quality of a water resource is good enough to allow it to be used for humans, food production or aquatic ecosystems (these uses are termed environmental values). If the water quality does not meet the water quality guidelines, the waters may not be safe for those environmental values and management action could be triggered to either more accurately determine whether the water is safe for that use or to remedy the problem.

Table 2-6: ANZECC – Fresh and Marine Water Quality Standards

Parameter	Primary Contact (e.g. swimming)	Secondary Contact (e.g. boating)	Visual use (no contact)
Microbiology	The median bacterial content in fresh and marine waters taken over the bathing season should not exceed 150 faecal coliform organisms/100 mL or 35 enterococci organisms/100 ml. Pathogenic free-living protozoans should be absent from bodies of fresh water	The median value in fresh and marine waters should not exceed 1000 faecal coliform organisms/100 mL or 230 enterococci organisms/100 ml.	Macrophytes, phytoplankton scums, filamentous algal mats, sewage fungus, leeches, etc., should not be present in excessive amounts. Direct contact activities should be discouraged if algal levels of 15 000–20 000 cells/mL are present, depending on the algal species. Large numbers of midges and aquatic worms should also be avoided

<table>
<tr><th>Parameter</th><th>Primary Contact (e.g. swimming)</th><th>Secondary Contact (e.g. boating)</th><th>Visual use (no contact)</th></tr>
<tr><td>Visual Clarity and colour</td><td colspan="3">To protect the aesthetic quality of a waterbody:
The natural visual clarity should not be reduced by more than 20 %;
The natural hue of the water should not be changed by more than 10 points on the Munsell Scale;
The natural reflectance of the water should not be changed by more than 50 %.</td></tr>
<tr><td>pH</td><td>The pH of the water should be within the range 5.0–9.0, assuming that the buffering capacity of the water is low near the extremes of the pH limits.</td><td>-</td><td>-</td></tr>
<tr><td>Temperature</td><td>For prolonged exposure, temperatures should be in the range 15 to 35 ºC.</td><td>-</td><td>-</td></tr>
<tr><td>Toxic Chemicals</td><td colspan="2">Waters containing chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable for recreation. the chemicals are listed in the regulation for Inorganics, Organics, Radiological, Other Chemicals, and Pesticides</td><td>-</td></tr>
<tr><td>Surface films</td><td colspan="3">Oil and petrochemicals should not be noticeable as a visible film on the water nor should they be detectable by odour</td></tr>
</table>

2.3.6 Government of Dubai – Harbour Water Quality

The water quality standards have been developed to protect the long term resources of marine life and water supply in the Free Zone (FZ) area/ Dubai World (DW) Communities. These standards have been established to minimize the impact on harbour and Gulf water quality, the Gulf ecosystem and the local fishing industry. Table 2-7 presents the harbour water objective.

Table 2-7: Harbour Water Objective

Parameter	Standard
BOD_5	10 mg/l
Total Residual Chlorine	0.01 mg/l
Dissolved Oxygen	Not less than 5 mg /l or 90% saturation
Nitrogen – Ammonia	0.1 mg/l
Nitrogen - Nitrate	0.5 mg/l
Nitrogen – Total	2.0 mg/l
Petroleum Hydrocarbon	0.001 mg/l (aromatic fraction)
pH	1 pH unit from ambient level
Phosphate – Phosphorus	0.05 mg/l
Temperature	2 °C from background Level

Parameter	Standard
Total Dissolved Solids	2% from background level
Turbidity /Colour	75 NTU or none that will reduce light penetration by more than 20% from background levels
Surfactants	0.02 mg/l
Suspended Solids	10 mg/l mean 15 mg/l max
Aluminium	0.2 mg/l
Arsenic	0.01 mg/l
Cadmium	0.003 mg/l
Chromium	0.01 mg/l
Copper	0.005 mg/l
Iron	0.2 mg/l
Mercury	0.001 mg/l
Zinc	0.02 mg/l
Bacteria (*E. coli*)	0.02 mg/l

2.4 Significant International Convention

2.4.1 ROPME

Oman is a member of the Regional Organisation for the Protection of the Marine Environment (ROPME). Established in 1979 with its headquarters in Kuwait City following the environmental disasters of the Gulf War, ROPME aims to promote environmentally sound practices, prevention of pollution and sustainable development in Arabian Gulf waters.

Oman was one of the first ROPME member states to become signatory to the:

- International Maritime Organisation (IMO) Convention, MARPOL 73/78 (the International Convention for the Prevention of Pollution from Ships 1973 and modified by Protocols 1978 & 1997)
- London Convention 1972
- UN Convention on Law of the Sea 1982.

2.4.2 MARPOL

Annexes I and V of MARPOL 73/78 defines Special Area (i.e. protection area) between Ras Al Hadd (22º 30' N; 59º 48' E) and Ras al Fasteh (25º 04' N; 61º 25' E) to include the Arabian Sea. This is in order to maximise protection of highly significant and sensitive marine habitats along this coast. The habitats are threatened due to serious pollution incidents that have been caused by the high numbers of oil tankers that pass through Omani waters and cleaning out their tanks prior to entering the Gulf area to load oil. It is estimated that between 20,000 and 35,000 tankers pass through the Strait of Hormuz every year.

The MARPOL convention requires Parties to ensure the provision of reception facilities to deal with the ship-generated waste "without causing undue delay" to the ships using them. Annexes I, II and V, defines a Special Area as: "*a sea area, where for recognised technical reasons in relation to its oceanographic and ecological condition and to the particular character of its traffic, the adoption of special mandatory methods for the prevention of sea pollution by oil, noxious liquid substances or garbage, as applicable, is required*".

Under this Special Area designation, no discharges are permitted except clean or segregated ballast.

MD 159/2005 implements MARPOL requirements in Oman.

3 DLBB PROJECT DESCRIPTION

3.1 Overview

The aim of this chapter is to describe each and every aspect of the DLBB Project in sufficient detail to give a picture of the Project's potential environmental and social impacts. The Guidelines for Obtaining Environmental Impacts published by the Director General of Environmental Affairs and International Finance Corporation (IFC)[1] requires that the project description covers:

- Relevant parts of the project including the location (using maps of appropriate scale)
- Physical layout and design
- Details on the size and capacity
- Pre-construction activities
- Construction plans and scheduling
- Facilities and services
- Operating procedures and decommissioning plans
- Required off-site activities or project
- Estimates the types of emissions
- Life span of the project.

It should be noted that the layout drawings used in this document are preliminary and may be subject to change as the design progresses. Significant changes will be communicated to the regulator.

3.2 Present and Future Development

The present phase of the DLBB Project only involves developing along half of the length of the current LBW; the rest of the LBW is set aside for future development. It should be noted that the future development is excluded from the scope of the current EIA and the respective project proponent(s) will undertake the necessary project studies. The larger port operations including ship movement and navigation is being addressed by PDC in a separate operation phase EIA.

Figure 3-1 highlights the area set aside for development as part of the present phase and the area earmarked for future development.

[1] Source: The International Finance Corporation Procedure for Environmental and Social Review of Project Guidance Note B: Content of an Environmental Impact Assessment Report

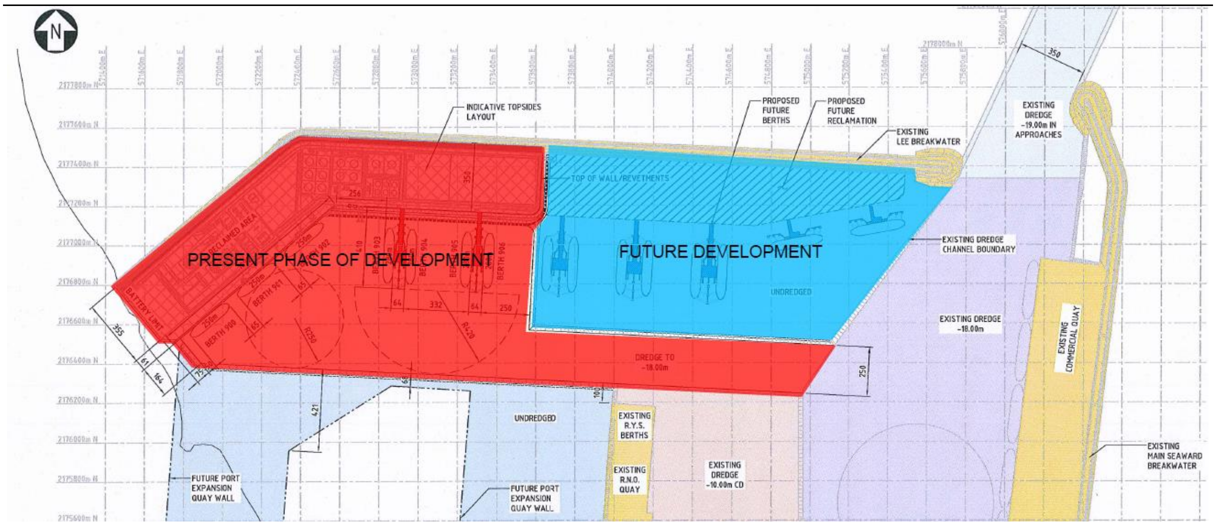

Figure 3-1: Sketch of Present and Future Developments

3.3 The Project

The DLBB Project is located in Al Wusta region for the Sultanate of the Oman (Refer Figure 1-1) and is part of the Port of Duqm and the Duqm Industrial Zone development. Figure 1-3 and Figure 1-4 presents the relative location of the DLBB Project relative to the Duqm Port and the Duqm Industrial Zone Development. Figure 3-2 presents the layout for the DLBB Project facility.

Salient features of the project, construction and operation, which are covered in this EIA, are:

- Dredging of the liquid bulk berth basin
- Reclamation to the south of the existing LBW including ground improvement and foundation to support equipment, buildings, tanks, pipeline, and other equipment (as required)
- Construction of the following berths:
    - Liquid product export berths (4 Nos)
    - Bulk solids export berth (1 No)
    - Spare berth (2 Nos)

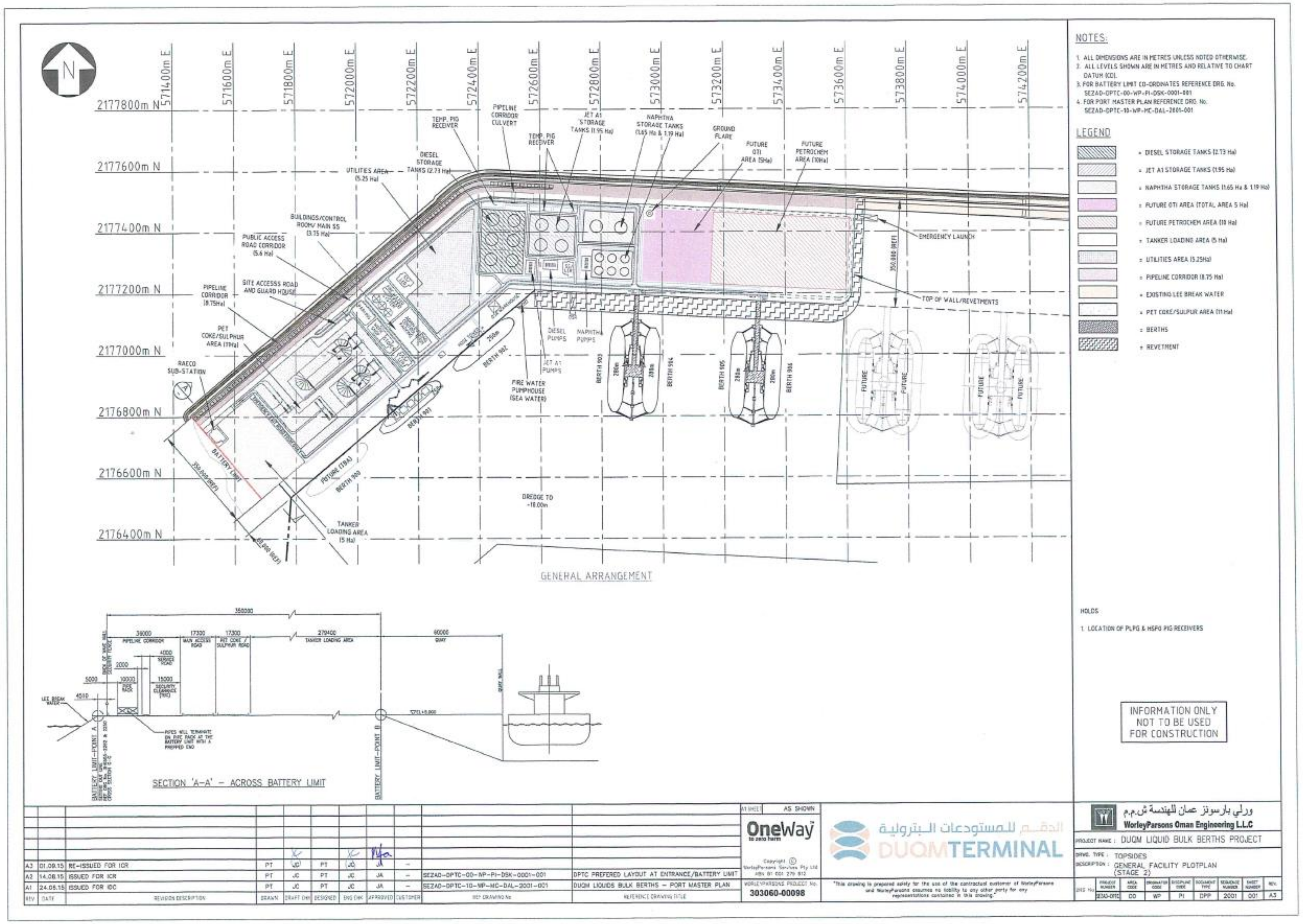

Figure 3-2: Layout of Facility

- Installation of the following items on the berths:
  - Ship loading equipment
  - Pipelines
  - Tanks
  - Flare
  - Auxiliary equipment
  - Utilities
  - Equipment for control of loading and shipping operations
  - Access Road.
- Housing up to 5,000 personnel in an existing construction camp for the peak construction

Associated facilities such as access roads, pipelines, external drainage and power lines will be developed by third parties and will extend until the battery limit at the root of the LBW. These facilities though important for the construction and operation of the DLBB Project have been excluded from the scope of this EIA. Separate EIA's for these ancillary facilities will be prepared by the respective third parties and submitted to the regulator for approval. Section 3.7 identifies and summarises detail related to associate facilities.

3.3.1 Marine Structures

As part of the Project, an area 150 to 350 m wide area will be reclaimed along the LBW and the area south of the reclamation will be dredged to -18 m CD (Refer Section 3.5.1 on dredging and reclamation). As part of the project, seven berths will be constructed. Table 3-1 presents a summary of the berths.

Table 3-1: Summary of Berths

Berth	Use	Proposed Structure[NOTE]
900	Dry Bulk Material Export Berth – Spare	Continuous Quay (Blockwork wall)
901	Dry Bulk Material Export Berth for Pet Coke and Sulphur	Continuous Quay (Blockwork wall)
902	Multi-purpose /Small Vessel Refined Product Export	Continuous Quay (Blockwork wall)
903 and 904	Liquid Refined Product Export Berth for Jet-A1 and Diesel	Double-sided Island Jetties (Concrete deck on steel piles)
905	Liquid Refined Product Export Berth for Naphtha and PLPG	Double-sided Island Jetties (Concrete deck on steel piles)
906	Liquid Refined Product Export Berth - Spare	Double-sided Island Jetties (Concrete deck on steel piles)
Note: The proposed structures listed are typical structures and the EPC Contractors could modify the structures depending on field conditions		

3.3.2 Topside Facilities

The DLBB Project will export refined products namely Naphtha, Jet A-1, Diesel, HSFO, PLPG, Pet Coke and Sulphur.

Refined liquids, such as Naphtha, Jet A-1 and Diesel shall be pumped from the refinery to the Terminal Storage Tanks, through the pipeline network from refinery. HSFO and PLPG will be pumped from the refinery by pipeline directly to the ships. Duqm refinery will be responsible for the construction and operation of the pipelines from the refinery to the DLBB Project terminal battery limit. The Pet Coke and Sulphur will be transported from the refinery to the DLBB Project by trucks owned and operated by the refinery (Refer Section 3.5.6 for details).

Table 3-2 presents the proposed storage at site.

Table 3-2: Tank Farm Capacity

Product	Type of Tank	No of Tanks	Tank Working Capacity (m^3)	Dimensions D × H (m)	Tank Farm Capacity (m^3)
Naphtha	Floating Roof tanks with geodesic roof, Conical Base	2	41,500	41×35	83,000
		6	13,800	28×26	82,800
Jet A-1	Floating Roof tanks with geodesic roof, Conical Base	4	41,500	41×35	166,000
Diesel	Fixed Roof, Conical Base	6	41,500	40×35	249,000
HSFO	Refinery by pipeline directly to vessels				
PLPG	Refinery by pipeline directly to vessels				
Pet Coke	In covered stockpiles (total storage 90,000 tons)				
Sulphur	In covered stockpiles (total storage of 60,000 tons)				
Note: HSFO export is anticipated to occur during the first 90 days after the initial Refinery start-up and then for short periods when the Delayed Coker Unit is shut down for maintenance					

Export of product from the facility will be in 4 modes as listed below:

- Storing of product in tanks at the terminal (i.e. Naphtha, Jet A-1 and Diesel)
- Loading of stored products to vessels (i.e. Naphtha, Jet A-1, and Diesel)
- Loading products directly from the refinery to ships (HSFO and PLPG)
- Loading Diesel and Jet A-1 from storage tanks to road trucks
- Loading of bulk material by conveyor system on to vessels (Pet Coke and Sulphur)

Miscellaneous Quay Furniture

Table 3-3 presents a summary of miscellaneous quay that will be installed on the continuous quay and island jetties.

Table 3-3: Miscellaneous Quay Furniture

Furniture	Comments
Rope Rails and Stainless Steel Formers	Rope Rails and Stainless Steel Formers will be used to prevent damage to the mooring lines. The island jetties will use rope rails, while the continuous quay will use stainless steel formers
Marine monitoring systems	The marine mooring systems will consist of the following sub-systems such as: • Central control and monitoring equipment in control room • Berthing/Dock Aid System laser based • Mooring load Monitoring system
Oil spill containment equipment (Oil Boom)	The oil spill containment equipment will as a minimum meet the following requirements: • Containment of spilled products • Spilled product recovery • Transportation and storage of recovered products
Kerbs and traffic barriers	Continuous kerbs will be provided around the loading platform to contain spills and reduce the risk of vehicles driving off the edge of the quay. Kerbs will also be provided along the edge of the quay wall with breaks at the bollard locations for the bulk berths. Traffic barriers will also be erected to direct traffic.
Access Gangway	Access gangways for light vehicles will be provided between the loading platforms and breasting dolphins. Only pedestrian access gangways will be provided to berthing and mooring dolphins.
Handrails	Handrails will be provided along the pedestrian access ways on any edge which is open to the water, excluding the port side edge and where they will interfere with normal operations of the berth such as berthing, un-berthing, mooring and ship loader/loading arm operations
Emergency ladder	A minimum of two emergency ladders will be provided for each loading platform and a minimum of one ladder on each breasting and mooring dolphin. For the continuous quay and access trestles, ladders will be provided at a maximum spacing of 30 m in accordance with BS 6349-2:2010.
Lifesaving equipment	Life-saving equipment such as life buoys, life jackets, etc. will be provided at all ladder locations
Jetty/Quay Service	The jetty will also offer various services such as low voltage, information technology, firefighting, compressed air, etc.
Utility trenches	Utility trenches and/or utility trays will be provided at locations to facilitate the functions of the berths and to avoid the obstructions at the platform due to the utility lines if installed above deck level.
Walkway services	Cable tray supports (cantilever structural members) at both sides of the walkway will be provided for an adequate number of cable trays considering the current requirements and spares for future use.

3.3.3 Buildings

Table 3-4 presents details of buildings onsite.

Table 3-4: Buildings at site

Building	Comments
Admin Building/ Control Room/Amenities	• 3 storey RCC framed structure with blockwork infill • Plan area of about 1,200 m^2 in each floor, i.e., 3,600 m^2 • 50 users of admin building • 25 operators in control room
Parking area	• Open area, for admin building./control room • Additional parking facility in front of workshop (if required) • Tarmac pavement will be provided
Substations / Local Equipment Room	• 2 storey, RCC structure • Number of substations 6 • Number of operators 10
Workshop	• Single floor • Steel framed structure • Number of users 20
Guard house	Guard House complex will be a single storey building in protected air-conditioned environment consisting of • Approach road • Main gates • Security gates • Time office • Speed breakers • Traffic barriers and • Parking/waiting space –
Warehouse	Warehouse for storage of miscellaneous material
Firewater Pump House	Pump house for storage of fire water
Product Pump Rooms	Rooms housing pumps for transferring products. Details not available in current stage of the Project.
Bulk Storage Buildings	Sheds for storage of Pet Coke and Sulphur
Fire and First Aid Building	Buildings housing firefighting and response tools and equipment. Details not available in current stage of the Project.

3.4 Operation Phase

The operation of the terminal will consist of the following activities:

- Storing of Naphtha, Jet A-1 and Diesel in tanks at the terminal

- Loading of stored Naphtha, Jet A-1 and Diesel onto the vessels
- Loading HSFO and PLPG directly from the refinery onto the vessel
- Loading Diesel and Jet A-1 from storage tanks to road trucks
- Loading of bulk Pet Coke and Sulphur onto the vessels

The subsequent sections present various aspects of facility operations.

3.4.1 Products

The products that will be loaded to vessels and road tankers at the terminal are: Naphtha, Jet A-1, Diesel, HSFO, PLPG, Pet Coke and Sulphur. Subsequent sections elaborate on the same.

Naphtha

Naphtha is a highly flammable clear colourless to dark brownish coloured liquid with an aromatic odour. It is less dense (608 to 628 kg/m^3) than water and insoluble in water, hence floats on water and its vapours are heavier than air. Naphtha is used as a solvent, and as a raw material for making various chemicals.

The Duqm Refinery will produce Naphtha and transfer the same to the DLBB Project via a pipeline running though the Centralized Utility Company LLC (CUC) utility corridor. A typical production rate of Naphtha by the Duqm Refinery is 690 m^3/hr. In the DLBB Project Naphtha will be stored in 2 tanks with capacity of 41,500 m^3 and 6 tanks with capacity of 13,800 m^3. Naphtha will be loaded from berth 905 to waiting vessels via a loading arm.

Jet A-1

Jet A-1 is a highly flammable watery colourless liquid, which is less dense than water and insoluble in water and hence floats on water. The Duqm Refinery will produce Jet A-1 and transfer the same to the DLBB Project via a pipeline running though the CUC utility corridor. A typical production rate of Jet A-1 by the refinery is 560 m^3/hr. In the DLBB Project Jet A-1 will be stored in 4 floating roof tanks with internal geodesic roof and a conical base, each tank will have a working capacity of 41,500 m^3. Jet A-1 will be loaded from berth 903 and 904 to waiting vessels via loading arm. It should be noted that Jet A-1 will also be exported by road using road tankers.

Diesel

Diesel is a highly flammable straw yellow to dark coloured liquid with a petroleum-like odour. Flash point is below 61°C. It is less dense than water and insoluble in water and hence floats on water. Diesel vapours are heavier than air and tend to accumulate in low lying areas. The Duqm Refinery will produce Diesel and transfer the same to the DLBB Project via a pipeline running though the CUC utility corridor. The typical production rate of Diesel by the refinery is 1,380 m^3/hr. In the DLBB Project, diesel will be stored in 6 fixed roof tanks and a conical base; each tank will have a working capacity of 41,500 m^3. Diesel will be loaded from berth 903 and 904 to waiting vessels via a loading arm. It should be noted that Diesel will also be exported by road using road tankers.

PLPG

PLPG is a highly flammable a mixture of butane, iso-butane, propane, propylene, butylene and other hydrocarbons of low molecular weight that is refined from petroleum. As Liquefied Petroleum Gas (LPG) is maintained as a liquid under pressure, leaking vessels will release either the liquid, which quickly vaporizes, or a gaseous mixture. The gas is heavier than air and a flame can flash back to the source of the leak very easily. Used as a fuel, an aerosol propellant, in cigarette lighters, and to make other chemicals. PLPG will be loaded to the vessels directly from the refinery, without intermediate storage at the DLBB Project. PLPG will be loaded to vessels at berth 905.

HSFO

HSFO is a flammable oily yellow-brown liquid, which is less dense than water and insoluble in water, hence HSFO floats on water. HSFO will be only produced at the refinery when the Delayed Coker Unit (DCU) at the Refinery is offline. HSFO export is anticipated to occur during the first 90 days after the initial Refinery start-up and then for short periods when the DCU will be shut down for maintenance. HSFO will be directly loaded at berth 902 to vessels, i.e., there will be no intermediate storage at the DLBB Project. HSFO will be transferred by pipeline from the refinery through the CUC utility corridor.

Sulphur Pellets

Sulphur is a strong reducing agent which is pale yellow crystalline solid with a faint odour of rotten eggs. It is insoluble in water and poses a fire and explosion risk above 232 °C but solid Sulphur (solid does not burn) melts at about 121 °C and will burn if there is an ignition source and air supply. Auto explosion temperature is 191 °C for dust. It may be irritating to skin, eyes and mucous membranes. Used in sulphuric acid production, petroleum refining, and pulp and paper manufacturing. Sulphur will be produced at the refinery and it will be transported by the refinery by road to the DLBB Project. The refinery will also be responsible for transporting the Sulphur to DLBB Project by truck, through the dedicated road along the utility corridor built by CUC. Sulphur will be transported from the Refinery to the DLBB Project using 25 tons tipping trucks. The typical production rate of Sulphur (based on the Design Case) is 900 ton/day. The Sulphur will be stockpiled at the terminal and exported through berth 901.

Pet Coke

Petroleum coke is a chunky, porous, black, carbon material and when calcined, it is crushed and pulverized into a fine black powder. Petroleum Coke is produced from high temperature treatment of heavy petroleum fractions. Composition varies depending on source of final product. Polycyclic aromatic hydrocarbons (3 to 7 C-ring), such as benzo(a)pyrene, are present in trace concentrations (<0.1 %). Pet Coke is neither a flammable nor combustible material, but it could burn if heated to extremely high temperatures. The auto ignition temperature for solid Pet Coke is about 677 °C. Green Pet Coke can burn at temperatures of 371°C. Auto explosion temperature is not available for dust. Petroleum Coke will be transported from the Refinery to the DLBB Project using 25 tons tipping trucks. The typical production rate of Pet Coke (based on the Heavy Crude Blend) is 2,714 tons/day. Pet Coke will be stockpiles at the DLBB Project and will be exported through berth 901.

3.4.2 Operation of Onshore Facilities

On arriving at the terminal vessels arriving will load their entire volumetric capacity of cargo and undertake non-loading activities, such as manoeuvring, berthing time, mobile loading arm hook-up/disconnect and administration. The responsibility for safe cargo handling operations is shared between the ship and the Terminal and rests jointly with the Harbour Master and the Terminal Representative.

For quality assurance and safety reasons simultaneous loading of two tanks, from the refinery, with the same product will not be allowed. Therefore, filling the storage tanks from the Refinery will be done in sequence i.e. one tank at a time. Each tank is to be fitted with a High and Low level alarm and High-High level trip to close the tank inlet and send a signal/alarm to the Refinery to cease export. It should be noted to avoid contamination all the tanks at the DLBB Project are dedicated to a single product.

The Refinery will control the transfer pumps to the DLBB Project, whereas shut-off valves and emergency shutdown valves located at the DLBB Project will be controlled by DPTC. When tank is filled, the refinery will be informed and the pumping to the tank stopped. The operator (i.e., DPTC) will then make the next tank available for filling. The inlet valve will be closed to the filled tank and opened for the next tank. In the event that any of the tanks fill to its capacity an alarm will be raised at the DLBB Project control room and the refinery and closure of the emergency shutdown valve will initiate.

Pet Coke and Sulphur are delivered by road, by Duqm Refinery to covered storage facilities on the Project terminal. Pet Coke and Sulphur will not be loaded to vessels concurrently, but rather will be loaded in sequence. Loading of Pet Coke and Sulphur uses identical equipment and methods. Level control shut off will ensure that the hold will not overfill. The design of the equipment on the wharf will be to contain potential spillage. Control of the system will be both local and remote, with the control centre being in communication with the local operator.

3.4.3 Ship to Shore Interface

Responsibility for the provision of safe ship/shore interface is jointly shared between the ship and the terminal. All cargo operations will be carefully planned and documented in advance of their execution. The details of the plans will be discussed with all stakeholders, including the vessel, PDC and DPTC. Prior to the vessel arriving at the DLBB Project there will be:

- Pre-Arrival Exchange Of Information – which will involve exchange of information between the stakeholders (PDC and DPTC) and the vessel with regard to:
    - Vessel details (identification, draught, beam, manifold, cleaning of tanks or freeing of gas, cargo, safety concerns, hull damage, toxic material on board, etc.)
    - Port details will be communicated by PDC (depth of water, chart datum, salinity of water, Marine Pollution (MARPOL) facilities provided by PDC, bunkering facilities, tugs available, environmental restriction applicable to berth, security level, bunkering facilities, etc.)

    - Terminal details will be communicated by DPTC to the vessel (Details of any shore moorings, side to be moored alongside, number and size of hose connections and manifolds, inert gas requirements for cargo measurement, etc.)

- Pre-Berthing Exchange of Information – details of pre-berthing exchange of information is provided below:

    - Vessels to the DLBB Project terminal (Details of any deficiencies or incompatibilities in the ship's equipment that might affect the safety of the mooring)

    - Vessels to PDC (Identity of the chocks, bollards and strong points that can be used for towing, the Safe Working Load (SWL), of any equipment to be used for towing, the number and location of areas on the ship's hull that are strengthened or suitable for pushing, and description of relevant identification marks employed

- Pre-transfer Exchange of Information - Completion of safe and efficient cargo operations is dependent upon effective co-operation and co-ordination between all parties involved, i.e., DPTC and vessel

    - Information for cargo discharge – cargo specifications, water drips in cargo tanks, preferred order of discharge, max discharge rates and pressure, tank cleaning, etc.

    - Information for cargo loading- toxic specifications, tank venting requirements, loading rates, etc.

Spillages and accidents at the terminal will be addressed through Spill Containment Facilities. All marine loading arms will be designed to account for expected and unexpected movements of the vessels during connection and disconnection and an emergency shutdown system will be developed. Additionally, Powered Emergency Release Coupling will allow quick disconnection of a marine loading arm in an emergency, or when the operating envelope of a loading arm is exceeded. It has a valve on each side of the release point to minimise spillage. On release, the lower part of the coupling and its attendant valve remain attached to the ship's manifold while the upper part and its attendant valve remain attached to the cargo arm, which is then free to raise clear of the ship.

Loading – DLBB Project Tanks to Ship

During the marine tanker loading operation over the duration of ship loading continued telecommunication between the Master and the control room at the Terminal is required to ensure that the selected ship tanks are filled in a safe manner. For Naphtha, Jet A-1 and Diesel, an adequate number of pumps are proposed to achieve the desired peak loading rate of 7500 m^3/hr.

The loading pumps for Naphtha, Jet-A1 and Diesel are to be located outside the bunded areas of the respective tanks. Each product will be exported from one corresponding tank at a time; i.e., no parallel operation will be allowed except for unusual/abnormal circumstances or when 2 ships are loading the same product simultaneously. An alarm will be raised at the jetty control room when the liquid in the tank reduces below a predetermined level. In the case it is required to completely empty the tank, the stripping pump will be used (in manual control from the operator).

An emergency shutdown system will be provided, in order to cater to any emergency. The system will be adequately designed.

Loading – Refinery to Ship

This operation includes export of PLPG and HSFO (occasional) directly from the Refinery. Flow control equipment, shut off valves, ESDVs (Emergency Shutdown a Valve) and fiscal metering package (PLPG only) are located at and controlled by the DLBB Project. The Refinery has the control of the transfer pumps. There will be constant communication between the ship master, DLBB Project and refinery during loading operations. To facilitate unhindered communication, dedicated hot line between the refinery and terminal will be used.

The export of PLPG is undertaken under pressure at ambient temperature. The first step in the export process is the purging of nitrogen or contaminants from the PLPG tanks on the vessel. Loading starts at a very slow flow, giving time for the incoming liquid to expand safely at the first valves in the ship's system. Once the ship is ready to receive PLPG, the ship's manifold valves can be opened and the Refinery starts the PLPG export pump so PLPG export commences. PLPG ship loading operations will be directed from the DLBB Project and DLBB Project control room. The refinery controls the operation of the PLPG export pumping.

HSFO ship loading operations will be directed from the Terminal and Terminal control room. Once all necessary terminal and vessel valves in the loading system are open, and the ship has signified its readiness, loading can commence. As with PLPG, the refinery controls the operation of the HSFO export pumping. There is no HSFO fiscal metering at the Terminal. Fiscal metering will be done by the fiscal meter on the ship, with cross-checking on the tank gauge system at the Refinery. The Terminal will be responsible to verify/reconcile the data and issue the necessary documentation, also to the Refinery.

Loading – Road Tankers

Tanker loading facilities are provided for exporting Diesel and Jet A-1 from the truck loading tanks. The storage tank stripping pumps will be used for filling the truck loading tanks. Each tanker loading pump is expected to be able to load up to two trucks simultaneously, with any surplus product being recycled back to the product tank.

Fixed speed pumps are proposed meaning that there is a reliance on spill back of flow to the storage tank when the demand does not meet the minimum flow required by the pump. The loading pump shall not be started until a clear signal has been received from the truck loading station that the truck is ready, bonded and connected. The truck needs to be bonded to minimize the hazard of static electricity. The generation of static is controlled by limiting the flow rate at the commencement of loading.

Truck loading logic gradually ramps up the flow rate to the truck by acting on the dedicated control valve and diverting the excess of cargo back to the storage tanks via the spill back line. When truck loading is about to be finished, logic gradually ramps down the flow rate to the truck by acting on the dedicated control valve. The loading rate will be reduced sufficiently to permit effective control of the final flow. Further, the truck loading bay is provided with a bonding interlock system that interrupts loading if the connection is lost.

Loading – Bulk Material

Pet Coke and Sulphur are delivered by road, by Duqm Refinery to covered storage facilities on the Project terminal. The covered storage will be steel frame fabric storage building. Figure 3-3 presents an example of such a building.

Figure 3-3: Example of a Steel Frame Fabric Storage Building

Stacking in the covered storage will be with a boom stacker can be fully automated and allows flexibility and there is no need to manually move the stacking equipment around.

Pet Coke and Sulphur will not be loaded to vessels concurrently, but rather will be loaded in sequence. Loading of Pet Coke and Sulphur uses identical equipment and methods. When a vessel is ready to load, the ship-loader system will be connected to feed a designated hold and either Sulphur or Pet Coke will be reclaimed from the stockpiles and fed by a combined fixed and mobile conveyor system to the ship. The conveying system will be interlocked to prevent safety hazards and to prevent spillage and damage. All transfer points in the system will have dust control facilities, either through extraction or wet suppression. The final discharge to the hold will be through a dust containing cascade chute. The vessels holds will be filled in under control of automated weighing systems. Level control shut off will ensure that the hold will not overfill. The design of the equipment on the wharf will be to contain potential spillage. Control of the system will be both local and remote, with the control centre being in communication with the local operator.

3.4.4 Flare System

The flare will be located on the northeast side of the project area on the LBW, i.e., it will be located east of the Naphtha storage tank area and near the future development area. The function of the flare system is to combust flammable, toxic or environmentally damaging substances into safer material. The flare system will be designed for emergency operations in accordance with API 537. The principle aims and objectives of the flare are to:

- The protection of personnel.

- The protection of plant and equipment.
- The minimisation of air pollution to the environment (smokeless under normal operation).

The flare for the DLBB Project will be a refractory lined enclosed ground flare. Figure 3-4 presents a typical enclosed ground flare.

Figure 3-4: Typical Enclosed Ground Flare

Ground flares are typically used in process blocks as they are totally self-supporting and require only a small open area around them to ensure good air introduction. Further as the flame is enclosed, no major open area is required to guard against radiated heat. They are frequently used within process blocks. The flare will be designed for smokeless operation. This is industry best practice and can be achieved through use of air fans or appropriate design of the flare tip and burners. The principal dimensions of the flare are:

- Height – 24.2 m
- Stack diameter – 13.7 m
- Width of base – 23.7 m

The flare will be designed to operate in accordance with requirements of MD 118/2004, BAT, and IFC guidelines.

Although, the pilot flame will be continually lit, releases will occur during emergency scenarios from the flare. These intermittent releases will be of short duration and will result in the emissions of NO_X, PM_{10} and traces of other pollutants. The flare shall be designed for smokeless operation; therefore the predicted levels for PM_{10} are expected to be very low. The flare network will collect potentially flammable process gases from equipment and piping from the following units:

- PLPG vapour return
- Fuel gas storage

A Flare knock-out drum is also provided to collect any liquid, which will then be evaporated by the heater and sent to the flare. The Flare main headers and sub-headers shall be continuously purged with nitrogen at the extremities of the system to prevent ingress of oxygen via the flare tip. Table 3-5 presents flare cases.

Table 3-5: Flare Cases

Description	Source	Composition	Inlet Flowrate
Fuel Gas Storage	PSV	To confirmed during detailed design stage Q3-2016	To confirmed during detailed design stage Q3-2016
PLPG Vapour Return	PLPG Carrier	100 % Propane to 100 % Butane	35,150 kg/h

3.4.5 Spill Containment

The International Petroleum Industry Environmental Conservation Association (IPIECA) reference document (“A Guide to Contingency Planning for Oil Spills on Water, 2nd Edition, March 2000) which advises of three tiers of oil spill response. The level of oil spill response will be broadly dependent upon this Tier classification. In general it is considered unnecessary to expect every port, harbour or oil handling facility, to maintain an adequate capability to mitigate the effects and consequences of an oil spill incident at Tier 2 level and above.

Table 3-6 presents the response strategy at the DLBB Project for dealing with spills.

Table 3-6: Response Strategy

Tier	Description	Proposed Response
Tier 1	Operational type spill near company’s own activities, requiring company’s own resources to respond. Typically, this is considered to be a spill of less than 100 tons.	Response shall be by DPTC and PDC
Tier 2	A large spill in the vicinity of company’s facilities but requires assistance from other companies, and or regional resources to respond. Typically, this is considered to be a spill of 100 – 500 tons.	Response by PDC
Tier 3	Severe spill requiring national and international resources to respond. Typically, this is considered to be a spill greater than 500 tons.	Response by PDC and national agencies

Oil Spill Response (OSR) equipment to deal with Tier 1 spills will be provided at the DLBB Project terminal. The OSR equipment can be stored in custom built portable storage containers or, alternatively, the construction of a purpose built 'OSR Base Building' can be considered. Table 3-7 presents a list of expected OSR equipment.

Table 3-7: Expected DLBB Project OSR Equipment

DLBB Project Oil Spill Response Equipment	Notes
Floating Self Inflatable Oil Containment Boom 600 m	2 sets, to respond to an OSR event at two isolated berths
Electrically Powered Oil Boom Storage Reel	Containerised reels to handle the booms
Diesel Powered Air Inflator / Compressor	Containerised equipment to inflate the booms
Floating Oleophilic Type Skimmer Capacity 25m³/hr	2 sets
Floating Weir Skimmer Capacity 30m³/hr	2 sets
Floating Oil Storage Bladder 10T Capacity	5 number
Workboat / 2 × 90 HP Outboard Engine for Boom and Skimmer Deployment	2 units as supplied by PDC
Transport and Launching Trailer for LC6500 Workboat	2 units
Oil Boom / Skimmer Accessories	1 set – total 5 numbers
Manual Winch 300 kg SWL Pedestal Mounted Davit for Skimmer Launching	4 units
Purpose built ISO DC 20' Container for Storage of Boom Reels	1 units
Purpose built ISO DC 20' Container for Storage of Skimmers and Floating Tanks	-
Spare Parts / Consumables for Start Up	Adequate numbers

In addition to the equipment listed in the above table the option of using permanent booms is also being considered. It should be noted that DPTC in conjunction with PDC will prepare an oil spill response plan to deal with potential spills.

3.4.6 Storm Water Drainage Systems

Potentially contaminated surface runoff comprises of contaminated liquid run off from paved areas that are unsuitable for release directly to the environment. The storm water drains system shall collect all surface water; wash down water and rain water from potentially contaminated process areas including spillages, overflows and wash downs. Water will be collected in the storm water drains for approximately 10 min and directed to the wastewater treatment system before overflowing the collection sump. By this time, the areas where the rainwater has fallen will be considered clean and the rainwater is not liable to be contaminated so shall be discharged to outfall without further treatment.

Water from contaminated areas will include all permanent storage and transfer areas containing large volumes of hydrocarbons such as Diesel, Naphtha and Jet A-1. These areas shall be bunded. Discharge shall be managed via dedicated sumps, which are periodically sent to the Oily-Water System. Tank and pump draining operations are also forwarded to the Oily-Water System.

Similarly, the chemical storage areas shall be bunded and any accumulation of the chemical and rainwater shall be drained to a sump and periodically sent to the wastewater treatment plant. Lastly, water shall be sprayed onto the Pet Coke and Sulphur storage areas to help reduce the amount of product dust released. This water shall be collected and filtered to retain the captured Pet Coke and Sulphur, and cleaned for reuse, from the Terminal Wastewater Treatment Plant.

3.4.7 Operation Phase Resource Consumption

Fuel

During the operation phase refuelling of tug boats and vessels will be managed by PDC and the Oman Oil Marketing Company bunkering facility. The tug boats directing vessel movement in the port will be managed by PDC. PDC will also be responsible for bunkering of tug boats. Bunkering facilities for all vessels visiting the port, including the DLBB Project, will be by Oman Oil Marketing Company bunkering facility on the commercial quay or via bunkering vessels being used to fuel the vessels visiting the terminal. The bunkering vessels will berth alongside the vessels at their berths. Additionally, LPG will be used at the DLBB Project as a fuel for the pilot flame. LPG will be transferred to the site and stored in a LPG container. Land vehicles will be refuelled at the local fuel station in Duqm or through a fuel dispenser bought to the facility.

Power

CUC proposes to build a 300 megawatts (MW) combined cycle power plant in Duqm. This power plant is designated to serve the power requirements of Duqm Refinery, Oman Tank Terminal Company project in Ras Markaz and the DLBB Project. The power plant is proposed to be commissioned in October 2018, in time for the operation phase for the DLBB Project. The power demand of the DLBB Project during the operation phase is approximately 15 to 20 MW.

Water

In order to cater to the water demand at the facility a RO plant[2] has been proposed. Estimate of the water demand during the operational phase is provided below:

- Tankage for Fire Water – 4,250 m^3
- Tankage for Domestic Potable water – 54 m^3
- Tankage for Emergency Potable Water – 13.7 m^3
- Tankage for Utility Water – 271.6 m^2

[2] Permeate make-up = 91.4 m^3/day Brine Removal = 18.1 m^3/h

Emergency Power

An emergency power back-up (DGs) of approximately 1 MW will be provided at the DLBB Project.

Chemicals

A number of chemicals will be used at the DLBB Project for operation and maintenance and cleaning purposes. Use of chemicals will be in accordance with RD 46/95, MD 248/97, MD 20/99, MD 316/2001, MD 371/2001, and MD 25/2009. Chemical use at site will be subsequent to obtaining requisite permits and licenses from regulators.

3.4.8 Manpower

During the operation phase the DLBB Project will employ about 60 personnel. Accommodation for DPTC personnel during the associated operation phase will be in the Duqm Town.

3.5 Construction Phase

The DLBB Project will have a 3 years construction period, extending between 2016 and 2019. In this period the dredging and reclamation will be the first activity completed between 2016 and 2018. After which the top-side facilities will be between 2017 and 2019. The construction contract will be divided into 3 Work Packages, which are:

- Work Package 1 – Dredging and Reclamation
- Work Package 2 – Marine Structures and Civil Works
- Work Package 3 – Topside Works

These three Work Packages will be awarded to two EPC Contractors – EPC-1 (Marine side) and EPC-2 (Topside). Work Package 1 will be included in the scope of the EPC-1 Contractor, while Work Packages 2 and 3 will be included in the scope of the EPC-2 Contractor.

3.5.1 Work Package 1 – Dredging and Reclamation

The liquid berths basin area is currently un-dredged, varying in elevation from approximately Chart Datum (CD) to the dredge level for the existing port at -18m CD. Figure 3-5 presents the area earmarked for dredging in the port basin.

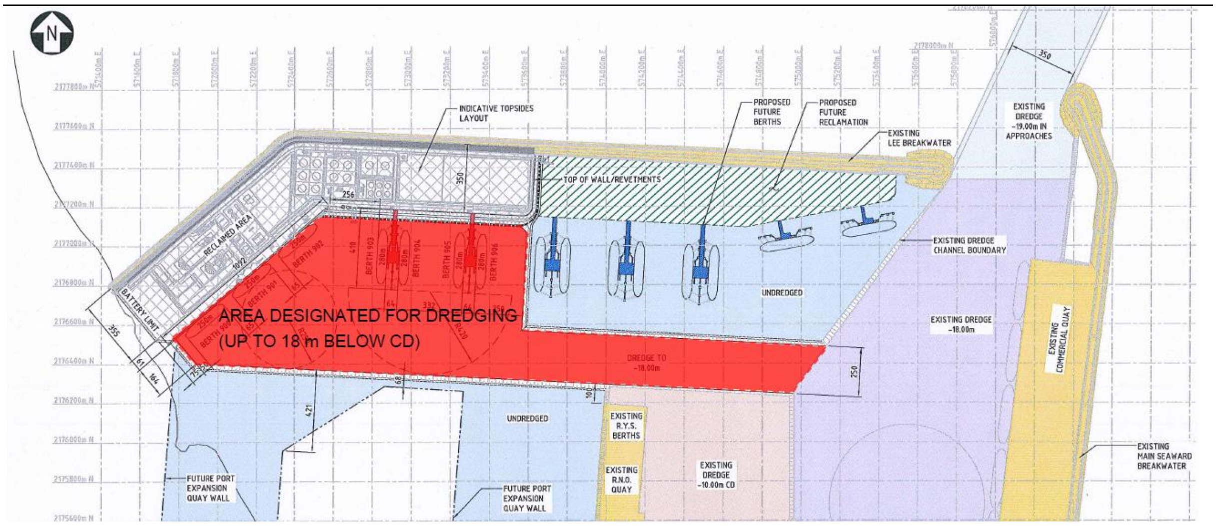

Figure 3-5: Area Earmarked for Dredging in the Port Basin (Highlighted in Dark Red)

In all, the DLBB Project involves the dredging of about 27 million m^3 of soil from the port area and about 6.5 million m^3 of soil from the offshore borrow area.

In addition to the dredging, reclamation will need to be undertaken along the LBW for construction of tanks and other facilities along the LBW. Approximately 6.5 million m^3 of soil will be required to create 150 to 350 m wide reclamation along the LBW, which may be sourced from the offshore borrow area. Figure 3-6 presents the area earmarked for reclamation.

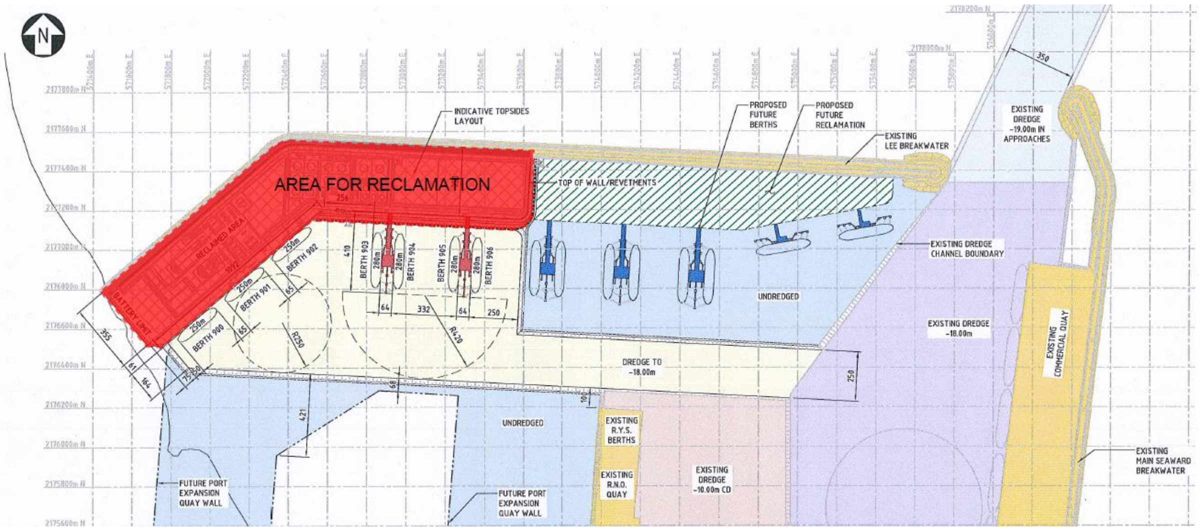

Figure 3-6: Area Earmarked for Reclamation (Highlighted in Dark Red)

Soil for reclamation will be obtained from the offshore borrows area. The material dredged within the port is deemed unsuitable for reclamation and will be disposed offshore in an offshore disposal area. The dredging and reclamation are expected to extend for a period of 2.5 years. Table 3-8 presents the approximate volume of material for dredging and reclamation.

Table 3-8: Dredging and Reclamation Volume

Activity	Approximate Volume (million m^3)
Dredged in the basin	27
Material dredged from offshore borrow	6.5
Unsuitable material disposed offshore	27
Note: The volumes presented are preliminary and will be confirmed as the design progresses	

The dredging and reclamation activities will consist of:

- Dredged from Basin
- Dredged from offshore borrow pit to use in reclamation
- Clay/Mudstone dredged from Basin for disposal

Figure 3-7 presents the offshore borrow and disposal area relative to the DLBB Project.

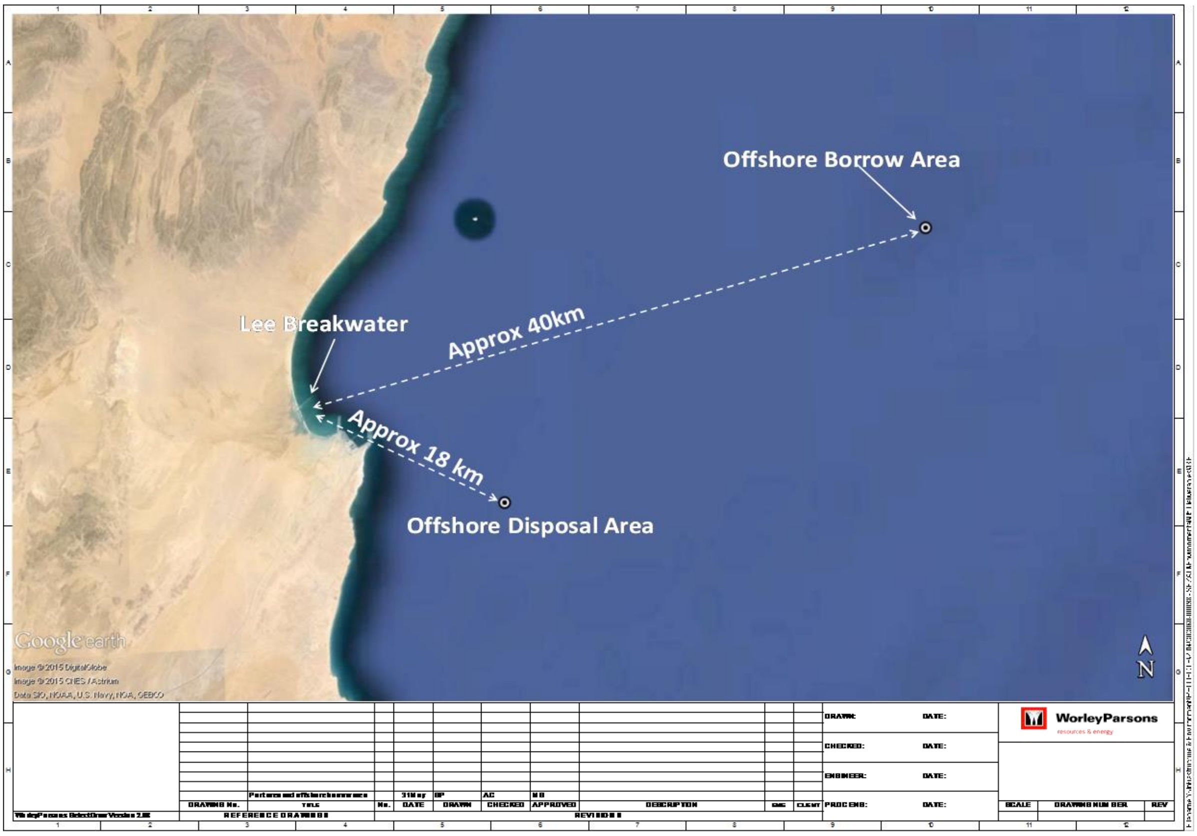

Figure 3-7: Offshore Borrow and Disposal Area

For dredging works use of Cutter Suction Dredger (CSD) and Trailer Suction Hopper Dredger (TSHD) is proposed. The CSD is expected to be used with the port basin to dredge sand and mudstone, while the TSH is expected to be used for dredging at the off shore borrow area and removing the sediment/siltation which accumulates in the port during construction activities.

It should be noted that the EPC Contractor may select alternate dredging methodologies, based on actual ground conditions. The final selected dredging methodology will be communicated by the EPC Contractor to the regulator.

A CSD is a type of stationary hydraulic dredger which uses a rotating mechanical device to cut through the stiff material and pumps with a head differential to transport the loose soil in soil-water slurry through a pipeline into an adjacent barge.

The suitable dredged material from the offshore borrow area will be used for reclaiming land along the LBW using spray pontoons. Reclamation bunds will be built from quarry material to contain the sand. Any material unsuitable for reclamation will be disposed offshore. While dredging, both sediment and water is lifted by the dredger and as a result, the barge will fill up. To extend capacity of barges water and fine sediments from the barge, will be allowed to overflow until the barge is filled with course material or the allowable total suspended particles limit is in danger of being exceeded.

Figure 3-8 and Figure 3-9 presents typical images of CSD.

Figure 3-8: Photograph of a Typical Cutter Suction Dredger *(Source: http://www.dredgingtoday.com/)*

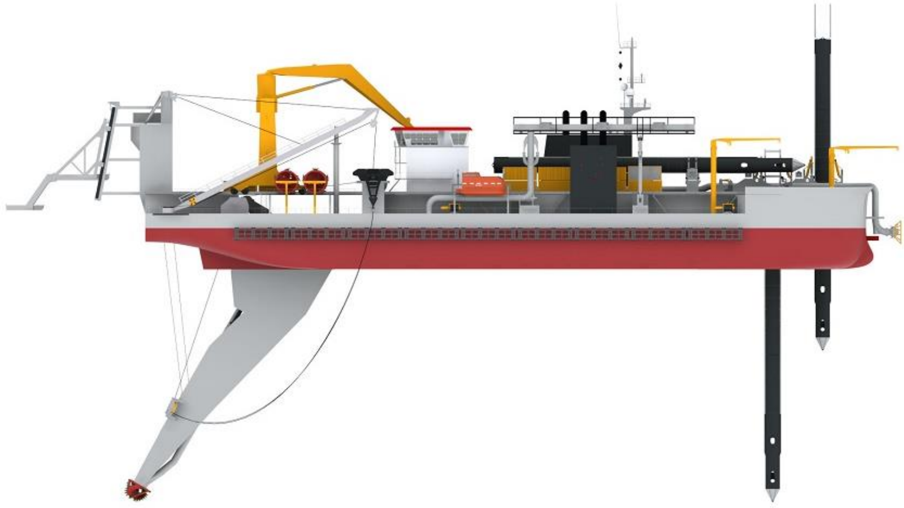

Figure 3-9: Sketch of Typical Cutter Section Dredger *(Source: http://www.corporate.man.eu/)*

The unsuitable material dredged in the port basin will be transported to the offshore disposal area by barges. The barges will be equipped with bottom doors, which will be opened once the barge reaches the disposal area to dispose the unsuitable dredged material.

TSHD is also a type of hydraulic dredger and uses suction to transport soil-water slurry to by means of a pipeline into a hopper. When dredging settling soils the dredging continues until the maximum level of the overflow is reached. Most of the solids will settle and the remainder is discharged with the water through the overflow. It should be noted that for reclamation activities the material dredged from the offshore borrow area will be transported back to the port and deposited in the reclamation area using rainbowing techniques. A TSHD will also be used to clean-up the port basin of fine after completion of dredging by CSD.

The dredge plume modelling associated with dredging is presented in Section 4.2.4.

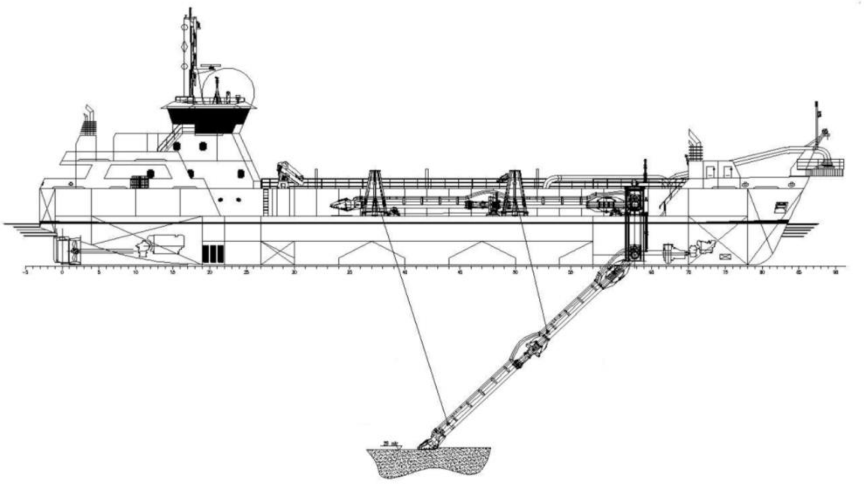

Figure 3-10: Sketch of Trailer Suction Hoper Dredger *(Source: www.damen.com)*

As highlighted earlier, reclamation of land along the LBW will be through rainbowing.

Rainbowing is the process in which a dredging ship propels dredged material in a high arc to a particular location. Figure 3-11presents examples of rainbowing by dredgers.

Figure 3-11: Examples of Rainbowing by Dredgers

After reclamation ground improvement will be undertaken, this will involve placing soil or fill material on the finished surface level of the reclamation and compacted by rolling in layers not exceeding 500 mm thick. The thickness of the fill material will be approximately 1.5 m thick. This layer will act as the completed level for construction of the topside works.

Access to the site will be through Road No. 5. The road itself will be constructed on an elevated embankment which will ultimately provide flood protection, in conjunction with wadi channel diversion works. Prior to the completion of the Road No. 5 embankment and/or wadi channel improvements, the Project works, particularly the dredged areas, will be vulnerable to the effects of wadi flooding. Temporary flood embankments constructed by SEZAD contractors from unsuitable material are considered inadequate without further reinforcement/erosion protection.

3.5.2 Work Package 2 – Marine Structures and Civil Works

As part of Work Package 2, seven berths will be constructed. Table 3-9 summarises details of the marine structures.

Table 3-9: Summary of Marine Structures

Berth	Expected Structure
900	Continuous Quay (Blockwork wall)
901	Continuous Quay (Blockwork wall)
902	Continuous Quay (Blockwork Wall)
903 and 904	Double-sided Island Jetties (Concrete deck on steel piles)
905 and 906	Double-sided Island Jetties (Concrete deck on steel piles)
Note: The Marine Structures will be finalised during the detailed design phase	

Blockwork Walls

Berth 900 and 901 may be expected blockwork wall structures or other structure type which is suitable for a continuous quay. Details and information on typical blockwork wall construction is included herein although it is noted that the EPC Contractor may propose alternative structure types and construction methodologies to construct the continuous quay wall. They will be used as a spare berth, for bulk material loading and liquid product loading. Figure 3-12 presents a typical cross section of the blockwork wall.

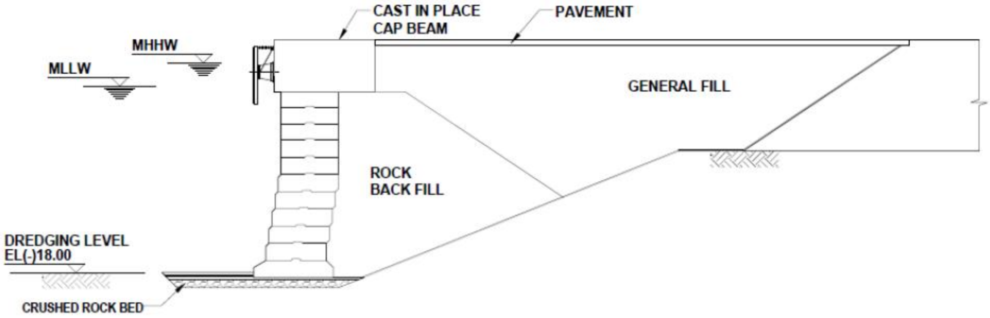

Figure 3-12: Typical Cross Section of Blockwork Wall

The construction of the block wall will involve dredging a trench until the formation level. The formation surface will be then cleaned to remove loose material like sand or silt that could interfere with the binding of concrete. A crushed rock bed, or similar, will be placed above to formation surface, with a uniformly graded blinding layer which the bottom base blocks will be placed upon. These blocks may be about 7×2×2.5 m in size and in excess of 6,000 blocks are expected to be required for construction.

Precast capping beam units will be constructed and placed onto the top block, levelled using shims. The cast-in-place portion of the capping beam will then be placed, using temporary formwork

Figure 3-13: Example of Precast Concrete Blocks Stored in Yard *(Source: http://www.npp.com.qa)*

The area behind the quay wall will be reclaimed with dredge material.

Deck on Steel Piles

Berths 903, 904, 905, and 906 will be constructed as a deck on steel piles. As the name suggests, the construction consists of installing steel piles, followed by laying a concrete deck on top of the steel piles.

The method of piling proposed for the DLBB Project is rock socket piling, which involves drilling of a hole into which a pile is installed. It should be noted that the geotechnical investigations may permit other methods of installing piles such as driving the piles with a diesel (or similar) type hammer. The sequence of construction for the rock and socket piling is summerised below:

- *Drilling of the Socket Hole*- the first step in rock socket piling involves drilling the socket holes where the piles are to be placed. The socket hole will be then cleaned using seawater and compressed air.
- *Placing of the Permanent Steel Pile* – the steel piles will be lifted by a crane and inserted into the socket hole. A grout tube will then be installed into the pile, filling both the bottom portion of the pile and the annulus between the outside of the pile and the drilled socket. The pile will be tested for static and dynamic loading (as required) prior to placing of the precast unit.
- *Placing of the precast unit* – the precast unit will be cast in the fabrication yard and transported using a hydraulic trailer/floating crane/barge to the permanent piles. Prior to lifting and placing the precast unit on the permanent piles, the piles will be prepared, which will involve cutting the precast pile and repairing the pile coating. Placing the precast elements on the piles will be done by crane.
- *In-situ casting* – will involve the placing of concrete on the pre cast unit which is in turn placed on steel piles. The in-situ casting process will consist of preparing a timber formwork, placing of reinforcement, pouring of concrete, removing of the formwork, and curing of concrete with water.

3.5.3 Work Package 3 – Topside Work

At this stage of the DLBB Project detailed information on the construction methodology for the topside works was not available and a brief description has been provided. Construction of the topside is expected to include the following activities:

- Establishment of fencing and gates: All fencing and gates will be done in accordance with DLBB Project/Port of Duqm specifications.
- Grading: The DLBB Project is located on the reclaimed area. The plot is developed with suitable soil fill material. The terrain is flat. Hence necessary site grading will be carried out by filling material as per DLBB Project specification
- Piling: tanks and the buildings will be constructed on pile foundations. Hence extensive piling work is expected.

- Construction of Roads: Asphalt roads will be provided within the terminal. Roads to and from the truck loading area will be designed for continuous heavy truck loads. Suitable drain system will be provided to collect the storm water from roads.
- Construction of Superstructure: A variety of RCC and steel framed structures will be constructed at site.
- Tanks construction: will be constructed and installed using standard methodologies
- Laying of pipelines: various pipelines will be laid on the LBW to carry product to and from the tanks and to the vessels.
- Non-Destructive Testing: will be undertaken to verify the integrity of the joints and seals hydro-testing and radioactive testing will be used for NDT.

3.5.4 Construction Camp

The construction camp for the DLBB Project will be in a designated area demarcated by SEZAD and PDC. The construction camp will have:

- Living area
- Toilet shower and wash area
- Dining area
- Kitchen area
- Recreation, Vehicle parking, and Garbage container areas

At peak construction it is expected that 5,000 personnel will be employed with the DLBB Project.

3.5.5 Construction Phase Resource Consumption

Fuel

During the construction phase fuel for use in construction equipment, vessels and vehicles will be transported to the site by the EPC Contractor. The fuel will be transported by road and/or barge. Detail of fuel requirement during the construction phase is unknown at the moment and the same will be monitored during the construction phase and reported to SEZAD. Bunkering of marine vessels during the construction phase will under the guidance of PDC.

Power

RAECO operates a temporary diesel power station in Duqm. The power station has a total installed capacity of 67 MW. Power is generated at 11 kV, which is stepped up to 33 kV for transmission. Power is distributed throughout Duqm via an underground cable network. Power requirements for the DLBB Project during the construction phase will be met by this existing power station. Additionally DG’s may be used at site. Figure 3-14 presents a photograph of this power station.

Figure 3-14: Existing Power Plant in Duqm *(Photograph 3-Sep-2014)*

Water

A reverse osmosis (RO) water desalination plant, with an initial daily capacity of 6,000 m^3 is operating in Duqm. This RO plant meets the water requirement of resident population in Duqm and the ongoing projects. Water for the construction phase of the DLBB Project will be sourced from this facility or through alternate available sources.

Cement

The DLBB Project is expected to require large quantities of cement, which could be procured from local produces or imported. The cement could be transported to the site using trucks or vessel. PDC propose to establish a 1,500,000 tons/annum cement and bitumen terminal at the port considering the rapid development. It is likely should this facility be available the cement is brought for the DLBB Project construction by vessel. It should be noted that the decision to source cement will be made by the EPC Contractor and will be selected to optimise the construction work.

Quarry Material

Quarry material is required for use as aggregate for construct, amour stone, engineered fill, and pipeline bedding. A large quantity of quarry material will be required by the DLBB Project. There are a number of potential sources of quarry material in the Duqm region. Alternatively, quarry material can also be sourced from other regions in Oman like Sohar, Nizwa and Salalah, however on account of the large transport distances it is likely that a source within Duqm will be selected. The EPC Contractor will be responsible for selecting a suitable source of quarry material and will be responsible to obtain necessary permits for quarrying of material.

Steel Rebar

The EPC Contractor will be responsible to source steel rebar for the DLBB Project. The steel may be sourced locally in Oman or from global suppliers.

Offshore Borrow Material

Reclamation material which is not supplied by dredging activities in the port basin will be sourced from an offshore borrow area located approximately 40km offshore. It is estimated that DLBB Project will borrow approximately 6.5 to 1.5 million m^3 of sand from this offshore borrow area.

Manpower

At peak construction it is expected that 5,000 personnel will be required at site. During the various phases of the DLBB Project the manpower at site will vary.

Chemicals

A number of chemicals will be used at the DLBB Project for operation and maintenance and cleaning purposes. Use of chemicals will be in accordance with RD 46/95, MD 248/97, MD 20/99, MD 316/2001, MD 371/2001, and MD 25/2009. Chemical use at site will be subsequent obtaining requisite permits and licenses from regulators.

3.5.6 Construction Phase Land Take

The construction phase of the DLBB Project will be associated with temporary land take around the Project. It is estimated that 123,000 m^2 or 12.3 ha will be required during the construction phase for Work Packages 1 and 2. It is expected that a similar area of land will be required for Work Package 3. The land take for the DLBB Project will be within SEZD in an area demarcated by SEZAD and PDC. Table 3-10 presents the temporary land take for the DLBB Project for the EPC Contractor for Work Packages 1 and 2.

Table 3-10: Construction Phase Land Take (Work Package 1& 2)

Elements	Description	Area (m^2)
Precast yard	Includes area for: Concrete blocks for continuous Quay – 14,000 m^2 Island berth pre-cast elements – 29,000 m^2	43,000
Construction Camp	Living area from 1000 labourers assuming 4.5m^2 for each labour. Toilet shower and wash area 2.25 m^2 per labour Dining area of 0.45 m^2 per labour Kitchen area of 0.15 m^2 per labour Recreation, Vehicle parking, and Garbage container 3 m^2 per labour	11,000
Batching plant, office, workshop and laydown area	Includes area for: Batching plant – 11,000 m^2 Site office – 3,000 m^2 Workshop/stores – 15,000 m^2 Laydown area – 40,000 m^2	69,000
	Total	**123,000**

3.6 Project Interfaces

The DLBB Project has a number of interfaces as it is being developed as part of development of the Duqm Port which in turn is being developed as part of the SEZD. Key interfaces for the DLBB Project are Duqm Refinery, RAECO, and CUC who are developing projects in the special economic zone. Additionally, the DLBB Project will have regulatory interfaces with the SEZAD Environmental Department and Ministry of Environment and Climate Affairs.

Table 3-11 summarises key Project interfaces. These are discussed in detail in subsequent sections.

Table 3-11: Summary of Key Project Interfaces

Stakeholder	Primary Role	Primary Interface with DLBB Project
SEZAD	Development and regulation of the SEZD	• Financial commitment to the DLBB Project • Development of infrastructure in SEZD including Road No. 5 • Environmental Regulator for the DLBB Project • SEZAD will provide waste facilities for the operation phase
PDC	Developing the Port of Duqm and Regulating it	• Would manage MARPOL waste generated at the DLBB Project • Operation and regulation of the port • Managing ship movement in and around the port as well as the wider bay of Masirah
CUC	Provision of utilities to industries within the SEZD	• Establish flood control for the SEZD and train the wadi flowing to the north of the LBW • Construction of the power and desalination plant in SEZD • Developing the road for transport of Pet Coke and Sulphur from the refinery to the DLBB Project • Development of the utility corridor in which Duqm Refinery will lay and operate pipelines to transfer product from the Duqm Refinery to the DLBB Project
RAECO	Rural Areas Electricity Company	Laying power supply lines from the power generation plant to the DLBB Project terminal, designing and building main 33/11 kV substation at the beginning of the terminal facility and will subsequently supply power
Ministry of Environment and Climate Affairs	The environmental regulator for the areas outside SEZD	Permits for use of the offshore borrow and disposal area
Duqm Refinery & Petrochemical Industries Company LLC	Development of the Duqm Refinery	• The primary purpose of the DLBB Project is to provide facilities for export of the refined product from the Duqm Refinery. The DLBB Project will be linked to the refinery through a corridor built by CUC and operated and maintained by the Refinery. • The refinery will own the trucks used for transporting Pet Coke and Sulphur from the refinery to the terminal • The refinery will own the pipelines used to transfer refined products from the refinery to the terminal
Vessel owners	Transport of refined product from the DLBB Project	Loading of the refined product from the jetty to the vessels

3.6.1 SEZAD

The SEZAD manages, regulates, and develops all economic activities in SEZD. SEZAD is also a key stakeholder in the DLBB Project and is financing the design of the entire DLBB Project and construction activity related to marine works for the DLBB Project. Additionally, SEZAD is responsible for the development of all external infrastructure related to the development of Duqm i.e. roads and utilities. In addition to being the developer of the Duqm area SEZAD will also act as the regulator in Duqm. The SEZAD Environmental Department is responsible to grant environmental permits for the DLBB Project. Additionally, SEZAD will be developing Road No. 5, which will be the permanent access route to the DLBB Project.

3.6.2 Port of Duqm Company (PDC)

Port of Duqm lies under the management of Port of Duqm Company SAOC, a 50:50 joint venture between the Omani Government and the Consortium Antwerp Port (CAP). Under an agreement signed with the Omani government in April 2011, the joint venture has been granted a 28-year concession to co-invest, operate, manage and market the Port of Duqm. Responsibility for the management and operation of the port area lies with the Port of Duqm Company. Also covered by its mandate is the responsibility for navigation within and around the port, as well as the wider bay of Masirah. PDC will be responsible to provide MARPOL facilities, tug boats and maintenance dredging in the port.

3.6.3 Duqm Refinery

Duqm Refinery is developing a refinery which is the current major greenfield development within the SEZD. The Duqm Refinery will occupy an area of 900 hectares and will have a capacity of 230,000 bbl/day from a variety of crude mixes. The primary goal of the DLBB Project is to offer a facility to allow the refinery to export refined products. The refinery itself is expected to be commissioned in Q3 2019 by which time the liquid berths must be available for export of product. The Duqm Refinery will:

- Construction and operation of pipelines to transfer refined product from the refinery to the DLBB Project through the utility corridor built by CUC
- Ownership and operation of trucks to transfer Pet Coke and Sulphur from the refinery to the DLBB Project on the road constructed, by CUC

Table 3-12 presents the production rates at the Duqm Refinery that the DLBB Project will need.

Table 3-12: Production Rates @ Duqm Refinery

Product	Production	Product	Production
Naphtha	690 m^3/hr	HSFO	670 m^3/hr
Jet-A1	560 m^3/hr	Pet Coke	2,714 tons/day
Diesel	1380 m^3/hr	Sulphur	900 tons/day

3.6.4 Centralized Utilities Company LLC (CUC)

CUC is a joint venture between Takamul Investment Company and Sembcorp Utilities (Oman) Ltd. CUC was established, to provide state-of-the-art, reliable, efficient and cost effective utilities, such as power, steam and water, to all industries in the SEZD. In relation to the DLBB Project CUC will be:

- Establishing a power and desalination to cater to industries in SEZD
- Establish flood control for the Duqm SEZ and train the wadi flowing to the north of the LBW, in the form of two dams
- Developing the road for transport of Pet Coke and Sulphur from the refinery to the terminal
- Development of the utility corridor in which Duqm Refinery will lay and operate pipelines to transfer product from the Duqm Refinery to the DLBB Project

3.6.5 Rural Areas Electricity Company (RAECO)

RAECO is a closed Omani joint stock Company. The Company undertakes electricity generation, transmission, distribution & supply and desalination activities. In relation to the DLBB Project RAECO will lay power supply lines from the power generation plant to the DLBB Project terminal, design and build the main 33/11 kV substation and will subsequently supply power.

3.6.6 Ministry of Environment and Climate Affairs (MECA)

The MECA is the primary environmental regulator in Oman. However, within SEZD the mandate to regulate environmental activities has been granted to SEZAD through RD 119/ 2011 (See Figure 1-2 on the boundary of the SEZD. That being said any activity outside the SEZD will be regulated by MECA. Hence, use of the offshore areas for borrowing and disposal, associated with the DLBB Project, will need to be permitted by and approved by MECA.

3.6.7 Vessels visiting the DLBB Project

It is expected that about 800 vessels will visit the DLBB Project every year. The vessels will be owned by independent shipping companies and their navigation within and around the port as well as the wider bay of Masirah will be directed by PDC. Furthermore, the product within the vessels will be owned by 3rd parties purchasing the product directly from Duqm Refinery, i.e., Duqm Refinery owns the product until it enters the ship, at no time does DPTC take ownership or custody of the product.

The primary carrier types are defined as Bulk Liquid for refined oil products, PLPG and other wet cargo, or Bulk Solids, which carry dry bulk cargo. In terms of product three types of carriers are expected to call at the DLBB Project, these are:

- *Product Tankers* (Figure 3-15) carry refined petroleum products in numerous bulk tanks and can carry a number of different products in a single voyage. Product tankers are built to transport refined oil products from the oil refinery to another refinery or to the end user. At the DLBB Project the Product Tankers will be used to transport Naphtha, Jet-A1, Diesel, and HSFO

- *LPG Tankers (*Figure 3-16*)* will be used to ship PLPG from the DLBB Project. These tankers have a slightly different design than Product Tankers due to pressurisation requirements for the transition from the gaseous state to the liquid state. LPG vessels are segregated into four main categories: 'ethylene' (extra refrigeration), 'fully refrigerated' (refrigeration only), 'semi refrigerated' (refrigeration and pressure) and 'fully pressurized' (pressure only).
- *Bulk Carriers* (Figure 3-17) carry dry or wet bulk cargo. Pet Coke and Sulphur will be exported using these vessels

Figure 3-15: Example of a Refined Product Tanker *(Source: http://7seasvessels.com/)*

Figure 3-16: Example of LPG Tanker *(Source: http://shipsandharbours.com/)*

Figure 3-17: Example of Bulk Carrier *(Source: http://www.tsuneishi-g.jp/)*

3.7 Associated Facilities

The IFC's Guidance Note on Performance Standards on Environmental and Social Sustainability defines the term 'Associated facilities' as those facilities which are not funded as part of the DLBB Project and that would not have been constructed or expanded if the DLBB Project did not exist and without which the DLBB Project would not be viable. Going by this definition associated facilities to the DLBB Project are:

- Laying water line to the DLBB Project and the subsequent supply of water
- Laying power supply power lines to the DLBB Project and will subsequently supply power
- Developing the road for transport of Pet Coke and Sulphur from the refinery to the DLBB Project
- Laying the pipelines to transfer product from the Duqm Refinery to the DLBB Project
- Vessels used to export refined products from the DLBB Project
- Construction of Road No. 5

While, using the same definition the DLBB Project could be considered as an associated facility to the Duqm SEZ, Duqm Port and Duqm Refinery.

3.7.1 Associated Facilities - Utility Corridor

CUC will be responsible for the construction of the utility corridor within which Duqm Refinery will lay pipelines to transfer product from the refinery to the DLBB Project. CUC will also construct the road between the refinery and the DLBB Project. The Duqm Refinery will use trucks to transport Pet Coke and Sulphur from the refinery to the DLBB Project. The trucks will use the road constructed by CUC to transfer product. Table 3-13 provides details of the same.

Table 3-13: Associated Facilities – Utility Corridor

Product/ Utility	Mode	Construction by	Operation by	Expected Specifications
Diesel	Pipeline	Duqm Refinery	Duqm Refinery	16 inch pipeline
Jet-A1	Pipeline	Duqm Refinery	Duqm Refinery	10 inch pipeline
Naphtha	Pipeline	Duqm Refinery	Duqm Refinery	12 inch pipeline
HSFO	Pipeline	Duqm Refinery	Duqm Refinery	16 inch pipeline with insulation
PLPG	Pipeline	Duqm Refinery	Duqm Refinery	12 inch pipeline
Sulphur	Truck	Duqm Refinery	Duqm Refinery	25 ton tipping trucks
Pet Coke	Truck	Duqm Refinery	Duqm Refinery	25 ton tipping trucks
Power Lines	-	CUC	CUC	Requirement will be 15 to 20 MW approximate
Utility corridor	-	CUC	CUC	The utility corridor will contain all the above utilities

Figure 3-18 presents a schematic of the utility corridor and road between the refinery and the DLBB Project.

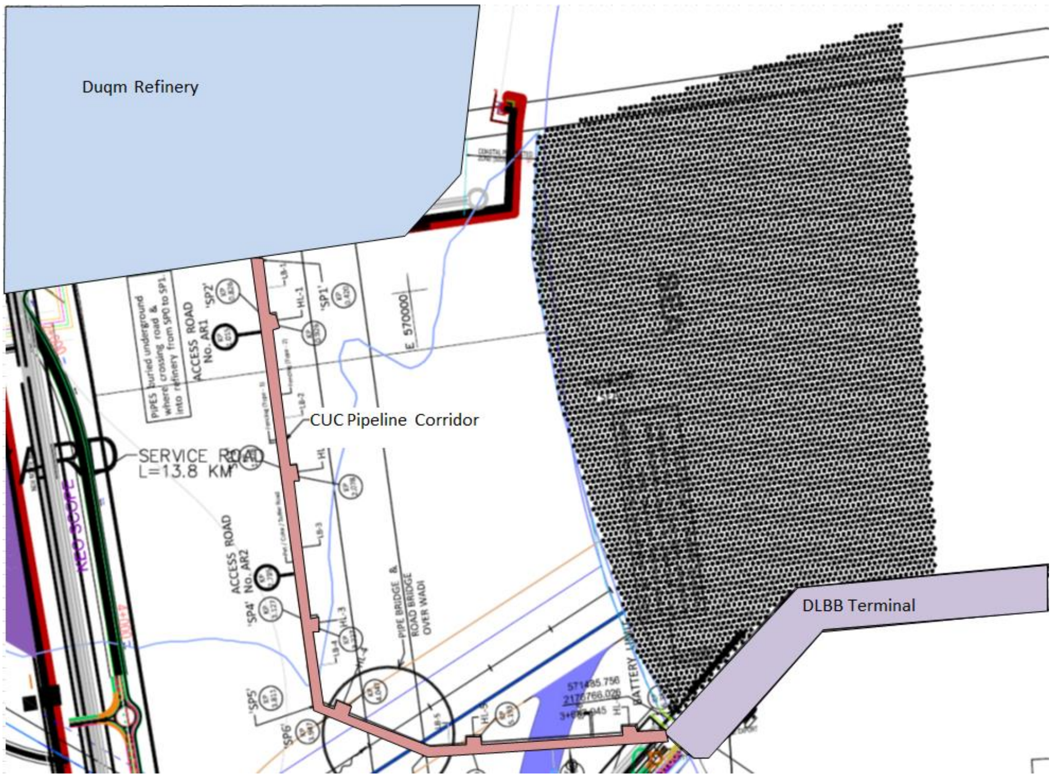

Figure 3-18: Utility Corridor between Refinery and DLBB Project

It should be noted that CUC and Duqm Refinery shall be responsible for undertaking the necessary EIA studies and obtain the necessary environmental permits for the construction and operation of the associated facilities. In addition to the above discussion CUC will develop necessary infrastructure and undertaken necessary for supply of power and water to the DLBB Project during the operation phase.

3.7.2 Associated Facilities – Vessel

It is expected that about 800 vessels will visit the DLBB Project every year. The vessels will be owned by independent shipping companies and their navigation within and around the port as well as the wider bay of Masirah will be directed by PDC. In addition to the movement of ships loading at DLBB Project, the ship movement in the area is expected to substantially increase. The activities leading to an increase in shipping will be attributed to the development of SEZAD industrial area, the Port and the Ras Markaz Crude Oil storage area.

As per the Royal Haskoning 2013 Master Plan, the traffic visiting the Port of Duqm excluding the LBW is expected to increase gradually, starting with 650 vessels in 2015 and increasing to 2800 by 2040.

PDC as port authority has assumed the responsibility for managing MARPOL waste generated by vessels visiting the port and at the DLBB Project. Table 3-14 below identifies the MARPOL waste streams and the proposed management strategy.

Table 3-14: Management of MARPOL Waste

Waste Stream	MARPOL Waste Type	Management Strategy
Ballast water	Annex I	Offshore de-ballasting in accordance with MD 159/2005, MARPOL 73/78 and PDC's Port Rules and Regulations (under review)
Oily bilge water oily waste, oily mixtures, slops, sludge, oily tank washings, oily cargo residues,	Annex I	Collection by a contractor appointed by PDC using vacuum truck and subsequent treatment at a MARPOL facility
Domestic Waste	Annex V	The domestic waste shall be shifted from vessel by crew to a covered skip placed at a designated location on the jetty. PDC will appoint a contractor to collect this waste from this designated location for disposal at the municipal dumpsite or engineered landfill when it becomes available.
Sewage	Annex IV	The ships will have on-board facilities for the treatment and discharge of sewage
Bulk HW	Annex II	To be shifted by the vessel crew to a designated area on the jetty. PDC will appoint a contractor to collect this waste from the designed area.

All records of MARPOL waste discharged by ships (coming to DLBB Project terminal) to PDC's port reception facilities or marine environment will be submitted to DPTC. All Ship Operators will be required to comply with the requirements of MD 159/2005, MARPOL 73/78 and PDC's Port Rules and Regulations.

3.7.3 Associated Facilities – Road No. 5

The Road No. 5 will be, theoretically, the permanent access route to the liquid bulk berths. As such it represents another physical interface with the Project. A contract will shortly be let by SEZAD to a design consultancy to re-visit the design of Road No. 5 together with Road No. 1. The road itself will be constructed on an elevated embankment which will ultimately provide flood protection, in conjunction with wadi channel diversion works. Prior to the completion of the Road No. 5 embankment and/or wadi channel improvements, the Project works, particularly the dredged areas, will be vulnerable to the effects of wadi flooding. Temporary flood embankments constructed by SEZAD contractors from unsuitable material are considered inadequate without further reinforcement/erosion protection. Figure 3-19 Alignment of Road No. 5 Flood Protection Bund

Figure 3-19: Alignment of the Road No. 5 Flood Protection Bund

It should be noted that CUC has the mandate to develop flood and drainage in SEZD and shall be responsible for undertaking separate EIA studies to address potential impacts from the same.

4 RELEASES

4.1 Overview

Construction and operation activities associated with the Project will result in the release of various liquid, solid and gaseous waste streams. In addition to this, the DLBB Project is also likely to have some noise, light, odour and visual impact. This section provides an overview of the key emissions, discharges and waste streams which are likely to originate from the proposed DLBB Project activities. This section identifies key sources of environmental releases during routine construction and operation as well as any accidental releases which may occur.

4.2 Construction Phase Releases

At the present stage of the DLBB Project the EPC Contractor has not been selected (Refer Project Schedule in Section 1.4), thus detailed construction methodology is not known. The estimates of releases during the construction phase are based on rules of thumb and available information. During the construction phase these estimates will be revisited and revised estimates will be provided in the audit reports to be issued to SEZAD.

4.2.1 Air Emissions during Construction

Emissions to air during the construction phase will mostly result from the combustion of fossil fuel at site for vehicles, vessels, and construction equipment. Additionally, there will be a release of VOC from storages for fuel, chemical, paint etc.

With dust emissions are expected to be the second most prevalent air emission and will occur as a result of movement of vehicles on unpaved areas, earth moving operations, material stockpiles and batching plant etc. VOCs and Hazardous Air Pollutant emission will occur in the form of fugitive emissions these emissions will be minor and dependent on the quantity of fuel and chemicals stored at the site.

Table 4-1 below presents details of emissions during the construction phase of the DLBB Project.

Table 4-1: Construction Phase Releases - Air Emissions

Emission Source	Frequency of Release	Estimated Quantity of Release	Proposed Control Treatment and Monitoring Method
Emissions from construction equipment vehicles and vessels	Intermittent release, Stationery and Mobile source CO_2, NO_X, SO_2, VOCs, and Particulate Matter (PM)	Not estimated as the number of vehicles, their class, and distance travelled or hours of operation is not known. The same will be estimated and presented as part of monthly monitoring regime	Construction equipment and vehicles to be periodically maintained
Fugitive emissions from fuel storage tanks or chemical storage area	Emissions of VOCs and Hazardous Air Pollutants	Not estimated as details are not known. The same will be presented as part of the monthly monitoring regime	The fuel and chemical storage should be designed and operated as per best available techniques

Emission Source	Frequency of Release	Estimated Quantity of Release	Proposed Control Treatment and Monitoring Method
Dust emissions from earthworks, vehicle movement, material stock piles and batching plant etc.	Intermittent emissions of PM	The same will be monitored using instruments during the construction phase.	Water spraying may be used for suppressing dust. Preferably treated wastewater is to be used to supress dust

The emissions identified in the table above could not be quantified as the necessary detail on the same is unavailable.

Omani regulations do not regulate air emissions from mobile sources such as construction equipment. MD118/2004 regulates the air emission from stationery sources and the MD requires the use of Best Available Techniques for control of emissions. There are no specific requirements for the control of fugitive emissions from storage areas and dust emission from stockpiles; however the MD provides the following general guidance:

- The Project proponent is to prevent the emission of noxious or offensive substances from the site
- Monitoring of emissions must be undertaken by the project proponent and reports of the same are to be submitted to the regulatory authority for evaluation
- The facility must obtain necessary permits prior to the activity

Measures for the management of these emissions have been discussed in Chapter 8.

4.2.2 Wastewater during Construction

The construction phase for the DLBB Project extends between 2016 and 2018. During peak construction there will about 5,000 construction workers at the site.

The philosophy for management of wastewater during the construction phase centres on maximising reuse and minimising sacrificial discharge to the environment. Any discharge to the environment will meet the MD 145/93 and MD 159/2005 for land or marine discharge respectively. The two main streams of wastewater expected during the construction phase are domestic wastewater and industrial wastewater. Domestic wastewater will mainly arise from the construction camp and offices at site, while industrial wastewater will be generated from construction activities at site and will include streams such as:

- Hydrotest water
- Wash water
- Runoff

Table 4-2 presents details of the construction phase wastewater.

Table 4-2: Construction Phase Releases - Wastewater

Type	Contaminant	Frequency of Release	Estimated Quantity of Release	Proposed Control Treatment Method
Industrial waste water	Hydro-test water from hydro-testing of pipelines and tanks containing - Oil, pieces of rust, high Total Dissolved Solids (TDS)	Intermittent	In excess of 85,000 m^3	After repeated cycles of reuse the hydro-test water will be disposed subsequent to treatment to the marine environment.
Industrial waste water	Wash-water from washing and cleaning operations containing - Oil, pieces of rust, high Total Dissolved Solids (TDS)	Intermittent	Quantity difficult to quantify	The wash-water will be collected in designated areas and disposed after verification of quality will either be reuse or discharged to the environment
Domestic wastewater from construction camp	BOD, pH and suspended solid	Continuous	Peak generation 450 m^3/day	The sanitary wastewater will be treated at site and reused for construction
Clean runoff	None	Intermittent	Dependent on rain event	Uncontaminated hence discharge to the environment through designated discharge
Potentially contaminated runoff from fuel storage area or chemical handling area	Mostly hydrocarbon	Intermittent	Dependent on rain event	Collects within bunds subsequently allowed to evaporate or collected and taken for treatment.
Notes: *At peak 5000 construction workers at site and assuming wastewater generation at 90 litres/person/day*				

4.2.3 Solid Waste during Construction

A range of hazardous waste (HW) and non-hazardous (NHW) will be produced by the DLBB Project. The management of NHW and HW will be in line with MD17/93, MD 18/93, and IFC EHS guidelines.

Non Hazardous Waste

Majority of the waste generated by the DLBB Project will be NHW and will be generated during the construction phase of the DLBB Project. MD 17/93 is the governing regulation related to the management of NHW in Oman. Key articles in the MD related to solid waste management are:

- Article 5 – The users of commercial, industrial, agricultural or any other sites who produce solid NHW shall collect these waste and transport it in a safe manner to a designated site
- Article 10 – No solid NHW must be mixed with any category of HW

Waste management in Oman is in its nascent stage, with almost no recycling. Recycling of metal waste has a reasonable market, with almost all other recyclable material is disposed in local landfills and dumpsites. There have been recent attempts by private organisations to promote recycling of paper; however this for the most is restricted to the capital. Hence, the focus is on segregated collection of metals and disposal of other NHW streams.

At present, there is no engineered landfill operating in Duqm. NHW generated in Duqm is disposed at a dumpsite operated by the Duqm Municipality. The dumpsite is spread on approximately 15 ha of land, and is about 12 km northeast from the DLBB Project / LBW. The Universal Transverse Mercator (UTM) coordinates of the dumpsite are E-567291 and N-2188213. The dumpsite is accessible from National Highway No. 32 and is adjoining the Municipal Sewage Treatment Plant (STP). The dumpsite is almost full and in order to provide service into the future, an engineered NHW landfill is being constructed in Duqm.

SEZAD and be'ah have proposed an Integrated Waste Treatment, Storage and Disposal Facility in Duqm, which will include a new engineered NHW landfill. The integrated facility will be located in an area adjoining the existing dumpsite. The new NHW landfill will be developed in phases with the first phase approximately 170 m × 490 m. The new NHW landfill will be ready in Q4-2016. The NHW will be transported to the landfill using licensed contractors. Table 4-3 presents the NHW streams generated by the DLBB Project.

Table 4-3: Construction Phase Releases – NHW

Waste Stream	Source	Estimated Quantity of waste to disposal (Peak)	Proposed treatment method
Domestic NHW (municipal wastes)	Construction camp, offices, kitchen	6 tons/day	Will be disposed in license landfill
Scrap metal include (Aluminium tins, reinforced steel etc.)	Construction camp and office kitchens workshops	360 kg/day	Metal waste will be recovered and sold to recyclers
Food waste	Construction camp and office kitchens	3.18 tons/day	Will be disposed in license landfill
Cardboard and paper	Packaging waste offices and camps	780 kg/day	Will be disposed in license landfill. Recovered where possible
Plastic waste	Construction site, maintenance workshops, offices and camps	750 kg/day	Will be disposed in license landfill. Recovered where possible
Damaged wooden wastes	Construction site and maintenance workshops	Not estimated	Will be disposed in license landfill. Recovered where possible

Notes:

(1) Peak population at site during construction is 5,000

(2) Domestic solid waste to disposal in Oman is 1.2 kg/person/day. Source: http://www.ecomena.org/solid-waste-oman/

(3) Proportion of various material in domestic waste Metal 6%, Cardboard & Paper 13%, Plastic waste 12.5% and food waste 53% Source: An Overview of Waste Management in the Sultanate of Oman R Taha A, Al Rawas, Al Jabri, Al Harthy, H Hassan and Al Oraimi, 2003 Resources conservation and recycling.

Hazardous Waste

A variety of HW will be generated by the DLBB Project. The management of HW in Oman is governed by MD 18/93. Key articles of the MD applicable to the DLBB Project are:

- Article 2 - The application submitted for a HW Licence shall be according to the standard format developed by the Ministry and the applicant shall explain and describe how the waste generator will apply the best available technology relevant to his production and operational practices to minimize the generation of HW, including the application of any practicable recycling procedures covered by Article (7) of these Regulations.
- Article 8 - Every HW generator shall store HW in approved storage facilities on his land or at his premises until its removal in accordance with the terms of the licence issued by the Ministry
- Article 9 - HW shall be transported by transporters licenced by the Ministry to collect, handle, store and dispose HW outside the waste generator's premises. This licence will be issued with conditions after the approval of Royal Oman Police
- Article 10 - Every owner of any site where HW is to be stored, shall apply for a licence from the Ministry and shall operate the site only in accordance with the terms of the issued licence which shall include a requirement that all HW received at the site shall be accompanied by appropriate Consignment Note(s) in accordance with Article (5)

It must be noted that since SEZAD Environment Department is the environmental regulator within the SEZD, the HW license mentioned in the articles above shall be obtained from SEZAD Environment Department.

A particular challenge with HW management in Oman is the lack of an operational HW treatment facility. As a result of this, the HW generators are mostly required to store the HW onsite. To reduce the quantity of HW stored, recyclable HW such as waste oil are sent to approved / licensed recyclers.

Reportedly, SEZAD and be’ah have proposed an Integrated Waste Treatment, Storage and Disposal Facility in Duqm, which will include a new engineered HW landfill and storage area. The first phase of the engineered HW landfill is approximately 100m x 100m and is located close to the exiting dumpsite. The new HW landfill will be ready by Q4 2016. Additionally, be’ah is developing a slag waste landfill, HW landfill and HW treatment facility (including incinerator) in Sohar (about 700 km from Duqm by road). The timeline for the projects in Sohar is currently not known.

Construction of the DLBB Project is scheduled to start in Q1 2016, with operation scheduled for Q1 2019. Hence, as a minimum about 1 year of HW generated during the construction will need to be stored at site, before be’ah’s HW landfill in Duqm will be available for use; whereupon, all HW generated by DLBB Project will be transported to the landfill for disposal. The amount of HW generated during that first 12 months is likely to be small. Note that the amount of HW generated during the first year of construction is likely to be small since only dredging and land reclamation works will be undertaken during this period.

A small amount of medical waste is expected to be generated during the construction phase of the DLBB Project when clinics will be established at site for providing basic medical care and first aid to the construction personnel. Any medical emergencies requiring intensive care will be transferred to the nearest government hospital.

The clinics at site are expected to only generate sharps, expired pharmaceuticals, and medical gauze as waste. Typically, specialist medical contractors establish and operate these clinics for the contractors/Project proponent. These specialist medical contractors also take the responsibility for the management of medical waste and typically transfer the waste to the medical waste incinerator in Muscat.

Radioactive (low-ionising radiation) sources will be used at site for industrial radiography / Non Destructive testing. EPC Contractors will be required to take all equipment containing radioactive sources back from the site on completion of the testing activities. Therefore, there will be no radioactive or low ionising waste generated through the DLBB Project.

Table 4-4 presents the HW streams generated by the DLBB Project.

Table 4-4: Construction Phase Releases – HW

Waste Stream	Source	Estimated Quantity of Release	be'ah HW Categories	Proposed treatment method
Contaminated Soil	Spills on land	Small quantities	HW17-50	Will be sent to be'ah HW waste facility in Duqm
Contaminated textile	Textile/rags used for cleaning or in workshop	Small quantities	HW15-20 (most often)	Will be sent to be'ah HW waste facility in Duqm
Waste Electrical and Electronic Equipment (WEEE)	Workshops, fabrication yards, offices, construction area	Small quantities	HW18-10 HW18-20 HW18-30 HW18-40	Will be sent to be'ah waste facility in Duqm
Empty chemical containers	Paint container (tins, cans), chemical container (bottles)	Small quantities	HW15-20	Will be sent to be'ah HW waste facility in Duqm
Grit blasting residue	Construction site painting booths, fabrication yards, workshops	Small quantities	HW17-60	Will be sent to be'ah HW waste facility in Duqm
Oil in water	Spills or leaks contaminated runoff, slops oil	Small quantities	HW16-10	Sold to recycler or sent to be'ah HW in Duqm
Waste chemicals / solvents / paints	Wastewater treatment facility, workshops, painting booths	Small quantities	HW12-10 HW12-20 HW13-10 HW13-30	Will be sent to be'ah HW waste facility in Duqm
Medical Waste	Clinic(s) at site	Small quantities	HW19-10 HW19-30	Will be disposed by the licensed clinic operator at a

Waste Stream	Source	Estimated Quantity of Release	be'ah HW Categories	Proposed treatment method
			HW19-40	licensed facility
Radioactive sources (low-ionising radiation sources)	Industrial radiography (non-destructive testing)	No waste generation	HW06-40	EPC Contractors bringing low ionising sources to site will be required to take the source away when they leave the site

4.2.4 Dredged during Construction

The liquid berths basin area and channel to offshore area is currently un-dredged, varying in elevation from approximately Chart Datum (CD) to the dredge level for the existing port at -18m CD. This area will be dredged to a level of -18m CD. In all the DLBB Project involves the dredging of 27 million m^3 of soil from the port basin (Refer Figure 3-5 for the area earmarked for dredging). Poor engineering property of the material dredged in the basin makes it unsuitable for reuse and hence will be disposed approximately 40 km offshore. The area selected for offshore disposal has been used previously for disposal of dredged material during construction of the port (Refer Figure 3-7 for approximate location of offshore disposal area relative to the port). Additionally, borrow material will be

Table 4-5: Construction Phase – Dredged Material

Type	Contaminant	Frequency of Release	Estimated Quantity of Release	Disposal of material
Dredged Material – Port basin	Natural rock and soil	During the dredging phase of the DLBB Project	27 million m^3	On account of the poor engineering property of the material dredged in the basin. All the material will be disposed in the offshore borrow area.
Dredge Material – Offshore borrow	Natural rock and soil	Intermittently during the dredging phase of the DLBB Project	6.5 Million m^3	Offshore borrow will be minimised through efforts to maximise reuse
Note: The volumes presented are preliminary and will be confirmed in the design				

Dredge Plume Modelling

The following numerical models (set up using Danish Hydraulics Institute MIKE suite of software) were used to assess the impact of the dredging activity on the environment:

- North Indian Ocean Hydrodynamic Model (NIOHD) – A regional 2D hydrodynamic model of the North Indian Ocean covering the Red Sea, Arabian Gulf and the northern basin of the Indian Ocean was used to define the boundary conditions for the local hydrodynamic model described below.
- Local Hydrodynamic Model – A smaller, higher resolution 3D hydrodynamic model covering the DLBB Project site was used to simulate water levels and current conditions.

- Dispersion Model – The Mud Transport module has been used in combination with the local hydrodynamic model results to simulate dredge plume dispersion for typical summer and winter conditions for various dredging and disposal activities.

It must be noted that the present modelling exercise was undertaken without considering any mitigation/control measures. Key findings for the dredge plume modelling report are presented below:

- The initial dredging for the sand layer at the entrance to the DLBB Project port will create a dredge plume with a higher TSS compared to later in the dredging on account of the shallower depth of water at the start of dredging as compared to later in the dredging.
- On account of changes in the metocean conditions between the summer and winter months, there is a distinct seasonal behaviour of the sediment plume. Values of TSS expected during winter are expected to be higher than that during summer.
- Sediment plumes are tide and current speed dependent. The summer and winter scenarios have been modelled representing the highest seasonal tide and current events. The extents of the plume between seasons are expected to be smaller.
- Re-dredging of spilt fines in the port basin is the activity associated with the highest TSS levels as compared to other dredging activities.

Table 4-6 below presents the percentage of exceedance TSS level of 10, 50, 100 and 500 mg/l at 500 m from dredging source

Table 4-6: Expected TSS Levels within port basin

Area	Season	TSS Level Above Ambient			
		10 mg/l	50 mg/l	100 mg/l	500 mg/l
Dredging in Port Basin	Winter	0%	0%	0%	0%
	Summer	0%	0%	0%	0%

From the above table it is apparent that it is unlikely the sediment plume will exceed 10 mg/l at 500m in any of the scenarios. Modelling for the offshore borrowing and disposal is currently being investigated and the same will be submitted to the regulator subsequently.

4.2.5 Noise during Construction

Noise will be generated at all stages (Construction, Operation and decommissioning) of the Project. During the construction phase there will be a variety of noise originating from the construction work at site. Table 4-7 presents a list of typical noise sources expected during the construction phase.

Table 4-7: Typical Noise Sources Expected during the Construction Phase

Noise Source	Activity	Sound Pressure Level at 1m from Source
Batching Plant	Construction	108 dB(A)
Bulldozer	Earthmoving	115 dB(A)

Noise Source	Activity	Sound Pressure Level at 1m from Source
Concrete Mixer	Construction	96 dB(A)
Concrete Pump	Construction	109 dB(A)
Crane mobile/barge mounted	Construction	112 dB(A)
DG Standard	General Construction	108 dB(A)
Dredger	Dredging	118 dB(A)
Dumper	Earthmoving	106 dB(A)
Piling	Installation of piles	116 to135 dB(A)
Excavator/loader (wheeled /tracked)	Earthmoving	112 dB(A)
Tug Boat	Dredging	110 dB(A)
Water pump	Construction	103 dB(A)

Source:

- *Technical Memorandum on Noise from Construction Work other than Percussion Piling, Environmental Protection Department Hong Kong Noise Control Authority, 1998*
- *Technical Memorandum on Noise from Percussive Piling, Environmental Protection Department of Hong Kong Noise Control Authority*

MD 79/94 regulates noise level in public environment. The regulation defines a limit of 70 dB(A) for industrial, plants and public works industrial and commercial areas. MD 80/94 regulates the noise level in working environment and in line with its requirements all workers on the DLBB Project, working in areas over 85 dB(A) will be provided with noise protection equipment. The nearest settlement is 4 km from the LBW and as a result the focus of noise control will be on protection to workers.

4.3 Operation Phase Releases

4.3.1 Air Emissions during Operation

Air emissions from the operation phase will occur in the form of fugitive emissions from storage and handling of material and combustion emissions for combustion of fuel. Table 4-8 summarises the expected emissions from the DLBB Project.

Table 4-8: Operation Phase Releases – Air Emissions

Emission Source	Frequency of Release	Estimated Quantity of Release	Proposed Control Treatment
Emissions from maintenance vehicles at site including vehicles transporting manpower and material	Intermittent and transient release of combustion emissions from mobile source CO_2, NO_X, SO_2, VOCs, and PM	Not estimated as the number of vehicles, their class and distance travelled is not known. The same will be estimated and presented as part of monthly monitoring regime	Periodic maintenance and road worthiness certificate.

Emission Source	Frequency of Release	Estimated Quantity of Release	Proposed Control Treatment
Emissions from the operation of tug boats	Intermittent and transient release of combustion emissions from mobile source CO_2, NO_X, SO_2, VOCs, and PM	The tug boats for the DLBB Project will be owned and operated by PDC (Refer Section 3.5.6).	Not applicable
Emission from operation of shipping vessels	Intermittent and transient release of combustion emissions from mobile source CO_2, NO_X, SO_2, VOCs, and PM	The vessels visiting the port will be operated by independent vessel operators. Further, PDC is responsible to oversee the movement of ships in Bay of Masirah. All ships visiting the DLBB Project will need to comply with Omani regulation and PDC regulations. (Refer Section 3.5.6).	Not applicable
Fugitive emissions from storage tanks	Emissions of VOCs and Hazardous Air Pollutants (HAP)	Jet A-1 tanks : 4.12 t/year Naphtha Tanks: 13.94 t/year Diesel could not be estimate using Tanks Model on account of height over 65 m.	BAT recommendations (Refer Section 5.5)
Periodic testing and operation of the emergency generators and pumps	Intermittent and transient release of combustion emissions from mobile source CO_2, NO_X, SO_x, VOCs, and PM	Min 1 MW emergency generator operated for 30 min per week for testing or 26 hours per year. Emission per year: • NO_X: 505 kg/year • CO: 108 kg/year • SO_X: 33 kg/year • PM_{10}: 36 kg/year	Periodic maintenance
Fugitive emissions from chemical storage area , valves and fittings	Emissions of VOCs and Hazardous Air Pollutants (HAP)	Not estimated as details are not known	Preventative maintenance and periodic check on fuel level
Pet Coke and Sulphur Dust during transport from refinery to DLBB Project	Pet Coke and Sulphur particle	The refinery will own and operate truck used transport Pet Coke and Sulphur from the refinery to the terminal (Refer Section 3.5.6)	Not Applicable
Pet Coke and Sulphur Dust during loading and unloading at DLBB Project terminal	Pet Coke and Sulphur particle	Intermittent as a result of wind or handling hence not estimated	Water spraying of stockpiles and use of closed conveyors Enclosed truck dump with dust extraction, Enclosed conveyors and stockpiles with dust extraction, Wet suppression at transfers, Cascade chute at vessel load point.
Emissions from the	Intermittent and transient	The refinery will own and operate	Not Applicable

Emission Source	Frequency of Release	Estimated Quantity of Release	Proposed Control Treatment
use of trucks to transport Pet Coke and Sulphur from the refinery to DLBB Project	release of combustion emissions from mobile source CO_2, NO_X, SO_2, VOCs, and PM	truck used transport Pet Coke and Sulphur from the refinery to the terminal (Refer Section 3.5.6)	
Emissions from emergency flaring	Occasional emission of CO_2, NO_X, SO_2, VOCs, and PM	Dependent on emergency scenario (when and how long). The same will be reported to the regulator following flaring incidents for records.	Design of flare system and performance standards.

4.3.2 Wastewater during Operation

During the operation phase there will be up to 60 personnel (average) working onsite. The philosophy for management of wastewater during the operation phase centres on maximising reuse and minimising sacrificial discharge to the environment. Any discharge to the environment will meet the MD 145/93 and MD 159/2005 for land or marine discharge respectively. The two main streams of wastewater expected during the operation phase are domestic wastewater and industrial wastewater. Domestic wastewater will mainly arise from the offices at site, while industrial wastewater will be generated from activities at site and will include streams such as:

- Industrial wash water
- Dust suppression runoff from material stockpiles
- Storm water runoff

Although in addition to the existing 2,000 m^3/d STP, SEZAD proposes to build two additional STP's, each of 5,000 m^3/d treatment capacities. It is understood that these new STPs will be commissioned during 2017. However, these STPs will be unavailable for use by DPTC. Furthermore the SEZAD has instructed DPTC to install suitable treatment systems onsite for treatment of all wastewater generated during the operation phase. In line with these requirements, both industrial and domestic wastewater treated at site. Table 4-9 summarises treatment of wastewater during the operation phase.

Table 4-9: Summary of Wastewater Treatment during Operation

Type	Contaminant	Frequency of Release	Estimated Quantity of Release	Proposed Control Treatment Method
Industrial waste water	Water spraying on Pet Coke piles – the contaminant will be Pet Coke residue and hydrocarbons	Intermittent	10m^3/h	The wastewater will be collected, treated at site and reused for dust suppression.
Industrial waste water	Wash-water from washing and cleaning operations containing –Oil, pieces of rust, high Total Dissolved Solids (TDS)	Intermittent	Difficult to quantify	The wastewater will be treated at site and reused for dust suppression.

Type	Contaminant	Frequency of Release	Estimated Quantity of Release	Proposed Control Treatment Method
Domestic wastewater	WC – BOD, pH and suspended solid	Continuous	Approx. $6m^3/h$	The wastewater will be treated at site and reused for dust suppression.
Clean runoff	None	Intermittent	Dependent on rain event	Uncontaminated hence discharge to the environment through designated discharge
Potentially contaminated runoff from	Mostly hydrocarbons	Intermittent	Dependent on rain event	Treatment at site before discharge. First 10 minutes of rain event will be considered contaminated
RO Rejects	Brine rejects	Continuous	18.1 m^3/h	Adequate dispersion as per MD 159/2005

The water treatment plant will be in operation in continuous operation for the expected flowrate of $11m^3/h$ (10 m^3/h of oily water flow rate + 1 m^3/h of sewage water flow rate). There will be higher flow rates may be 5 to 10 times in a year for shorter periods (about 6 to 18 hours during each higher flow event) due to the higher effluent rates expected during tank cleaning, storm water drains and fire system testing water drains.

Normal streams to the industrial wastewater collection system are essentially intermittent. Almost no flow is expected on a continuous basis from the Pet Coke area since spray water is either recycled or lost by evaporation.

In order to provide a continuous flow to the waste water treatment plant, civil sewage is also expected to be treated at the terminal combined with pre-treated oily water.

4.3.3 Solid Waste during Operation

NHW and HW generated by the DLBB Project will be managed in line with MD17/93, MD 18/93, and IFC EHS guidelines. As with the construction phase the waste management during the operation phase will incorporate the principles of recycling.

Non Hazardous Waste

MD 17/93 is the governing regulation related to the management of NHW in Oman. Waste management in Oman is in its nascent stage, with almost no recycling. Recycling of metal waste has a reasonable market, with almost all other recyclable material is disposed in local landfills and dumpsites. There have been recent attempts by private organisations to promote recycling of paper; however this for the most is restricted to the capital. Hence, the focus is on segregated collection of metals and disposal of other NHW streams.

SEZAD and be'ah have proposed an Integrated Waste Treatment, Storage and Disposal Facility in Duqm, which will include a new engineered NHW landfill. The integrated facility will be located in an area adjoining the existing dumpsite. The new NHW landfill will be developed in phases with the first phase being 1 landfill cell, approximately 170 m × 490 m. The new NHW landfill will be ready in Q4-

2016 and will be available during the operation phase. The NHW will be transported to the landfill using licensed contractors. Table 4-10 presents the waste streams during the operation phase.

Table 4-10: Operation Phase Releases – NHW

Waste Stream	Source	Estimated Quantity of waste to disposal (Peak)	Proposed treatment method
Domestic NHW (municipal wastes)	Construction camp, offices, kitchen	72 kg/day	Will be disposed in the New Engineered Landfill
Scrap metal include (Aluminium tins)	Workshops and kitchen	4.3 kg/day	Metal waste will be recovered and sold to recyclers
Food waste	Construction camp and office kitchens	38 kg/day	Will be disposed in the New Engineered Landfill should no recycling outlets be identified
Cardboard and paper	Packaging waste and from offices	9.4 kg/day	Will be disposed in the New Engineered Landfill should no recycling outlets be identified
Plastic waste	Construction site, maintenance workshops, offices and camps	9 kg/day	Will be disposed in the New Engineered Landfill should no recycling outlets be identified
Damaged wooden wastes	Construction site and maintenance workshops	Not estimated	Will be disposed in the New Engineered Landfill should no recycling outlets be identified

Notes:

- Peak population at site during operation 60
- Domestic solid waste to disposal in Oman is 1.2 kg/person/day. Source: http://www.ecomena.org/solid-waste-oman/
- Proportion of various material in domestic waste Metal 6%, Cardboard & Paper 13%, Plastic waste 12.5% and food waste 53% Source: An Overview of Waste Management in the Sultanate of Oman R Taha A, Al Rawas, Al Jabri, Al Harthy, H Hassan and Al Oraimi, 2003 Resources conservation and recycling.

Hazardous Waste

MD 18/93 is the governing regulation related to the management of HW in Oman. The management of HW will be in line with the requirement specified in MD 18/93 and IFC EHS guidelines. SEZAD and be'ah have proposed an Integrated Waste Treatment, Storage and Disposal Facility in Duqm, which will include a new engineered HW landfill and storage area. The first phase of the engineered HW landfill is approximately 100 m × 100 m and is located close to the exiting dumpsite. The new HW landfill will be ready by Q4-2016. Table 4-11 presents the operation phase HW.

Table 4-11: Operation Phase Releases – HW

Waste Stream	Source	Estimated Quantity of Release	be'ah HW Categories	Proposed treatment method
Contaminated Soil	Spills on land	Small quantities	HW17-50	Will be sent to be'ah HW waste facility in Duqm

Waste Stream	Source	Estimated Quantity of Release	be'ah HW Categories	Proposed treatment method
Contaminated textile	Textile/rags used for cleaning or in workshop	Small quantities	HW15-20 (most often)	Will be sent to be'ah HW waste facility in Duqm
Waste Electrical and Electronic Equipment (WEEE)	Workshops, fabrication yards, offices, construction area	Estimate unavailable	• HW18-10 • HW18-20 • HW18-30 • HW18-40	Will be sent to be'ah waste facility in Duqm
Empty chemical containers	Paint container (tins, cans), chemical container (bottles)	Estimate unavailable	HW15-20	Will be sent to be'ah HW waste facility in Duqm
Hydrocarbon Sludge / Tank Bottom Sludge/ Pigging Waste	Tanks and pipelines maintenance and cleaning activities	Estimate unavailable	HW16-30	Will be sent to be'ah waste facility in Duqm
Grit blasting residue	Construction site painting booths, fabrication yards, workshops	Estimate unavailable	HW17-60	Will be sent to be'ah HW waste facility in Duqm
Oil in water	Spills or leaks contaminated runoff, slops oil	Small quantities	HW16-10	Sold to recycler or sent to be'ah HW in Duqm
Waste chemicals / solvents / paints	Wastewater treatment facility, workshops, painting booths	Small quantities	• HW12-10 • HW12-20 • HW13-10 • HW13-30	Will be sent to be'ah HW waste facility in Duqm
Medical Waste	Small Clinic at site	Small quantities	• HW19-10 • HW19-30 • HW19-40	Will be disposed by the licensed clinic operator at a licensed facility
Sulphur residue	From extraction system	Estimate unavailable	HW10-20	Return to refinery
Pet Coke	From drains / wastewater treatment system	Estimate unavailable	HW15-10	Returned to storage

4.3.4 Noise during Operation

Noise will be controlled both for employees within the facilities and for the community outside of the site boundary. Noise Control during the operation phase shall be implemented in accordance with the following hierarchy of controls:

- Elimination – removal of noise source.

- Substitution – e.g., quieter equipment.
- Engineering Controls - eliminate or minimise exposure by altering or removing the source or installing attenuating devices such as sound barriers
- Administration Controls-– control exposure by modifying exposure duration.
- Personal Protective Equipment (PPE) – or Hearing Protection Devices (HPD); only acceptable when all other practical methods do not sufficiently reduce noise exposure. As a minimum, HPD provided shall meet requirements of local legislation, international standards or equivalent. Examples of HPD include ear plug, semi canal ear plugs and ear muffs.

The best practicable means of noise control shall be followed at any location within the plant area to which personnel may have access, except for noisy equipment housings which are specifically designated as requiring ear protection devices to be worn. Individual equipment items (located outside without noise abatement) shall be designed with a maximum noise level of 85 dB(A) at 1.0 m during operation at full load.

The noise exposure that an employee will receive, during one day's work at the site is dependent on the noise levels that the employee is exposed to and also the duration of exposure to each noise level. Plant areas are not generally manned continuously. Operators will normally circulate a variety of areas checking equipment and instrumentation, and their overall daily exposure will therefore be an accumulation of exposures in a variety of areas. Individual equipment shall be designed with a maximum noise level of 85 dB(A) at a 1 metre distance during operational full load.

Based on equipment noise, noise levels within plant areas shall be estimated under operational full load and shall not exceed 85 dB(A). If area noise levels are estimated to exceed 85 dB(A), the levels shall be controlled to below 85 dB(A) using elimination/modification, substitution and engineering controls. Employees' noise exposure shall also be controlled by demarcating "restricted" areas of the plant, that exceed 85 dB(A), as "Noise Hazard Areas". If employees enter these areas, they are required to wear hearing protection indicated by warning signs.

As noise within the facility will be restricted and managed the external noise from the facility will be high. The noise level at the DLBB Project fence line will meet MD 79/94.

4.3.5 MARPOL during Operation

MARPOL 73/78 is the International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978. MARPOL is one of the most important international marine environmental conventions. It was designed to minimize pollution of the seas, including dumping, oil and exhaust pollution. All ships flagged under countries that are signatories to MARPOL are subject to its requirements, regardless of where they sail and member nations are responsible for vessels registered under their respective nationalities

MARPOL Waste is waste generated by ships during operation. MARPOL waste generated by ships may be broadly classified as:

- Annex I - Oil waste (such as oil, oily waste, oily mixtures, oily bilge water, slops, sludge, oily tank washings, oily cargo residues, ballast water containing oily mixtures)

- Annex II - Noxious Bulk Substances (such as leaking noxious cargo)
- Annex IV - Sewage
- Annex V - Garbage
- Annex VI - Air emissions (such as ozone depleting substances and exhaust gases)

MARPOL has a particular relevance to Oman as the Oman Area of the Arabian Sea is identified as a Special Area under MARPOL 73/78 Annex I, where Special Areas are defined as areas where more stringent requirements are placed for the management of MARPOL waste.

PDC as port authority has assumed the responsibility for managing MARPOL waste generated at the port and at the DLBB Project. Table 4-12 below identifies the MARPOL waste streams and the proposed management strategy

Table 4-12: Management of MAROL Waste

Waste Stream	MARPOL Waste Type	Management Strategy
Ballast water	Annex I	Offshore de-ballasting in accordance with MD 159/2005, MARPOL 73/78 and PDC's Port Rules and Regulations (Under Review)
Oily bilge water oily waste, oily mixtures, slops, sludge, oily tank washings, oily cargo residues,	Annex I	Collection by a contractor appointed by PDC using vacuum truck or by vessel and subsequent treatment at MARPOL facility
Domestic Waste	Annex V	The domestic waste shall be shifted from vessel by crew to a covered skip placed at a designated location on the jetty. PDC will appoint a contractor to collect this waste from this designated location for disposal at the municipal dumpsite or engineered landfill when it becomes available.
Sewage	Annex IV	The ships will have on-board facilities for the treatment and discharge of sewage
Bulk HW	Annex II	To be shifted by the vessel crew to a designated area on the jetty. PDC will appoint a contractor to collect this waste from the designed area.

All records of MARPOL waste discharged by ships (coming to DLBB Project terminal) to PDC's port reception facilities or marine environment will be submitted to DPTC. All ship operators will be required to comply with the requirements of MD 159/2005, MARPOL 73/78 and PDC's Port Rules and Regulations.

4.3.6 Maintenance Dredging during Operation

The entire port including the basin along the DLBB Project will need annual maintenance dredging, to ensure that the depth of waterways is at all times maintained so that they always remain accessible to shipping traffic. PDC as the port authority will be responsible for the maintenance dredging in the entire Duqm port including the basin along the DLBB Project. It should be noted that PDC shall be responsible for undertaking the necessary environmental studies associated with maintenance dredging and the disposal of maintenance dredging spoils.

5 ANALYSIS OF ALTERNATIVES

5.1 Overview

The IFC's Guidance Notes on Performance Standard on Environmental and Social Sustainability requires that 'the environmental and social impact assessment includes an examination of technically and financially feasible alternatives to the source of such impacts, and documentation of the rationale for selecting the particular course of action proposed'. In compliance with these requirements analysis of alternatives has been undertaken to document the major project alternatives considered and the rationale behind their selection.

The subsequent section has been discussed under the following broad headings:

a) No Project Scenario

b) Tank Farm Location

- Tanks at Duqm Refinery vs Tanks at Port
- Tanks on LBW vs Onshore

c) Construction Methodology

- Dredging Methodology
- Onshore vs offshore disposal of dredged material
- Onshore borrow vs Offshore borrow

d) BAT analysis

5.2 No Project Scenario

Oman is located on the east side of the Arabian Peninsula and surrounded by the Sea of Oman to the North, by the United Arab Emirates to the north-west, by the Kingdom of Saudi Arabia to the west, by Yemen to the south-west and by the Arabian Sea to the east. The Government of Oman is in the process of developing the Port of Duqm as a strategic dry dock, free trade zone, industrial and tourism destination.

The SEZAD was established to oversee the planning vision and strategic development of the SEZD as a result of the Royal Decree No. 119/2011.

The Port of Duqm is seen as a catalyst for the development of the Al Wusta region. The Port and Dry Dock are being developed to increase the trade; i.e., cargo trans-shipments, ship repair, manufacturing industry and tourism. The site enjoys proximity to the busy regional sea-lanes of Oman's coastal waters and is characterised by a friendly climate.

DPTC will be the logistics provider for the storage and handling of Naphtha, Jet-A1, Diesel, PLPG, HSFO, Pet Coke and Sulphur. The DLBB Project is crucial for the viability of the Duqm Refinery as it provides a venue for export of the refinery product.

A no project scenario would result in the Duqm Refinery being unable to export product and hence make the refinery unviable. This in turn would affect the overall SEZAD development. It could be hence argued that the DLBB Project is crucial for the overall SEZAD development and the development of the Omani Economy.

5.3 Tank Farm Location

5.3.1 Tanks at Duqm Refinery Vs Tanks at Port

Two scenarios were considered for export of refined products (Naphtha, Jet-A1, and diesel). The first being that the refined liquid products will be pumped directly from the refinery storage tanks to the berths for loading onto ships with no storage facilities at or near to the berths. Figure 5-1presents a sketch on direct loading

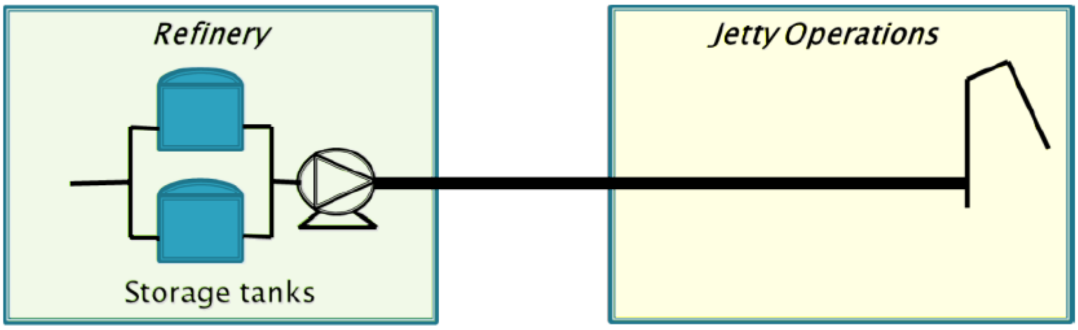

Figure 5-1: A Direct Loading of Product from Refinery

An alternative to direct loading is to provide storage and terminal facilities close to the berths allowing continuous transfer of product from the refinery to the tank storage near the jetty using smaller pumps and pipelines. The tank storage terminal manages and controls vessel loading. Custody transfer to the vessel is controlled and managed by the tank storage terminal. Figure 5-2 presents the sketch of the storage tank near berth.

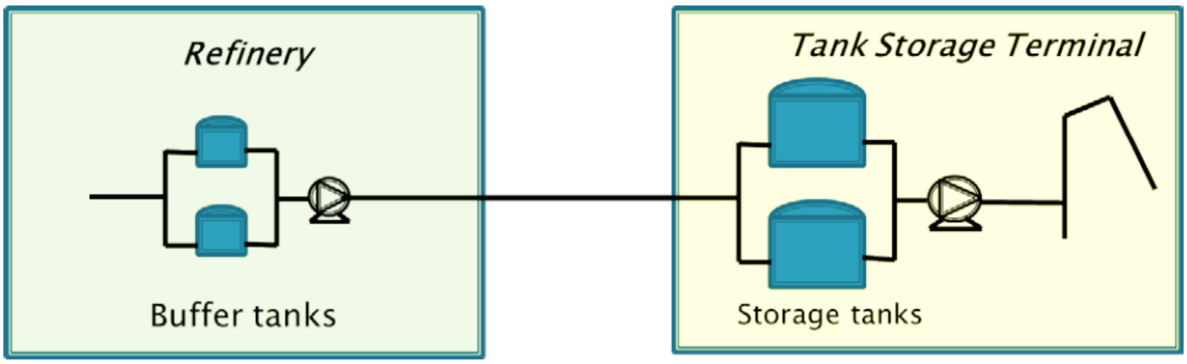

Figure 5-2: Sketch Alternative – Tank Storage near Berth

The distance between the refinery and the berths is around 15km which presents several disadvantages in product handling (surge, thermal relief, heat leak, etc.), loading and custody metering, while pumping directly from the refinery storage tanks. Therefore, the second option with intermediate storage at the DLBB Project has been considered.

5.3.2 Tanks at on the LBW Vs Onshore

An option evaluated during the concept selection for the DLBB Project, considered locating the tanks and storage facilities on the LBW (Option A) versus locating the tanks onshore (Option B). Figure 5-3 and Figure 5-4 presents schematics for the schemes.

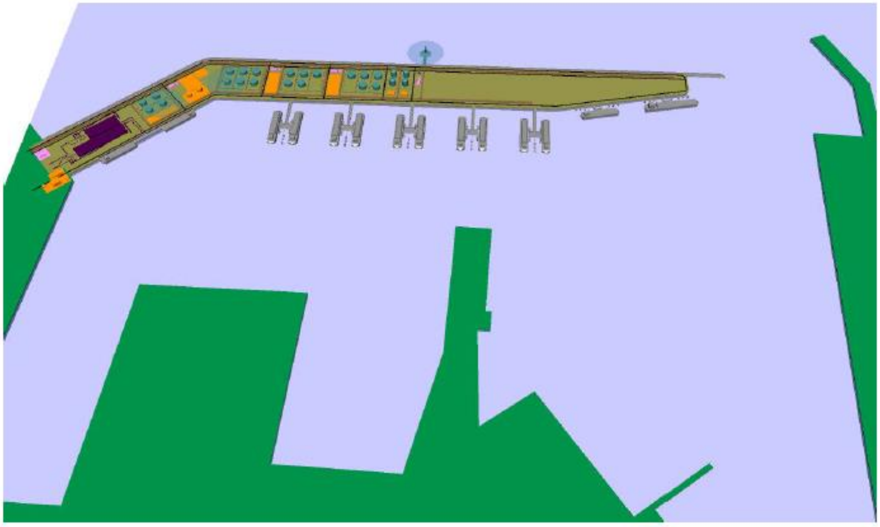

Figure 5-3: Early Concept Drawings of Option A - Schematic for Tanks on the LBW

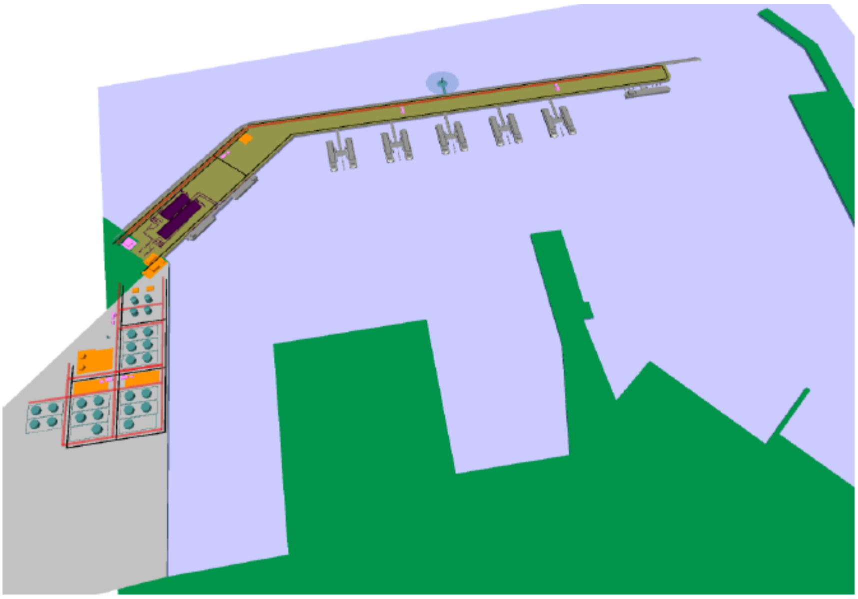

Figure 5-4: Early Concept Drawings of Option B- Schematic for Tanks Onshore

The key discussion related to Options A and B is presented below:

- **Land-Take:** Option A minimises the land-take of the DLBB Project as it does not take up any port land or water frontage. The entire terminal (plus space for future expansion) is located on reclaimed land (approx. 2,000 m) along the existing LBW, thus maintaining the existing land adjacent to Road No. 5 free for future port development not necessarily related to the DLBB Project. On the other hand Option B requires the use of a significant area (approx. 50 to 60 ha) of existing land adjacent to Road # 5 for the DLBB Project. Once utilised for this purpose the land and water frontage in this area will no longer be available for future development for the Port. In addition, Option B also requires the reclamation of land along the LBW to accommodate the pipe track, roads and berths which once constructed would severely restrict any future development in the area south of the LBW.

- **Construction Period:** Option B requires construction on the *sabkha*. The *sabkha* on account of its geotechnical (See Section 6.11) and environmental sensitives (See Section 6.16) would require special preparation and additional precautions for construction. This in turn, increases the risk of longer construction duration and as a result the duration of potential construction-phase environmental impacts. Option A on the other hand will involve typical construction process and hence comparatively less risk for extension of schedules.

- **Turning Radius for Vessels:** The reclamation along the LBW for Option B is only 150m, versus 350 m for option B. Hence, Option B offers a larger turning radius for vessels as compared to option A.

- **Resource Consumption:** Option A the various storage tanks are located in close proximity to the loading berths minimising the distance between them. This arrangement has several technical advantages compared to Option B, which are:

    - Smaller capacity pumps on account of lower head requirement and hence lower power consumption
    - Smaller size pipeline
    - Lower surge loads - hence lower power consumption
    - Less differential pressure for valour handling – reducing the total VOC emissions
    - Allows the use of common utilities such as nitrogen, air, potable water, and fire water
    - Option A will only require a single control room as compares to Option B which will require an auxiliary control room

Considering the discussion above it is seen that the Option A has inherent benefits compared to Option B and hence the tanks and other facilities are located on the LBW.

5.4 Construction Methodology

5.4.1 Dredging Methodology

The use of six types of dredgers was considered for the DLBB Project, these were discussed below:

Cutter Suction Dredger (CSD)

A CSD is a type of stationary hydraulic dredger which uses a rotating mechanical device to cut through the stiff material and pumps with a head differential to transport the loose soil in soil-water slurry through a pipeline into the dredger, an adjacent barge, or to a pipeline for use in disposal / reclamation. Figure 3-9 presents a CSD dredger.

Back Hoe Dredger (BHD)

The back hoe dredger uses mechanical excavation methods, similar to that of land based excavation equipment, to remove soil at the bottom of the seabed. Figure 5-5 presents an example of Back Hoe Dredger (BHD).

Figure 5-5: Example of Back Hoe Dredger *(Source: http://www.dredging.org/)*

Trailer Suction Hopper (TSH) Dredger

A trailer suction hopper dredger uses suction to pick sand and all loose material in the sea bottom. As the dredger trailer moves at a low speed, the drag-arms use suction to transport the material as soil-water slurry from the sea bed by means of a pipeline into its own hopper. The material in the hopper can either be dumped by opening the bottom doors, pumped ashore as a soil-water slurry (depending on the hopper/vessel type), pumped it to a disposal location, or “rainbowed for reclamation purpose”. Figure 3-10 presents the Trailer Suction Hopper Dredger.

Grab Dredger

A Grab Dredger is a type of mechanical excavation, which uses a clamshell to remove material from the seabed. Figure 5-6 presents an example of a grab dredger.

Figure 5-6: Example of Grab Dredger *(Source: www.hiseamarine.com)*

Dipper Dredger

A typical Dipper Dredger, similar to a BHD but acts as a front shovel pushing into the material rather than pulling it towards itself like a BHD. Figure 5-7 presents an example of a Dipper Dredger.

Figure 5-7: Example of a Dipper Dredger ***(Source: www.czbrats.com)***

Bucket Chain Dredger

A Bucket Chain Dredger uses a series of buckets attached to a rotating chain which continuous circulate, removing material from the seabed in the buckets and at the top of the chain (above the barge), the bucket is dumped and the material is carried down a chute to barges or hoppers. Figure 5-8 presents an example of a bucket chain dredge.

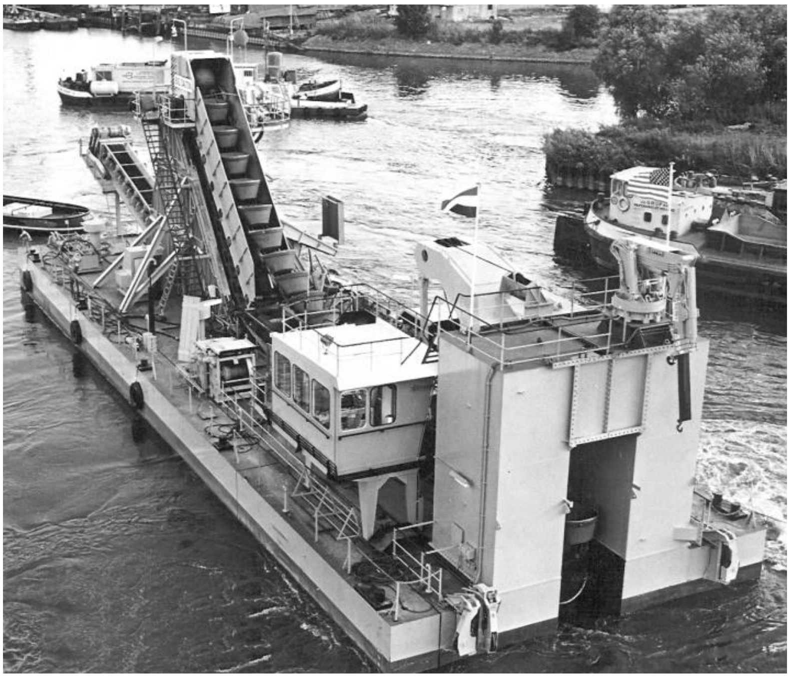

Figure 5-8: Example of a Bucket Chain Dredger *(Source: http://www.dredging.org/)*

Discussion

Dredging in the port basin requires a dredger with the ability to dredge both sand and mudstone in relatively shallow water (10 m to 18 m), while the offshore dredging area requires dredging of sand in deep water (over 35 m). Table 5-1 presents an equipment selection summary.

Table 5-1: Equipment Selection Summary

Type of Dredger	Dredge Sand in Basin	Dredge Mudstone in basin	Sand in offshore
Cutter Section	Yes	Yes	No
Back Hoe	Yes	Yes	No
Trailer Suction Hopper	Yes	No	Yes
Grab	Yes	No	No
Dipper	Yes	Yes	No
Bucket Chain	Yes	Yes	No

From the table above it is apparent that the use of the Trailer Suction Hopper (TSH) dredger is necessary for offshore dredging of sand. The TSH dredger however is unsuitable for dredging of mudstone hence another dredger is required. The grab dredger is not suitable for mudstone or offshore hence it is considered unsuitable for use in this Project. Not many dipper and bucket chain dredgers are operational in the world hence they are also not considered suitable for this Project. Between the BHD and CSD, the CSD is preferred on account of the possible higher dredging rates.

It is noted that the EPC Contractor may mobilise multiple types and sizes of dredgers as suits their programme. It is expected that majority of the dredging work will be completed by a CSD and TSHD.

5.4.2 Onshore Vs Offshore Disposal of Dredged Material

During the construction phase for the DLBB Project approximately 27 million m^3 of material will be dredged from the port basin. On account of the unsuitable nature of the material dredged in the port basin, all the material dredged in the port basin will be disposed offshore. The details of the offshore material disposal location are presented in Section 3.5.1. Table 5-2 presents summary of dredge volumes.

Table 5-2: Summary of Dredge Volume

Source	Volume (million m^3)
Total material dredged from basin	27
Unsuitable material for reclamation disposed offshore	27
Note: The volumes presented are preliminary and will be confirmed though the design	

As part of the concept study for the DLBB Project the relative merits and demerits for the disposal of dredged material onshore and offshore was considered. The rationale driving the onshore disposal of dredged material is that the entire *sabkha* area surrounding the LBW is designated for development as part of the special economic zone and Duqm Port. Developing the *sabkha* land would require backfilling and hence alternate to disposing material offshore, onshore disposal was considered. The available options were evaluated from the perspective of technical feasibility, environmental aspects, capital cost, schedule, interface management and health and safety aspects. Discussion under each of these headings is presented below.

- **Technical Feasibility:** the primary concern with onshore disposal is related to the quality of the final land, which is expected to be lower that if the land was backfilled with good quality fill. Poor quality final land is prone to subsidence and would pose a challenge for the proposed industrial construction designated for the area, as part of the special economic zone and Duqm Port. On the other hand, offshore disposal would mean that good quality fill material will need to be obtained for backfilling avoiding any issues with construction.
- **Environmental Aspects:** the *sabkha* area surrounding the LBW is a designated as an Important Bird Area (IBA) (Refer Section 6.17 for additional detail) and onshore disposal of dredged material in the area, without compensation, would result in the loss of an existing bird habitat along the coastal strip (wetland area) north and south of the LBW and will result in additional risks and responsibilities to be taken by the DLBB Project and these risks and responsibilities will impact the DLBB Project from a cost and schedule standpoint. Furthermore, onshore disposal will result in visual / aesthetic impacts, increased dust, noise and odours and

potentially damaging diversions to storm water runoff. The offshore marine environment around the DLBB Project is also sensitive (Refer Section 6.16 for additional detail), however through the implementation of mitigation measures these impacts area considered acceptable (Refer Chapter 8).

- **Capital Cost:** the capital cost for onshore disposal of dredged material is significantly more than that of offshore disposal. The primary reason for the comparatively larger cost is on account of the cost associated with the ground improvement and construction of settling basins. Additionally for onshore disposal, the costs associated with compensation for loss of bird habitat will need to be taken into account.
- **Schedule:** The risks of delays on account of onshore disposal are far greater than that in case of offshore disposal. This is on account of the increased number of project interfaces, time taken for settling and ground improvement, and the compensation for the loss of the bird habitat. Any delay in the delivery of the DLBB Project would have a knock on effect on the Duqm Refinery Project.
- **Interface Management:** The number of interfaces in case of onshore disposal will be far greater than that during offshore disposal. In case of onshore disposal there would be need to coordinate with future tenants and utility providers, with projects in the *sabkha* area, which would run concurrently with the DLBB Project.
- **Health and Safety Aspects:** As a result of the additional activities (such as sedimentation, earthmoving, ground improvement, dumping etc.) associated with onshore disposal of dredged material the health and safety aspects will be greater than that associated with offshore disposal.

Considering the discussion above it is seen that the offshore disposal has inherent benefits compared to onshore disposal and hence offshore disposal has been adopted for the DLBB Project.

5.4.3 Onshore Borrow Vs Offshore Borrow

Reclamation along the LBW will require approximately 6.5 million m^3 of soil. There are five existing quarries that could be possible sources of material. These are:

- The Duqm Quarrying & Crushing LLC quarries (25 km from port, past production of 12,000 m^3 / week): Supplied material for the previous CCC Duqm Port project. Large facility established for 16 years. Closest quarry to the port and has its own supply of trucks that can deliver to site. Supplying limestone aggregate and sand and for asphalt production. Could supply armour stone. Have very large stock piles of materials. Recently reduced production by taking a crusher off line, but has capacity to increase production.
- The Consolidated Contractors Company quarry (38 km from port, past production of 50,000 m^3 / week)
- Duqm Crusher (Coordinates 19º 55' 13.7" N / 57º 41' 55.2" E): relatively new facility. Predominantly supplying limestone aggregate, but could also produce armour stone size if required

- Gulf Pulse Crusher (Coordinates 19º 56' 40.8" N / 57º 42' 19.6" E): current capacity 1,000 t/h. Supplying limestone aggregate and sand and for asphalt production. Could supply armour stone up to tons. Quarry covers 8 km^2. Has its own supply of trucks that can deliver to site. Supplied material for the previous CCC Duqm Port project.
- Al Junaibi Crushers: They are 8.5 km along the same access as Pulse Crushers

The presence of these quarries and past production indicates that the dredging and reclamation Contractor should be able to procure reclamation material from an on land source. However, due to the quantities expected and the schedule requirements, the expected number of trucks to achieve the required production is more than 1 truck per minute, leading to excessive traffic in the area. Preliminary review has also suggested that the cost of transporting material from a land quarry is approximately double the cost of sourcing it from an offshore borrow site.

Alternatively, sand can be sourced from an offshore borrow pit for the reclamation of the LBW area. The offshore borrow pit is the same as used during the previous phases of the work, located approximately 34 km from the Port of Duqm. It is assumed that the sand will be dredged from the borrow pit by a TSHD as it is able to dredge in various sea conditions, whereas the use of other types of dredgers are not feasible in open sea conditions.

The offshore borrow pit is assumed to be the same as used during the previous phases of the work, located approximately 34 km from the Port of Duqm.

Therefore due to the traffic and cost implications, the first scenario of obtaining maternal from quarry has not been carried forward. Instead second option of using offshore borrow area will be considered.

5.5 BAT Analysis

The EIPPCB organises and co-ordinates the exchange of information between Member States and the industries concerned on BAT. The EIPPCB produces BAT reference documents (BREF) and BAT conclusions. The applicable BREF to the DLBB Project is Emissions from Storage. Table 5-3 presents the BAT recommendation for Liquid and Gas Storage, while Table 5-4 presents the BAT recommendations for Storage of Solids.

Table 5-3: BAT Recommendations – Liquids and Gas Storage

Area	BAT Recommendations from EIPPCB BREF	DLBB Project Compliance with BAT
Tanks	The tank design should take into consideration: • The physico-chemical proprieties of the substance being stored • How is the storage operation what level of instrumentation is needed how many operators are required and what is their workload • How will the operators be informed of deviations from normal process conditions • How the storage is protected against deviations from normal process conditions (safety instructions, interlock systems, pressure relief devices, leak detection and containment	Tank design and facility layout will take into consideration BAT requirements.

Area	BAT Recommendations from EIPPCB BREF	DLBB Project Compliance with BAT
	• What equipment has to be installed, largely taking account of past experiences of the product (construction materials, valve quality, etc.) • Which maintenance and inspection plan needs to be implemented and how to ease the maintenance and inspection work (access, layout, etc.) • How to deal with emergency situations (distances to other tanks, facilities and to the boundary, fire protection, access for emergency services such as the fire brigade, etc.).	
Inspection and Maintenance	• BAT is to apply a tool to determine proactive maintenance plans and to develop risk-based inspection plans such as the risk and reliability based maintenance approach. • Implementation of leak detection and repair program	An operation and maintenance (O&M) plan will be prepared by DPTC. The requirement for the O&M plan will be presented in the framework environmental management plan presented in Chapter 8.
Location and Layout	For building new tanks it is important to select the location and the layout with care, e.g. water protection areas and water catchment areas should be avoided whenever possible. BAT is to locate a tank operating at, or close to, atmospheric pressure aboveground.	In line with BAT all tanks considered for the DLBB Project are above ground tanks. The tanks are located in the DLBB Project on the LBW within the Port of Duqm away from water protection and catchment areas.
Tank colour	BAT is to apply either a tank colour with a reflectivity of thermal or light radiation of at least 70 %	A project painting specification will be developed acknowledging the BAT requirements.
Monitoring of VOC	On sites where significant VOC emissions are to be expected, BAT includes calculating the VOC emissions regularly. The calculation model may occasionally need to be validated by applying a measurement method.	Requirements for regular monitoring of VOC through calculation and measurement have been specified in in Chapter 8.
Dedicated Systems	BAT is to apply dedicated systems. In 'dedicated systems', tanks and equipment are dedicated to one group of products. This means no changes in products.	BAT compliant all tanks are dedicated tanks.

Tank specifications - Liquid	• External floating roof tanks, with:
	  ○ at least 95 % of the circumference the gap between the roof and the wall is less than 3.2 mm and the seals are liquid mounted, mechanical shoe seals
	  ○ Liquid mounted primary seals and rim mounted secondary seals.
	  ○ BAT is to apply direct contact floating roofs (double-deck), however, existing non-contact floating roofs (pontoon) are also BAT
	• Additional measures to reduce emissions are:
	  ○ Applying a float in the slotted guide pole
	  ○ Applying a sleeve over the slotted guide
		Floating Roof tanks with geodesic roof are proposed with seal system to comply with the requirements specified in Section 12.3 of Engineering Equipment and Materials Users Association (EEMUA) 159 in addition to the requirements specified in the American Petroleum Institute (API) 650 standard.

Area	BAT Recommendations from EIPPCB BREF	DLBB Project Compliance with BAT
	pole, and/or o Applying 'socks' over the roof legs.	
Tank specifications – PLPG	Pressurised tanks the only significant emissions to air from normal operation are from draining. BAT for draining depends on the tank type, but may be the application of a closed drain system connected to a vapour treatment installation	Pressurised LPG Storage tanks for export purposes are not envisaged in the terminal. To run the flare pilot burners, a LPG storage facility is envisaged. The vapour release from this vessel will be also connected with flare.
Safety and Risk Management	• A major accident prevention policy (MAPP) and a safety management system implement the MAPP • Safety report and an on-site emergency plan and maintain an up-to-date list of substance	A MAPP system will be implemented. We highlight that emergency response plan (ERP) is mandatory requirement for insurance and legal purposes. However, development of MAPP and ERS is responsibility of the operator and not the FEED contractor.
Operational procedures and training	BAT is to implement and follow adequate organisational measures and to enable training and instruction of employees for safe and responsible operation of the installation	Preparation of Plant Operation Manual and Training to the personnel is part of DLBB Project scope and it will be undertaken by EPC Contractor.
Overfill	BAT is to implement and maintain operational procedures to ensure that: • High level or high pressure instrumentation with alarm settings and/or auto closing of valves is installed • Proper operating instructions are applied to prevent overfill during a tank filling operation, • Sufficient ullage is available to receive a batch filling.	• High level or high pressure instrumentation with alarm settings and/or auto closing of valves will be installed on the tanks. • Proper operating instructions will be detailed in the operation manual that is to be applied to prevent overfill during a tank filling operation. • Before the filling operation is started, it will be ensured the tank will have enough ullage to receive the product from the refinery. The same will be captured in the plant operation manual during detail design/EPC stage of the DLBB Project.
Leakage detection	BAT is to apply leak detection on storage tanks containing liquids that can potentially cause soil pollution	The product storage tanks will have routine preventive maintenance. So, leakage due to integrity is highly unlikely. In case, if there is a leak from the tank it will be contained within the bund. The leakage collected in the bund will be sent to oil water sewer for further treatment.
Emissions to soil below tank	BAT is to achieve a 'negligible risk level' of soil pollution from bottom and bottom-wall connections of aboveground storage tanks	BAT is to achieve a 'negligible risk level' of soil pollution from bottom and bottom-wall connections of aboveground storage tanks
Containment	BAT is to apply a full, impervious, barrier in the bund	Full, impervious, barrier in the bund will be provided and it is will be designed as per applicable international standard like NFPA, API etc.
Transfer and handling techniques	• BAT is to apply aboveground closed piping in new situations • BAT is to minimise the number of flanges by replacing them with welded connections • BAT is to prevent corrosion by: o selecting construction material that is	All these measures are standard requirements in good engineering practice and are expected to be implemented in full by the EPC Contractor.

Area	BAT Recommendations from EIPPCB BREF	DLBB Project Compliance with BAT
	resistant to the product ○ applying proper construction methods ○ applying preventive maintenance, and ○ where applicable, applying an internal coating or adding corrosion inhibitors	
Vapour treatment	BAT is to apply vapour balancing or treatment on significant emissions from the loading of volatile substances to trucks, barges and ships	Based on the available data in this stage, the current design has considered flaring of the vapour/emissions generated from the barges and ships.
Valves	• BAT for valves include: • Correct selection of the packing material and construction for the process application • With monitoring, focus on those valves most at risk (such as rising stem control valves in continual operation) • Applying rotating control valves or variable speed pumps instead of rising stem control valves • Where toxic, carcinogenic or other hazardous substances are involved, fit diaphragm, bellows, or double walled valves • Route relief valves back into the transfer or storage system or to a vapour treatment system.	• All these items are standard requirements in good engineering practice and are expected to be implemented in full by the EPC Contractor. • Thermal relief is considered and relief from the relief valve will be routed back into the storage system. Relief from the PLPG system will be routed to flare.
Pumps	• Proper fixing of the pump or compressor unit to its base-plate or frame • Having connecting pipe forces within producers' recommendations • Proper design of suction pipework to minimise hydraulic imbalance • Alignment of shaft and casing within producers' recommendations • Alignment of driver/pump or compressor coupling within producers' recommendations when fitted • Correct level of balance of rotating parts • Effective priming of pumps and compressors prior to start-up • Operation of the pump and compressor within producers' recommended performance range (The optimum performance is achieved at its best efficiency point.) • The level of net positive suction head available should always be in excess of the pump or compressor • Regular monitoring and maintenance of both rotating equipment and seal systems, combined	• Proper fixing of the pump or compressor unit to its base-plate or frame will be done during pump installation. The pump foundation and GA drawings will be checked / verified by the EPC Contractor as well as by the project management engineers during the detail design and construction stage of the DLBB Project. • EPC Contractor shall follow the pump vendor recommendations as well as verify their design using approved software during detail design stage of the DLBB Project. • Proper design of suction pipework to minimise hydraulic imbalance is part of Detail Design which will be done by EPC Contractor. Also, piping design for the entire terminal will be as per international standard like API B31.1 etc. • Alignment of shaft and casing within producers' recommendations is part of installation which will be done by EPC Contractor during the construction phase of the DLBB Project. • Alignment of driver/pump or compressor coupling within producers' recommendations when fitted will be checked by EPC Contractor along with Owner's engineer during the construction phase of the DLBB

Area	BAT Recommendations from EIPPCB BREF	DLBB Project Compliance with BAT
	with a repair or replacement programme	Project. • Correct level of balance of rotating parts will be done and checked by EPC Contractor along with Owner's engineer during the construction phase of the DLBB Project. • Effective priming of pumps and compressors prior to start-up will be done by EPC Contractor commissioning engineers along with Owner's engineer during the commissioning phase of the DLBB Project • Operation of the pump and compressor within producers' recommended performance range (The optimum performance is achieved at its best efficiency point) will be checked by EPC Contractor commissioning engineers along with Owner's engineer during the commissioning phase of the DLBB Project. • The level of NPSHA will always be in excess of the pump or compressor NPSHR. The pump and the piping system design will take care of the NPSH requirement of the pump. • Regular monitoring and maintenance of both rotating equipment and seal systems, combined with a repair or replacement programme will be part of the owner's preventive maintenance programme during operation of the facility. However, the requirement of periodic maintenance of pump and its seal system will be detailed in the pump operation and maintenance manual.
Sealing system in pumps	BAT is to use the correct selection of pump and seal types for the process application	Selection of pump and its seal type will be as per the API standard.
Sampling connections	BAT, for sample points for volatile products, is to apply a ram type sampling valve or a needle valve and a block valve.	As the refinery is responsible for export product quality all the sampling and analysis of the products will be done in the refinery. So, no sampling arrangement will be provided.

Table 5-4: BAT Recommendations – Solid Storage

Area	BAT Recommendations from EIPPCB BREF	DLBB Project Compliance with BAT
Storages	BAT is to apply enclosed storages for dust control	The Pet Coke and Sulphur will be stored in enclosed storages.
Prevention of Major accidents	• A major accident prevention policy (MAPP) and a safety management system implement the MAPP • Safety report and an on-site emergency plan and maintain an up-to-date list of substance	A MAPP system will be implemented. We highlight that emergency response plan (ERP) is mandatory requirement for insurance and legal purposes. However, development of MAPP and ERS is responsibility of the operator and not the FEED contractor.
Transfer and handling	• BAT is to make transport distances as short as possible and apply wherever possible continuous transport modes. • Cleaning of tyres is BAT	The Duqm Refinery will be responsible to transport Pet Coke and Sulphur to the DLBB Project. Within the DLBB Project facility the transport of bulk material is minimum through use of pile front end loaders onto conveyors and transferred to the ships via grasshopper

Area	BAT Recommendations from EIPPCB BREF	DLBB Project Compliance with BAT
	• Loading and unloading activities BAT is to: ○ minimise the material movement velocities ○ minimise the drop height	conveyors.
Conveyor transfer	• BAT is to design conveyor transfer chutes in such a way that spillage is reduced to a minimum • To minimise dust generation, drops to be eliminated wherever possible, minimised, or drop heights reduced to be as small as possible.	The planned design based on the data available is a Pet Coke / Sulphur will be sent to the carriers via enclosed conveyor so that spillage will be minimized.
Reduce energy consumption	• To reduce energy consumption BAT is : ○ Good conveyor design including idlers and idlers spacing ○ Accurate installation tolerance ○ Belt with low resistance	Conveyor design will be on par. EPC Contractor scope and it shall be designed as per the latest international standards. The FEED specification will include the requirements as well as reference the international standards for a good conveyor design.

From the above tables it is apparent that the storage for solids, liquid and gas comply with BAT recommendations.

6 ENVIRONMENTAL BASELINE

6.1 Overview

The DLBB Project is located in the Al Wusta Region of the Sultanate of Oman. Al Wusta Governorate makes up 25.8 % of the land area of Oman, however only represents about 1 % of the population in the Sultanate with population density of 0.5 persons/km^2. The ecology in Al Wusta is diverse with many birds passing the Al Wusta region during their annual migration. On land, the climate, influenced by the annual autumn season in Dhofar, helps the growth of a variety of plants and rare mammals such as the Arabian Oryx and the Nubian Ibex. The waters off Al Wusta are home to marine cetaceans of conservation concern. The DLBB Project is a part of Port of Duqm, which in turn is a part of the Duqm Industrial Zone Master Plan.

6.2 Project Location

As highlighted above the DLBB Project is located in Duqm and is a part of the larger developments at Duqm, such as the Duqm Port and Duqm Industrial Zone. The approximate coordinates of the root of the LBW is at 571347E; 2176683N 40Q. Table 6-1 and Figure 6-1 presents a list of significant features around the DLBB Project.

Table 6-1: Significant Features around the Project

Feature	Straight Line Distance	Comment
Public Road (Highway #32)	3 km west	Connected to the site by a graded road
Say Village	5.5 km southwest	Nearest populated village to the DLBB Project site
Fish factory and landing area	4 km north	The area where the fish factory is located is designated for industrial use. It is expected that this fish factory will be relocated.
Commercial Quay	4.8 km east	The commercial quay is within the Duqm Port
Government Berth	2.65 km east	The government berth is within the Duqm Port
Rock Garden	3.5 km southwest	The site is fenced and access to the site is restricted through a gate
Oryx Sanctuary	70 km west	The sanctuary is a protected area

Figure 6-1: Significant Features around the Project

Figure 6-2: Photograph of Say Village *(Photograph on 19-Aug-2015)*

Figure 6-3: Fish Factory and Landing Area *(Photograph on 3-Sep-2014)*

6.3 History of the Site

Prior to the construction of the port the DLBB Project area consisted of headland of Ras Duqm, a smaller headland some 2 km to the northwest of Ras Duqm and the seabed lying in the bay between. The topography of the area is characterised by Ras Duqm, which is located at the eastern end of a sandy bay approximately 2 km wide. There was a fish-landing area adjoining this headland, which has been since been moved to a location 4 km north of the LBW. Figure 6-4 is a historic photograph looking east towards Ras Duqm headland from northwest headland. A close look at Figure 6-4, the fish landing area can be seen just below the headland.

Figure 6-4: Historic Photograph of Project Area prior to Port Construction *(Source: EIS for New Port and Dry Dock Complex, Duqm, MOTC, 2007)*

Figure 6-5 presents a Google Earth image, dated 4-Jul-2004, of the DLBB Project area prior to construction of the port.

Figure 6-5: Historic Google Earth Image of Project Area (4-Jul-2004)

Construction of the port began in 2006 and was completed in 2013. Figure 6-6 below presents an image, dated 7-Jul-2009, of the port while construction of the breakwaters was in progress. The image clearly shows the completed road linking the LBW to Highway #32. The government pier is seen partly constructed and construction of structures related to the port and dry dock are ongoing.

Figure 6-6: Historic Google Earth Image of Project Area (7-Jul-2009)

Figure 6-7 dated 25-Feb-2011, shows the complete LBW and reclamation of the Commercial Quay and Government Berth. The dry dock appears to have been completed. Figure 6-8 presents the Google Earth Image for the DLBB Project area, dated 21-Jan-2015. This figure is representative of the current status of the DLBB Project area. The changes between Figure 6-7 and Figure 6-8 is the completion of the Commercial Quay and Government Berth. Furthermore, construction of Road 5 had commenced.

Figure 6-7: Historic Google Earth Image of Project Area (25-Feb-2011)

Figure 6-8: Historic Google Earth Image of the Project Area (21-Jan-2015)

6.4 Previous Studies Undertaken

Listed below are studies undertaken for the DLBB Project area:

Table 6-2: Previous Studies Undertaken

Document Details	Comments
3H6503/ Feasibility Study Report New Port and Drydock Complex at Duqm (August 2004)	Posford Haskoning in association with Khatib & Alami 3H6503/ Feasibility Study Report and Al Baraka Economic Consultancy
Duqm Industrial and Free Zone Master Plan Final EIA report (Rev 02 Jun 2011)	• Prepared by JURONG Consultants Pte Ltd (Oman Branch) • EIA Study for the Duqm Industrial Free Zone and Master Plan
Phase 1 Operations Environmental Services – Final Environmental Assessment Report (Rev 01 Feb 2012)	• Prepared for Port of Duqm Company • Environmental Assessment report for Phase 1 Operations
New Port and Dry Dock Complex (Apr 2007)	• Prepared for the Ministry of Transport & Communication • EIS for construction of the port and dry dock
Ship Repair Yard and Dry Dock Complex in Duqm – EIA for the Operation Phase (Feb 2010)	• Prepared for Oman Dry Dock Company SAOC • EIA for operation of the ship repair yard and dry dock
New Port and Dry Dock Complex Maritime Works – Current Measurement and Entrance Channel (25 Jun 2012)	Prepared for Sultanate of Oman Ministry of Transport and Communications Director General of Ports
Hydrodynamic and Sediment Transport Report (Draft 26 June 2009)	• Prepared by Royal Haskoning • Desk study on sediment transport and hydrodynamics of the area
Environmental Baseline Survey Report for Disposal Area (18 Feb 2008)	• Prepared for Director General of Ports and Maritime Affairs Ministry of Transport and Communication • Videography, in-situ baseline water quality, baseline water quality, and sediment quality and benthos/ecology determination for the disposal area
Environmental Baseline Survey Report Borrow Area for Borrow Area (07 Jul 2008)	• Prepared for Director General of Ports and Maritime Affairs Ministry of Transport and Communication • In-situ water quality sampling tests, baseline water quality laboratory tests, sediment quality, benthos/ecology determination and correlation NTU-TSS
Master Plan for Duqm Industrial Zone	It is understood that the Master Plan is not finalised and is being still developed.
Master Plan for Duqm Port	It is understood that the Master Plan is not finalised and is being still developed.
Drainage Model Final Results – General report (30 Mar 2012)	• Prepared for the Supreme Committee for Town Planning • Prepared for the master-planning of the Duqm Development
Consultancy Services For Design, Supervision And Operation & Management Studies For A New Port And Dry Dock Complex At Duqm (Oct 2002)	Prepared for Ministry of Transport and Communication Director General of Ports and Marine Affairs

6.5 Climate and Meteorology

The DLBB Project is located on the eastern coast of Oman and experiences average temperatures between 15.4 ºC and 40.8 ºC and sparse rainfall. The main weather systems that deliver rainfall to the region comprise:

- **Frontal systems:** originating in the Red Sea or Mediterranean Sea and occur late December to April. These are also known as the winter monsoons or Shamal. The winter monsoon is characterized by a relatively gentle and variable, dry northeast wind;
- **Cyclones:** Originating in the Arabian Sea during May, June and October-November, they are relatively infrequent, occurring once every 7 to 10 years; and
- **Summer Monsoon/*Khareef*:** occurs annually between late June and September as wind, light drizzle and mists.

The *Khareef* season represents the most reliable source of aquifer recharge and accordingly water supply. During the *Khareef*, monsoon clouds give rise to both orographic rainfall and occult (fog) precipitation. The *Khareef* precipitation is the sum of rainfall mostly in the form of drizzle (vertical component) and occult precipitation (horizontal component); the collection of the latter is increased by vegetation. The summer monsoons are also responsible for coastal upwelling, which makes the area rich in marine life.

The effect of occasional cyclonic events and major storms are evident as large peaks in rainfall and the annual variations in *Khareef* as more numerous smaller peaks of rainfall. Cyclones are reported to occur about every 7 to 10 years, usually in May-June or November. These rainfall events result in substantial flows of short duration in major wadis draining south that cause flooding in coastal areas.

Table 6-3 presents the mean total rainfall in Duqm, which shows that rainfall is sparse with December being the wettest month.

Table 6-3: Rainfall in Duqm

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Total Rainfall (mm)	0.5	0	0.2	0	0	0	0	0	0	2.3	0	4.3
Source: Meteorological Affairs Director General of Meteorology and Air Navigation												

Table 6-4 presents the average maximum and average minimum temperature.

Table 6-4: Average Temperature

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Maximum (ºC)	26.4	29.2	33.2	38	40.8	38.5	38.2	33.6	35.6	33.2	31.1	27.6
Average Minimum (ºC)	15.4	16.7	18.8	23.2	25.8	26.6	24.4	23.5	23.7	20.8	19.7	17.3
Source: Meteorological Affairs Director General of Meteorology and Air Navigation												

Duqm experiences a hot, arid climate. Two distinct seasons occur, winter (November to April) and summer (May to October). Monthly mean temperatures at Duqm range from 22 ºC (January) and 32 ºC (June), and the average annual temperature is 27 ºC.

A statistical analysis of the hind-cast wind data (CSFR) shows that winds are predominantly from the South-Southwest and Southwest directions. The maximum and average hourly wind speeds in the wind dataset under analysis are 21.2 m/s and 6.7 m/s, respectively. Winds from the north east, north-north east, south and west south west directions are also frequent but have lower wind speeds and percentages of occurrence compared to the prevailing south-south west winds. The hind-cast wind data also indicates that the most energetic winds occur during the summer months, peaking in June and July. Figure 6-9 presents common occurring wind speeds/directions are highlighted in orange, rare wind speeds/directions are highlighted in various shades of yellow and wind speeds/directions which were not recorded are highlighted in light grey.

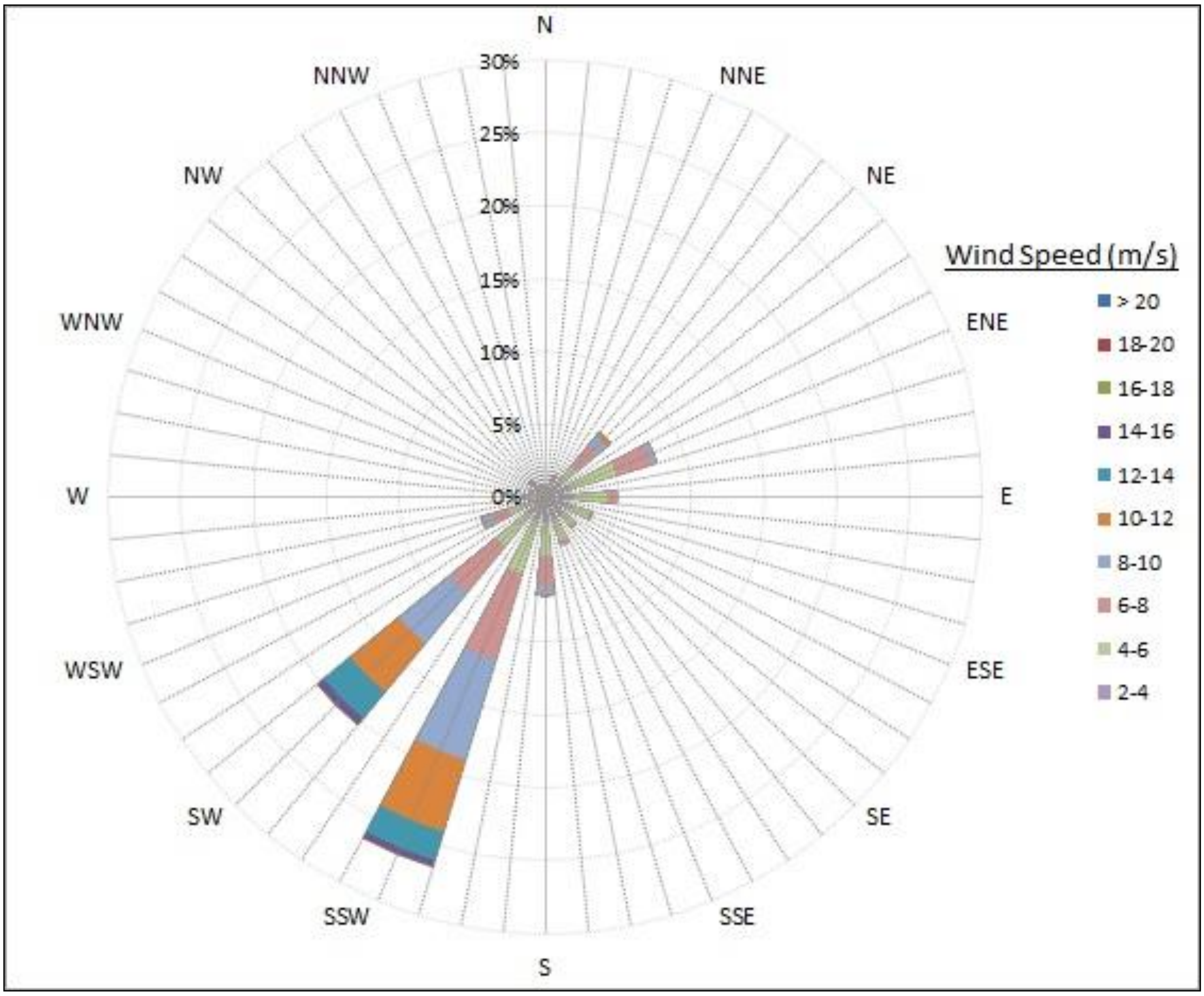

Figure 6-9: Annual Wind Rose (CFSR at WAVEWATCH Node 52567, 1979-2009)

All wind speeds presented in this section are provided for a height of 10 m above ground level.

6.6 Natural Hazards

Tropical cyclones generally develop off the western coast of India and track westwards across the Arabian Sea. Most storms diminish before reaching land, but occasionally they cross the southeast coasts of Oman and Yemen. Seasonal heavy rains and cyclones also result in flooding, causing serious damage to urban settlements and infrastructure.

A review of cyclone data obtained from the Joint Typhoon Warning Centre for the period 1972 to 2010 shows that three main cyclones affected the coast of Oman during this period. The two most energetic events recorded were Gonu in 2007 (red line) and Phet in 2009 (green line). Figure 6-10 shows that the DLBB Project area is affected by tropical storms (on average 1 every 2 years). The tropical storms/cyclones are generated in the Indian Ocean and propagate in a West-Northwest direction during monsoon seasons transition (May to June and October to November).

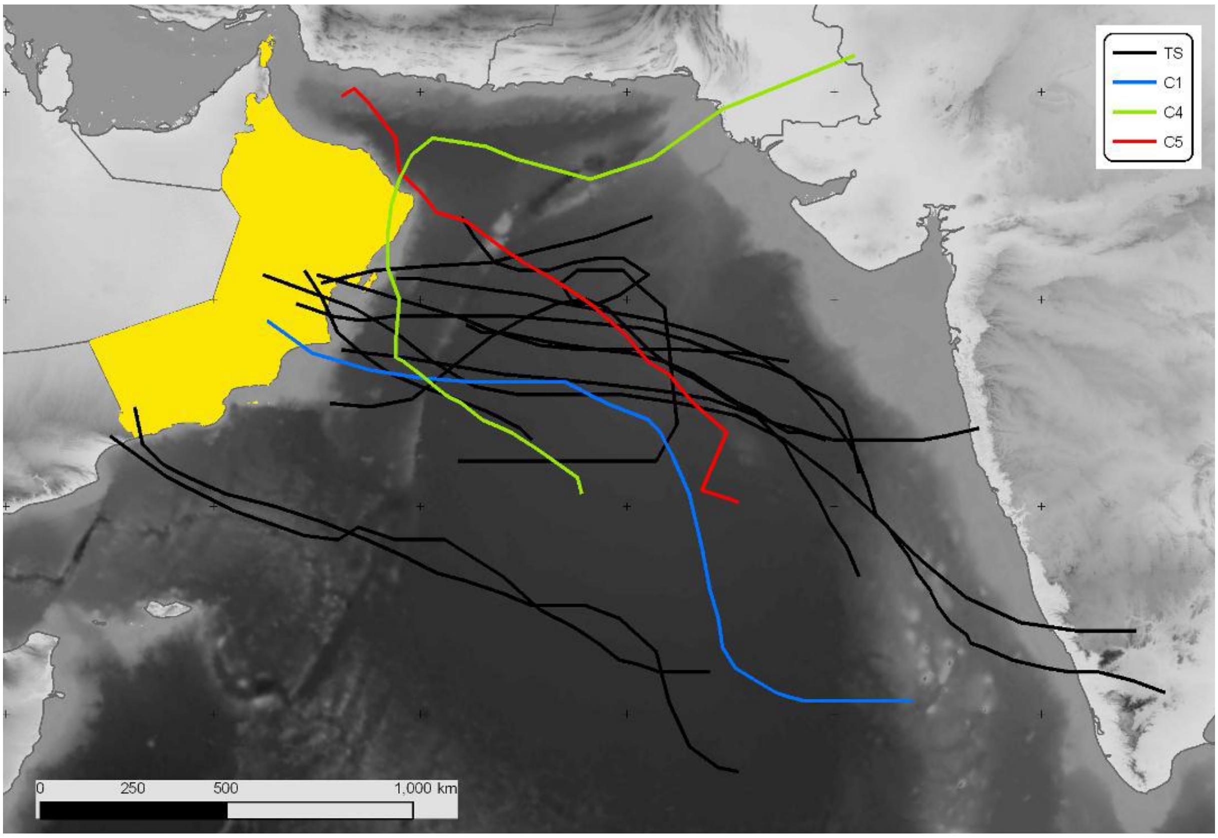

Figure 6-10: Historic Cyclone Tracking *(Source: Joint Cyclone Warning Centre)*

6.7 Seismic Hazard

Oman is a part of the Arabian plate, which comprises the continent of Arabia as well as oceanic areas consisting of parts of the Red Sea, Arabian Sea, Gulf of Aden and Gulf of Oman. Along the north-eastern margin, the Arabian plate is in continental collision, which has given rise to the folded Zagros Mountains. The oceanic part of the Arabian plate is subducting along the Makran Trench. The destructive plate-margin of the Arabian plate along the Zagros and Makran is marked by intense earthquake activity. As the Arabian plate moves north-eastwards, parts of the plates are differentially deformed and periodic release of such stress accumulations causes earthquakes within the plate. The 1971 Al-Kamil earthquake in Oman and the 1982 Dhammar earthquake in Yemen are examples of such intraplate earthquakes.

Since the late 1990s Sultan Qaboos University has been establishing earthquake monitoring stations across Oman and in 2014 there were 62 stations installed. The south of Oman has very low seismic activities. In contrast, the northern portion of Oman has a moderate to high seismic activity. The Middle East Seismic Hazard Map prepared by the Global Seismic Hazard Assessment Program (GSHAP) indicates a Low seismic hazard in the DLBB Project area (see Figure 6-11).

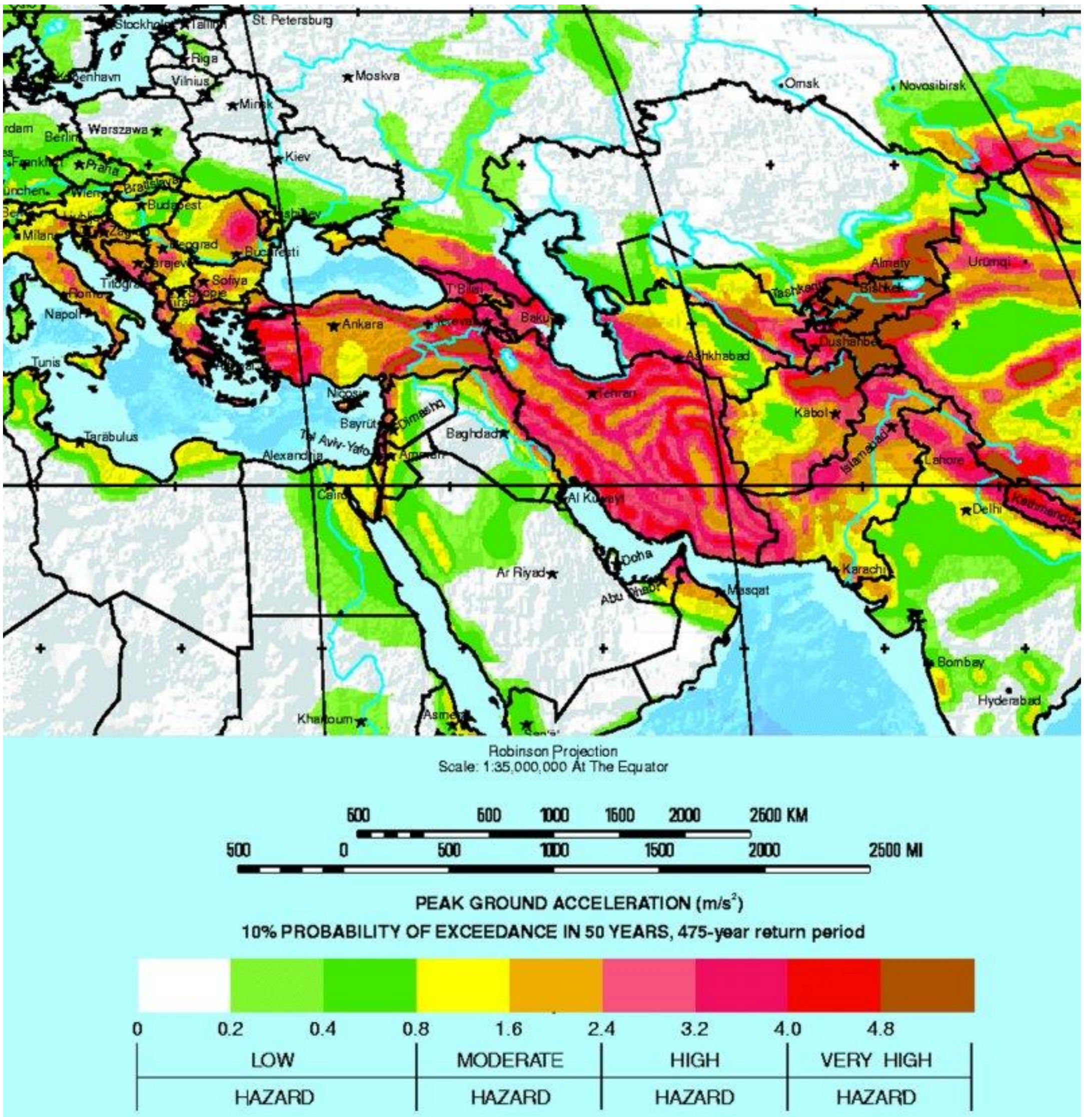

Figure 6-11: The Middle East Seismic Hazard Map prepared by GSHAP

6.8 Tsunami Risk

The east coast of Oman lies on the Arabian Sea, which is the in the north-western part of the Indian Ocean. The east coast of Oman is exposed to two known tsunami producing subduction zones, these being the Makran Subduction Zone which lies in the Gulf of Oman and the Sumatra Subduction Zone (Sundra Arc) along the west coast of Sumatra. Figure 6-12 presents the subduction zones affecting the coast of Oman

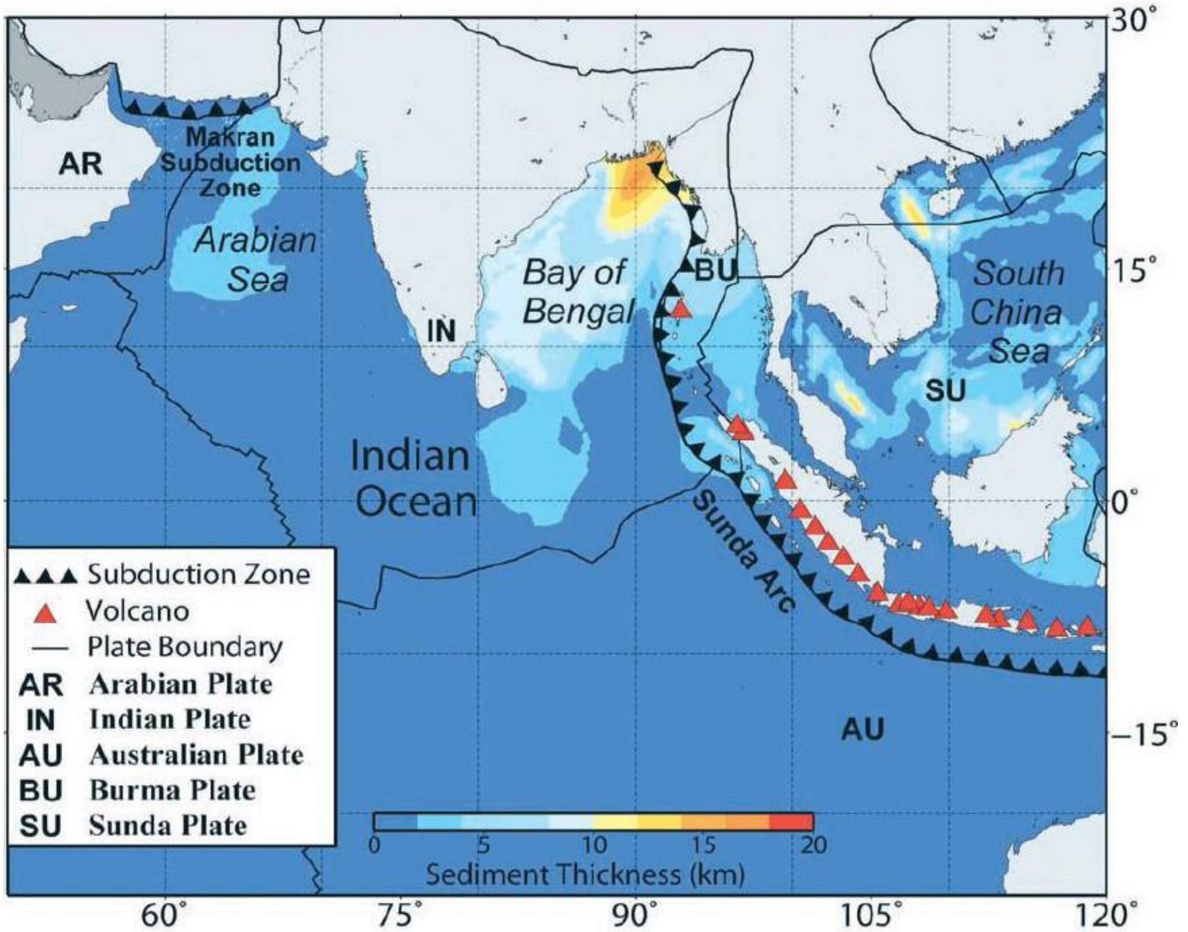

Figure 6-12: Subduction zones affecting the coast of Oman

A literature review suggests that a total of 23 earthquakes were reported in the Arabian Sea between 326 BC and 2007 AD, with the moment magnitude (M_W) greater than 6.5. Most of the earthquakes occurred in India, Pakistan and Iran, and as such did not generate any tsunamis. The two largest tsunamis on record in the Indian Ocean which affected the Oman coastline are:

1. The 1945 Makran Tsunami which had a return period of around 200 years resulted in a catastrophic loss of life along the coasts of Pakistan, Iran, India and Oman.
2. The Boxing Day Indian Ocean Tsunami, which has a return period of between 400 and 1,000 years was also felt in the Arabian Sea, and was felt in Salalah and Duqm.

Based on recorded earthquakes and tsunami events, the risk of a large tsunami reaching the DLBB Project site is considered medium to small since the site is relatively sheltered from the main tsunami generating areas, i.e., the Makran and the Sumatran subduction zones.

6.9 Topography and Land-take

The DLBB Project is located in the Port of Duqm on the eastern coast of Oman approximately 7 km to the east of the Say village (also known as Al Duqm). The DLBB Project involves development of the LBW, though reclamation of about 2.5 km of land along the LBW (reclaimed area 860,000 m^2). The area immediately around the root of the LBW is *sabkha* (salt flats). The *sabkha* comprised of several infra-littoral mud areas, intertidal sand and mud habitats, tidal and non- tidal lagoons, vegetated and non-vegetated dunes, and supra-littoral sand bars. These sand bars were broken through in areas, more so within the Port area than north of the LBW, with tidal inlets leading to tidal lagoons. North of the LBW are a series of non-tidal lagoons (otherwise known as '*khawrs*'), whereby the water has seeped underground to produce highly saline lagoons. The lagoons were then surrounded by a variation of sand and mudflats. On the whole the site topography is generally low lying and very flat, with the nearshore area fronting the port generally between 1 and 2 m above MSL.

Figure 6-13 presents a sketch of the existing and future features around the DLBB Project area.

Figure 6-13: Sketch of Existing and Future Features around the DLBB Project Area

From the figure it is apparent that the actual land take for the DLBB Project will be limited as most of the land for the development being reclaimed along the LBW. It is understood that all the land around the DLBB Project area will be developed as part of developments by SEZAD and the Port of Duqm (see Figure 6-14 and Figure 6-15, overleaf).

Figure 6-14: Dumping of Soil in the *Sabkha* as part of ongoing SEZD Development *(Photograph 20-Aug-2015)*

Figure 6-15: Truck Movement near the LBW *(Photograph on 20-Aug-2015)*

Figure 6-16: Photograph of the Existing LBW *(Photograph on 3-Sep-2014)*

6.10 Landscape and Visual Amenity

The area around the root of the LBW is a large salt flat, making the LBW visible from Highway #32, which passes through Say village. It should be noted that SEZAD has earmarked the salt flats between the LBW and Highway #32 for development into an industrial zone.

Plastic and other litter is spread across the area near the root of the LBW. This litter is a result of wadis flow carrying waste from its catchment and depositing around the DLBB Project site. Other sources of litter are fishermen operating in the area and locals using the LBW for recreational fishing.

Images of the study area are presented in Figure 6-17, Figure 6-18 and Figure 6-19.

Figure 6-17: View to the South of root of LBW *(Photograph taken on 6-Jan-2015)*

Figure 6-18: View of the *Sabkha* *(Photograph taken on 6-Jan-2015)*

Figure 6-19: View of the *Sabkha* with the Port in the Background *(Photograph Taken on 6-Jan-2015)*

Figure 6-20: Litter Seen to the North of LBW *(Photograph Taken on 3-Sep-2014)*

6.11 Geology

The Project lies in the Huqf area and contains the best outcrop of the Al Khlata reservoir, a huge but massively complex formation that serves fields including Marmul and Nimr which form the bedrock of Petroleum Development Oman's production in south Oman. Al Huqf's rocks are the oldest sedimentary sequence found in Oman, dating back to the Pre-Cambrian era (more than 700 million years ago). The wider Project area is dominated by the Ras Duqm headland, a north-south directed limestone ridge with steep sea cliffs on the eastern side and a height of 100 m or more. It marks the northern limit of the Shuwayr formation. The Shuwayr Formation is a thick unit of Oligocene-Miocene age consisting of inter-bedded white bioclastic limestone with corals, debris-flow deposits and dolomitic laminated limestone with black dolomite at the top. Figure 6-21 presents the geological map of Duqm.

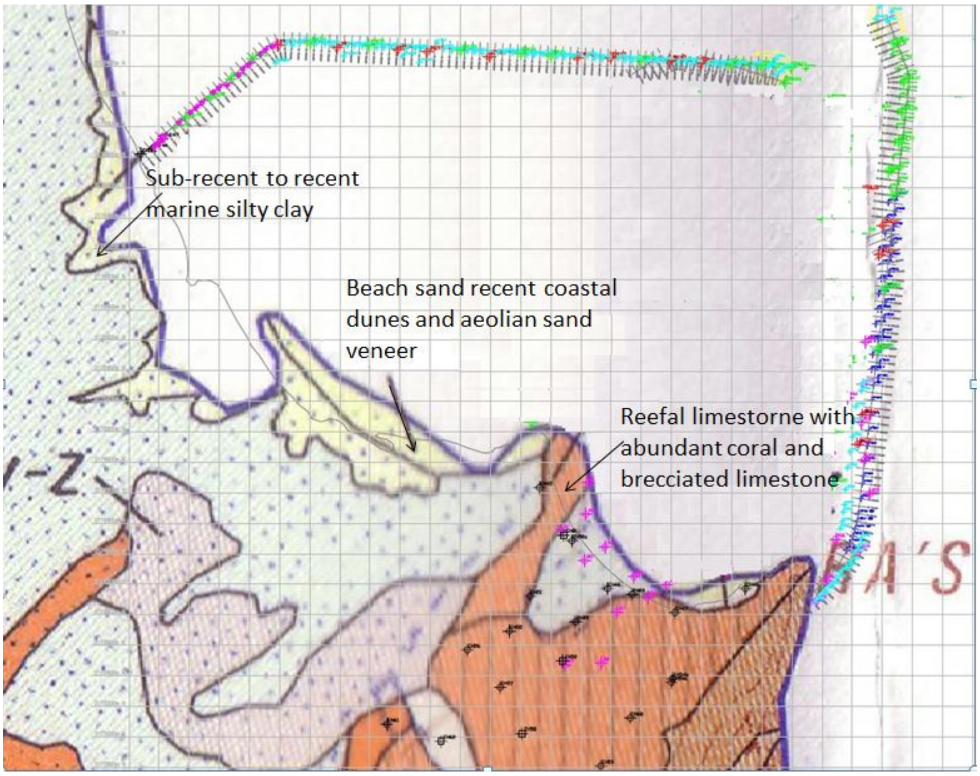

Figure 6-21: Geological Map of Duqm

The surface geology of the study area is characterised by *sabkha*. The presence of *sabkha* is of particular significance to the coastal region. It is a type of soil type that forms over low lying coastal area that are filled overtime, by windblown fine sand and silt with concentration of salt deposits derived from evaporation of seawater that inundates the area at high tide. Eventually the deposits build up above the tidal range leaving a dry crust that conceals a soft mud with a high concentration below the surface. The dry crust can easily collapse under light loads. The high salt concentration in *sabkha* soil is a challenge for construction as it would cause damage to concrete and steel. Significant ground improvement would be required prior to construction which would involve excavation of the *sabkha* areas and backfilling with clean earth.

An area of particular cultural importance is the Rock Garden located about 3.5 km southwest from the DLBB Project. The Rock Garden is made up of limestone and sandstone rocks that were formed in an underground freshwater aquifer more than 46 million years ago. The action of wind, water, frost and other natural forces over millions of years resulted in the formation of these sculpted rocky wonders spread over a three-square kilometre area. The Rock Garden is one of the top 25 sites of geological scientific importance in Oman. In order to protect the rock garden from ongoing construction works the area has been fenced by SEZAD. Figure 6-22 presents a photograph of the fencing, while Figure 6-23 presents a photograph of the rock garden collated from the internet.

Figure 6-22: Chain Link Fencing around the Rock Garden (Photograph Taken on 3 Sep 2014)

Figure 6-23: Photograph from the Rock Garden *(Source: Times of Oman, 11 Nov 2012)*

Prior to the construction of the LBW, in order to ascertain the subsurface geology four boreholes were drilled, up to a depth of 20 m, along the alignment of the LBW (Geotechnical Investigation on LBW for New Port Development at Duqm Sultanate of Oman, June 2009 PO/4052/09/02). The findings of the subsurface conditions are as below:

- From ground (Seabed) level to a depth of about 0.6 m: Medium dense, very silty, very sandy, fine to medium gravel / gravelly sand/ very stiff, slightly, gravelly, sandy silt/ made ground consisting of angular, cobble to boulder grade fragments
- From about 0.5m to depths of between 3.6 m and 7.5 m: Slightly to moderately weathered, weak to moderately weak calcarenite/ extremely weak to very weak calcisiltite
- Below this to the boreholes termination depth of 20m below the existing ground (Seabed) level: Slightly to moderately weathered, very thinly laminated, weak to moderately weak, calcareous mudstone, locally interbedded with calcarenite

6.12 Soil Quality

In most of Oman the effective rainfall is very limited and soils are very dry most of the time. Soil formation is therefore very slow and weak. The General Soil Map prepared by the Ministry of Agriculture and Fisheries and Food and Agriculture Organisation of the United Nations identifies the DLBB Project area is mostly composed of tidal flats, with poor soil unsuitable for agriculture.

Figure 6-24: Close-up of *Sabkha* Surface (Photograph Taken on 6 Jan 2015)

Between Apr-2012 and Oct-2013, SEZAD undertook an environmental baseline study for the Duqm SEZ as part of this assessment soil sampling was undertaken the samples collected from nine locations (see Figure 6-25).

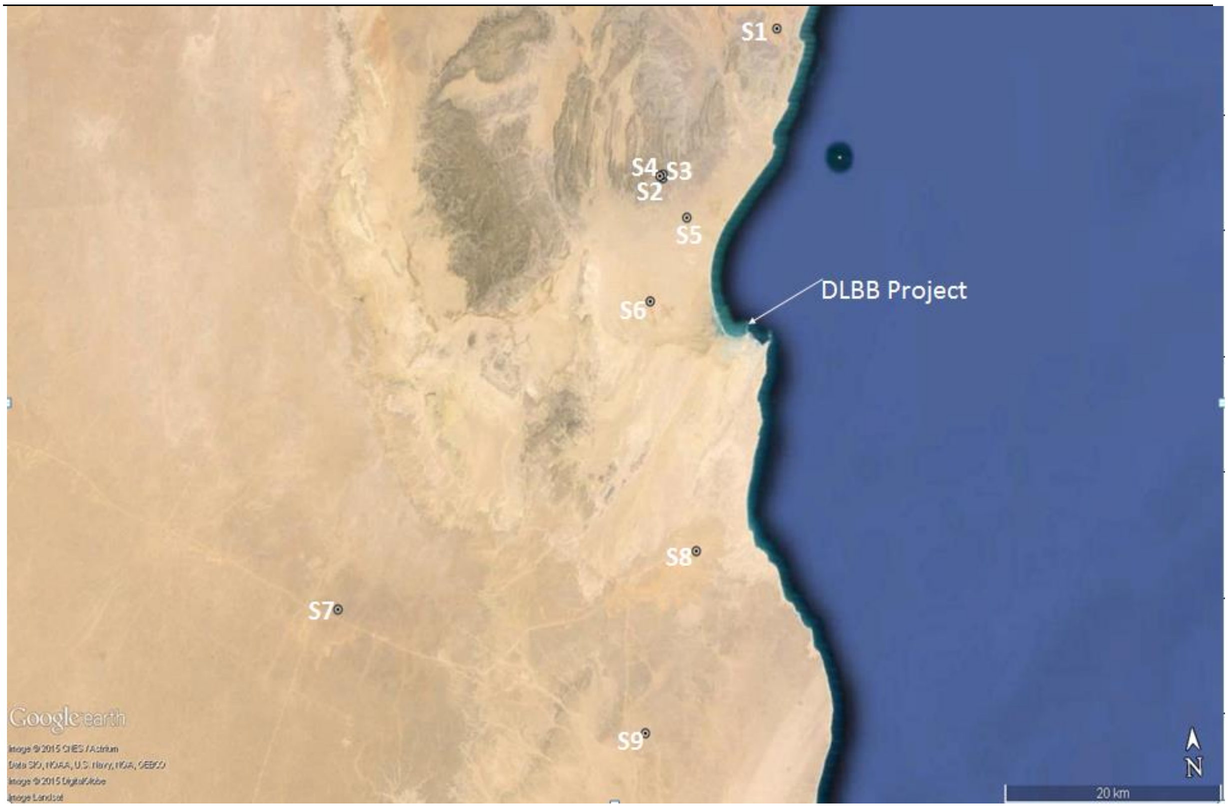

Figure 6-25: Locations of Historic Soil Sampling

Table 6-5, overleaf, summarises the findings of the survey. In lieu of absence of applicable Omani standards and limits for soil quality, the results of laboratory analysis of soil were compared with the Preliminary Remediation Goals (PRG) listed in the USEPA Site Notification Standards Region IV for “Industrial Soil”. Sample S-1 was taken from an area earmarked for future residential development, and therefore this has been compared with USEPA values for “Residential Soil”. In addition, all samples were compared with the Dutch Intervention Values for Soil Remediation (DIVSR) 2000.

Table 6-5: Soil Sample Results Comparison with USEPA Region IV and Dutch Standards

Parameter	Unit	USEPA 2008 Industrial Soil	USEPA 2008 Residential Soil	DIVSR 2000	S-1 (E578344; N2200153)	S-2 (E567197; N2188678)	S-3 (E567172; N2188386)	S-4 (E566891; N2188579)	S-5 (E569152; N2185000)	S-6 (E565389; N2178277)	S-7 (E535311; N2154528)	S-8 (E568354; N2157402)	S-9 (E562805; N2142630)
Arsenic	mg/kg	1.6	0.39	55	<0.5	<0.5	0.5	1.6	1.09	<0.5	6.48	8.46	1.78
Cadmium	mg/kg	810	70	12	<2	0.45	0.49	0.69	0.59	0.51	0.5	0.69	0.5
chromium	mg/kg	1,400	280	380	45	5.99	6.19	14.4	9.2	8.51	28.6	37.9	21.1
Copper	mg/kg	4.1×10^4	3.1×10^4	190	26	6.17	5.43	10.7	7.81	4.27	6.18	8.54	6.7
Lead	mg/kg	800	400	530	<5	1.06	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nickel	mg/kg	2.0×10^4	1600	210	453	5.82	7.63	15.7	12.9	6.87	15.8	20.9	8.87
Cobalt	mg/kg	300	23	240	<2.5	0.97	1.39	4.65	2.44	1.05	3.05	3.46	3.17
Boron	mg/kg	2×10^5	1.6×10^4	-	<1	10.2	18.8	47.2	33.8	12.6	26.5	30	1.78
Sodium	mg/kg	-	-	-	-	181	159	1306	115	119	225	70.5	4.34
Iron	mg/kg	7.2×10^5	5.5×10^4	-	18,231	632	1265	2522	2297	1382	1957	2609	1770
Zinc	mg/kg	3.1×10^5	2.3×10^4	720	17	6.59	6.61	28.6	28.6	8.11	6.24	9.0	8.87
Mercury	mg/kg	28	6.7	10	<0.001	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Molybdenum	mg/kg	5.1×10^3	390	200	-	0.24	0.63	1.47	1.19	0.4	1.14	1.36	0.71
Magnesium	mg/kg	-	-	-	710	276	21.1	884	<0.01	72.5	432	24.5	150
Tin	mg/kg	$6.1x10^5$	4.7×10^4	900	-	1.76	2.64	<0.5	1.03	<0.1	<0.5	<0.5	8.41
pH	--	-	-	-	7.2	7.6	7.8	7.4	7.7	7.8	7.3	7.7	7.9
Sulphate	mg/kg	-	-	-	14,300	27.04	0.04	10.03	0.04	0.04	3.50	0.08	0.07
Chloride	mg/kg	-	-	-	25,800	<0.01	0.05	0.20	<0.01	0.03	<0.01	0.01	<0.01
Total Phosphate as PO_4	mg/kg	-	-	-	6.5	1.36	0.44	0.20	1.32	2.6	0.16	<0.1	0.28
Phenol	mg/kg	$1.80x10^5$	$1.80x10^4$	40	-	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
MTBE	mg/kg	190	39	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzene	mg/kg	5.6	1.1	1	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Toluene	mg/kg	300	5000	130	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ethyl benzene	mg/kg	29	5.7	50	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Xylene	mg/kg	2300	600	25	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PAH	mg/kg	-	-	40	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Parameter	Unit	USEPA 2008 Industrial Soil	USEPA 2008 Residential Soil	DIVSR 2000	S-1 (E578344; N2200153)	S-2 (E567197; N2188678)	S-3 (E567172; N2188386)	S-4 (E566891; N2188579)	S-5 (E569152; N2185000)	S-6 (E565389; N2178277)	S-7 (E535311; N2154528)	S-8 (E568354; N2157402)	S-9 (E562805; N2142630)
Volatile hydrocarbons (C_5-C_{10})	mg/kg	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Extractable Petroleum Hydrocarbons (C_{11}-C_{40})	mg/kg	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Source: Q3 Report Environmental Baseline Study for Duqm Development and Surroundings, for SEZAD, by HMR March 2013

The USEPA PRG is the average concentration of a chemical in an exposure area that will yield the specified target risk in an individual. The DIVSR intervention values indicate when the functional properties of the soil for humans, plants and animals is seriously impaired or threatened. They are representative of the level of contamination above which a serious case of soil contamination is deemed to exist. It is important, therefore, to make the distinction that these values are not limit values for contamination, rather they are guidance values for remediating contaminated soil, therefore even though pollution levels found in the soil samples may be below the limit values, concentrations may still exist indicating contamination.

The soil sample analysis results revealed negligible indication of contamination. Given the pH values ranging from 7.3 and 8.0 for all samples, the soils are alkaline which are commonly found in areas with low rainfall. There is no evidence of hydrocarbon contamination, and appreciable levels of magnesium and iron could be due to the presence of minerals in the region. Remaining parameters in the samples are well within the specified limits of all the used standards.

However, for four of the samples, which are named as S4, S7, S8 and S9, we noted higher arsenic level as per the USEPA Site Notification Standard 2008 for Industrial Soil Arsenic level, however, they are found below the DIVSR 2000 value.

Subsequent desktop research to explain higher arsenic levels revealed that it occurs naturally in the environment although rarely in its elemental form. However, in this case, the potential reason for higher accumulation of arsenic is due to geological formation of the areas. Literature review revealed that geologically composed marine deposits like bioclastic limestone with molluscs and scarce corals, along with white chalky limestone and biocalcarenite are attributing to the higher value of arsenic, since molluscs contain high levels of arsenic concentration. Therefore, it may be concluded that the occurrences are attributed to the geological nature of the soil rather than indication of any serious anthropogenic contamination.

6.13 Hydrology

The Project lies within the Huqf hydrologic area which is undertrained by rocks which are bowed upwards as part of a major structural arch. In the Al Wusta region groundwater discharge is in the dune fields of Ar Rub al Khali in the west and Huqf in the east, where highly fractured pre –Tertiary basement outcrops borders the Arabian Sea. The main regional aquifer in the area is the Umm ar Raduma (UAR) formation. Generally the salinity of groundwater gradually increases as groundwater migrates to the Huqf hydrological area and all regional groundwater is brackish to saline.

Between April 2012 and October 2013, SEZAD undertook an environmental baseline study for the SEZD as part of this assessment groundwater sampling was undertaken the samples collected from two wells (see Figure 6-26). Table 6-6 presents the results of the groundwater sampling.

Figure 6-26: Locations of Historic Groundwater Sampling Locations

Table 6-6: Groundwater Sample Analysis

Parameters	Units	OS 8/2006	WHO 1993	GW1 (Sidar)		GW2	
				UTM Coordinates			
				577019	2202023	567320	2173411
pH	-	6.5 – 8	-	7.8		7.1	
Conductivity	mS/cm	-	-	4.64		12.47	
TSS	mg/l	-	-	3		<1	
Bicarbonate	mg/l	-	-	136		176	
TDS	mg/l	120 - 600	-	**2,926**		**8,758**	
Chloride	mg/l	≤250	250 mg/l	**1,072**		**3,886**	
Sulphate	mg/l	≤250	500 mg/l	**780**		**1,066**	
Calcium	mg/l	-	-	218		568	
Magnesium	mg/l	150	-	128		**191**	
Ammonia	mg/l	-	-	<0.1		<0.1	

Parameters	Units	OS 8/2006	WHO	GW1 (Sidar)	GW2
Phosphorus	mg/l	-	-	<0.1	<0.1
Nitrate	mg/l	-	-	7.5	40.8
Iron	mg/l	1	-	<0.01	<0.01
Boron	mg/l	0.5	0.3 mg/l	**0.76**	**0.77**
Cadmium	mg/l	0.003	0.003 mg/l	<0.001	<0.001
Chromium	mg/l	0.05	0.05 mg/l	<0.003	<0.003
Cobalt	mg/l	-	-	<0.002	<0.002
Copper	mg/l	2	2 mg/l	<0.005	<0.005
Manganese	mg/l	0.4	0.5 mg/l	<0.002	<0.002
Lead	mg/l	0.01	0.01 mg/l	<0.005	<0.005
Sodium	mg/l	-	200 mg/l	**666**	**2,837**
Potassium	mg/l	-	-	42	164
Nickel	mg/l	0.02	0.02 mg/l	<0.003	<0.003
Zinc	mg/l	3	3 mg/l	<0.01	<0.01
TOC	mg/l	-	-	3.9	13.2

Source: Q3 Report Environmental Baseline Study for Duqm Development and Surroundings, for SEZAD, by HMR March 2013

From the table above it is apparent that the groundwater is saline in nature exceeds both the WHO and Omani Standard for a number of parameters and hence is deemed unfit for human consumption, without treatment.

The major wadis in the vicinity of the DLBB Project are Wadi Jurf and Wadi Say. Runoff in these wadis is limited to that generated by local precipitation which may cause temporary ponding in depressions. Wadis comprise unconfined aquifers of poorly consolidated to loose gravels with a sandy matrix and there is no base flow within the wadis.

Both these wadis pose a flood risk to the Port of Duqm and the adjoining SEZAD development and hence as part of the SEZAD development these wadis are to be trained and redirected. Figure 6-27 presents the drainage risk map developed by Sering International LLC for Duqm.

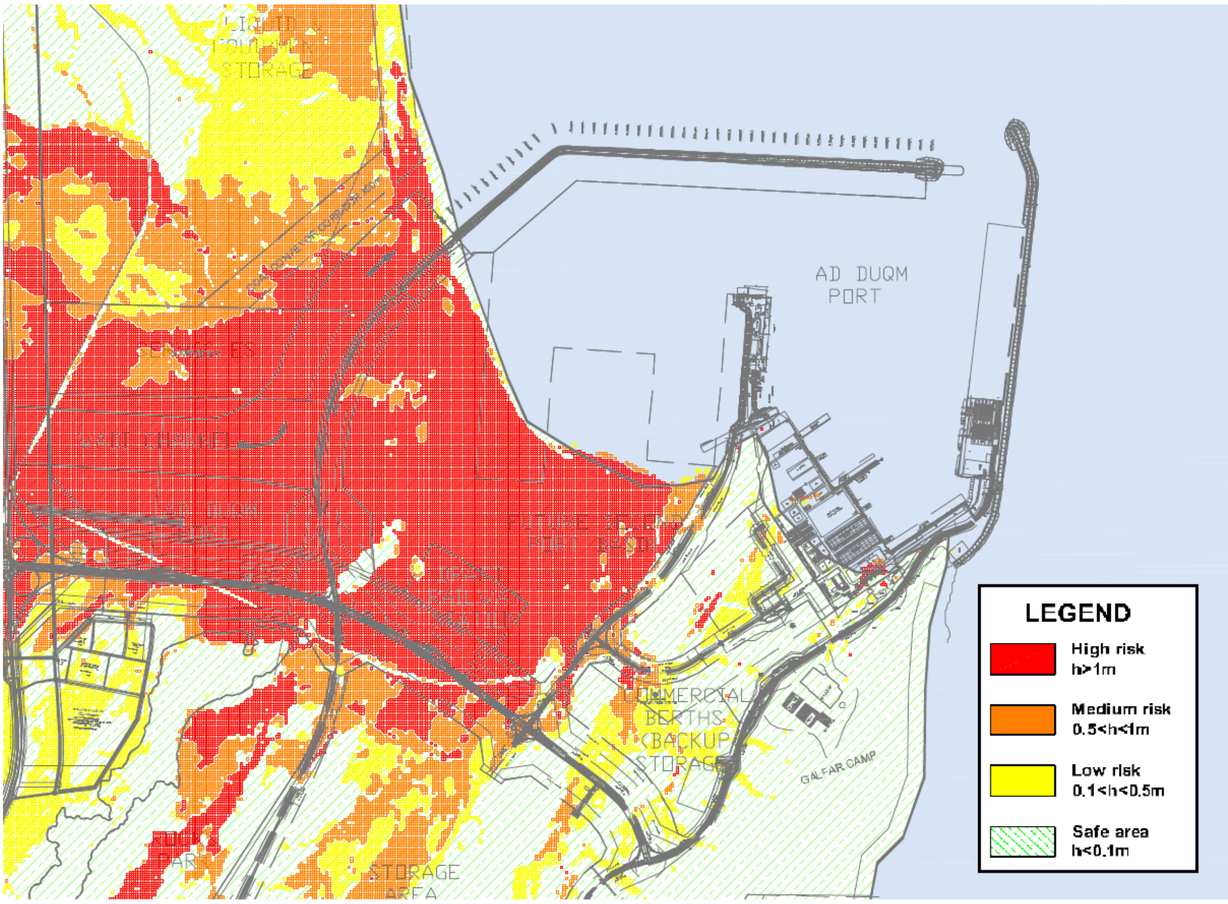

Figure 6-27: Drainage Risk Map of Duqm *(Source: Drainage Model Final Results)*

The report titled Drainage Model Final Results prepared as part of the Consultancy Services for the Preparation of a Drainage Master Plan for the Supreme Council of Town Planning recommends the construction of a 20 m high and 1,380 m long dam with capacity of 150 million m^3 in order to manage the discharge of Wadi Jurf and restrict the final discharge width. It should be noted that CUC has the mandate to develop flood and drainage in SEZD and will undertake separate EIA studies to address potential impacts from the same.

6.14 Ambient Air Quality

6.14.1 Past Air Quality Studies

Development in the SEZD began prior to 2005, with the construction of the Port beginning in 2006 and completing in 2013. Consequently, a number of baseline studies have been undertaken in Duqm; and air quality assessment was undertaken in two studies, which are available with WorleyParsons. The findings of these studies represent historic air quality levels in the study area and these are discussed in subsequent sections.

Ambient air quality monitoring studies were commissioned by Jurong (Duqm Industrial and Free Zone Master Plan – Final EIA Report, June 2011) and by SEZAD (Q3 Report Environmental Baseline Study for Duqm Development and Surroundings, March 2013. The study for Jurong used diffusion tubes, exposed between 5-Jul-2010 and 11-Aug-2010, while the study for SEZAD used a continuous ambient air quality monitoring station for a period between 14-Nov-2012 and 28-Nov-2012. Figure 6-28 presented the sampling locations used in these two studies.

Figure 6-28: Locations of Historic Ambient Air Quality Monitoring

It should be noted that in sampling at AQ1 to AQ4 was by diffusion tube for Jurong in 2010 and sampling at AQ5 was with a continuous ambient air quality monitoring system for SEZAD in 2012. The findings of the diffusion tube measurements are summarised in Table 6-7.

Table 6-7: Historic Ambient Air Quality Monitoring (AQ1 to AQ4)

Location	Sulphur Dioxide	Oxides of Nitrogen
AQ1	11.97 µg/m^3 (0.005 ppm or 5ppb)	4.07 µg/m^3 (0.002 ppm or 2 ppb)
AQ2	17.43 µg/m^3 (0.007ppm or 7 ppb)	2.93 µg/m^3 (0.002ppm or 2 ppb)
AQ3	16.33 µg/m^3 (0.006 ppm or 6 ppb)	3.33 µg/m^3 (0.002 ppm or 2 ppb)
AQ4	19.60 µg/m^3 (0.007 ppm or 7ppb)	3.57 µg/m^3 (0.002 ppm or 2 ppb)
USEPA NAAQS	1 hour 75ppb 3 hours 0.5 ppm	1 hour 100 ppb Annual 53 ppb

Source: Duqm Industrial and Free Zone Master plan, prepared for Jurong, by 5 Oceans in 2011

Note: comparison of the diffusion tube result with USEPA NAAQS is not entirely accurate on account of the different averaging periods and requirements on the sampling duration and number defined by the USEPA. However, an indicative comparison is accepted

The comparison shows that the levels of SO_2 and NO_X in the area are within standards set by the USEPA NAAQS. The findings of continuous ambient air quality monitoring at location AQ5 is presented in Table 6-8.

Table 6-8: Historic Ambient Air Quality Monitoring (AQ5)

Parameter	Averaging	Level	Max Measured for respective Averaging Period over monitoring duration
CO	8 Hours	9 ppm	521 µg/m^3 (0.455ppm)
	1 hour	35 ppm	534 µg/m^3 (0.466 ppm)
NO_2	1 hour	100 ppb	32 µg/m^3 (0.017 ppm or 17 ppb)
	Annual	53 ppb	-
O_3	8 hour	0.075 ppm	92 µg/m^3 (0.05 ppm)
SO_2	1 hour	75 ppb	18.7 µg/m^3 (0.007 ppm or 7 ppb)
	3 hour	0.5 ppm	-
PM_{10}	24 hour	150 µg/m^3	82 µg/m^3

Source: Q3 Report Environmental Baseline Study for Duqm Development and Surroundings, for SEZAD, by HMR March 2013

Note: The measurement through the continuous ambient air quality monitoring cannot be accurately compared with the USEPA NAAQS, on account of the limited sampling duration. However, an indicative comparison is accepted.

An indicative comparison shows that the results measured with the CAAQMS are within the USEPA NAAQS. It should be noted that the results of the continuous ambient air quality station and the diffusion tubes are comparable, indicating that there was not significant change in air emission between 2011 and 2012.

6.14.2 Current Air Quality Studies

The DLBB Project has been envisioned as storage facility with no processing at site and no combustion at site, excluding use of flare in case of emergency situations. The primary air emission that is expected from the facility is VOCs, which will be released as a fugitive emission from liquid storage tanks. Ground level ozone (O_3) is created by chemical reactions between oxides of nitrogen (NO_X) and VOC. Additionally some H_2S may also be released as a fugitive emission from the liquid storage tanks. The H_2S eventually transforms to SO_2 in ambient air. The project does not have major continuous source of CO emission; and thus the CO emissions from the project are expected to be low. Hence, in selection of the parameter for diffusion tube monitoring focus was placed on VOC, NO_X, O_3, and SO_2. Additionally, particulate matter could be generated during the construction and operation phase from material stockpiles. Hence, dust monitoring was undertaken a portable AEROCET 531 dust meter.

The diffusion tubes were planned to be installed at nine locations in the form of grid spread over an area of 2 km × 2 km around the LBW. However, the area around the LBW consists of *sabkha* and, thus, the final sampling locations had to be shifted depending on ease of accessibility. The final monitoring locations are shown in Figure 6-29 and their UTM coordinates are presented in Table 6-9.

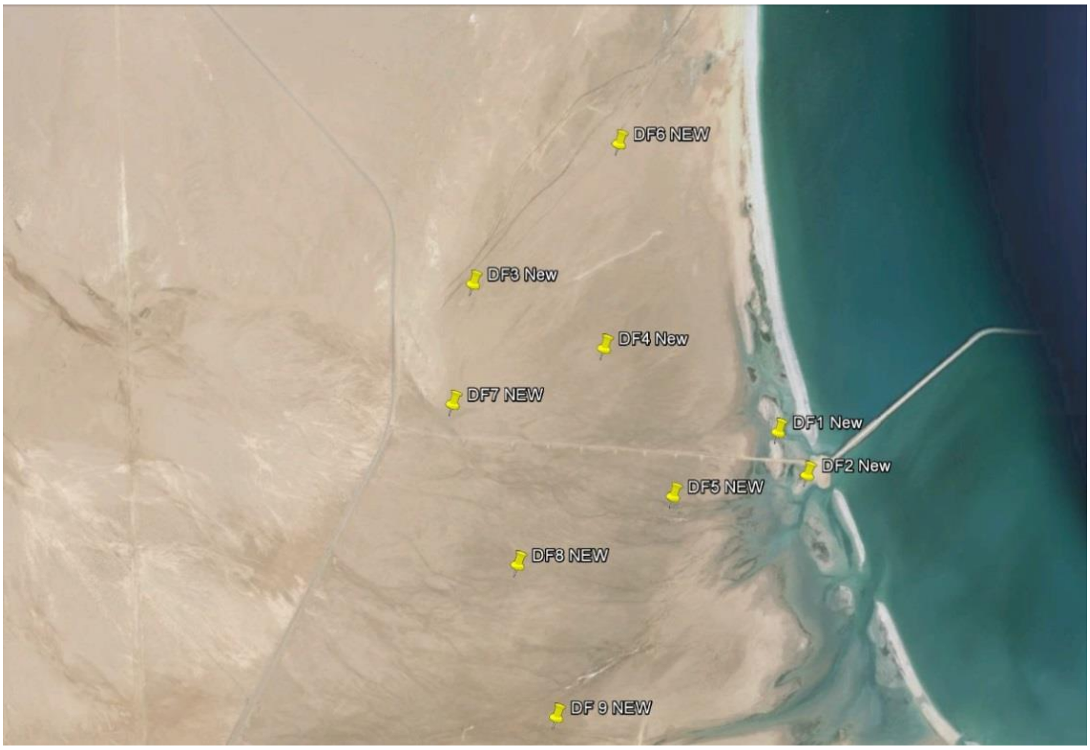

Figure 6-29: Ambient Air Quality Monitoring Locations

Table 6-9: UTM Coordinates of the Ambient Air Quality Monitoring Locations

Location Id	Eastings (m)	Northings (m)
DF1 New	0571085	2176872
DF3 New	0569212	2177766
DF4 New	0570016	2177378
DF5 New	0570440	2176482
DF6 New	0570106	2178615
DF7 New	0569087	2177039
DF8 New	0569486	2176067
DF9 New	0569724	2175145

Each diffusion tube was installed on custom-built stands that allowed uniform exposure (Figure 6-30 and Figure 6-31). These tubes were prepared and supplied by Gradko Laboratory in UK.

Figure 6-30: Diffusion Tubes Mounted on Stand *(Photograph taken on 6-Jan-2015)*

Figure 6-31: Close-up of the Diffusion Tubes on the Stand *(Photograph taken on 6-Jan-2015)*

The tubes were exposed for a period of 21 days, i.e., between 6 and 26-Jan-2015; and were retrieved at the end of the monitoring period.

Tubes from one of the nine locations were lost along with the stand. The collected tubes were then packaged and sent to Gradko Laboratory to analyse for concentrations of NO_X, SO_2, O_3 and top-10 VOCs captured by the tubes over the monitoring period. This represents concentration of the pollutants in the ambient air over the sampling period.

Table 6-10 presents the summary of the diffusion tube analysis results. The laboratory analysis certificates are presented in Appendix 1. From the table it is apparent that the results for the parameter measured are relatively consistent across all the locations.

Table 6-10: Summary of Diffusion Tubes Analysis Results

	SO_2	VOC	O_3	NO_X	NO	NO_2
Minimum	0.57	0.20	59	4.44	3.26	1.18
Median	0.67	0.32	68	5.79	3.91	1.63
Maximum	3.02	0.49	78	6.65	4.57	2.18
USEPA NAAQS	50 (3-hr); 75 (1-hr)	-	75 (8-hr)	-	-	100 (1-hr) 53 (Annual)

All units in ppb

For VOCs the measured value of benzene has been used

Comparison of the diffusion tube result with USEPA NAAQS is not entirely accurate on account of the different averaging periods and requirements on the sampling duration and number defined by the USEPA. However, an indicative comparison is accepted

The USEPA NAAQS does not specify standard for VOC, NO_X and NO levels

From the comparison it is evident that the parameters are within the USEPA NAAQS, excluding O_3 at one location, where the ozone level is marginally above the USEPA NAAQS limit.

The data collated from the diffusion tubes have been presented as contour maps, which are shown in the Figure 6-32, Figure 6-33, Figure 6-34, and Figure 6-35. These contour maps have been prepared using the software Surfer 12.

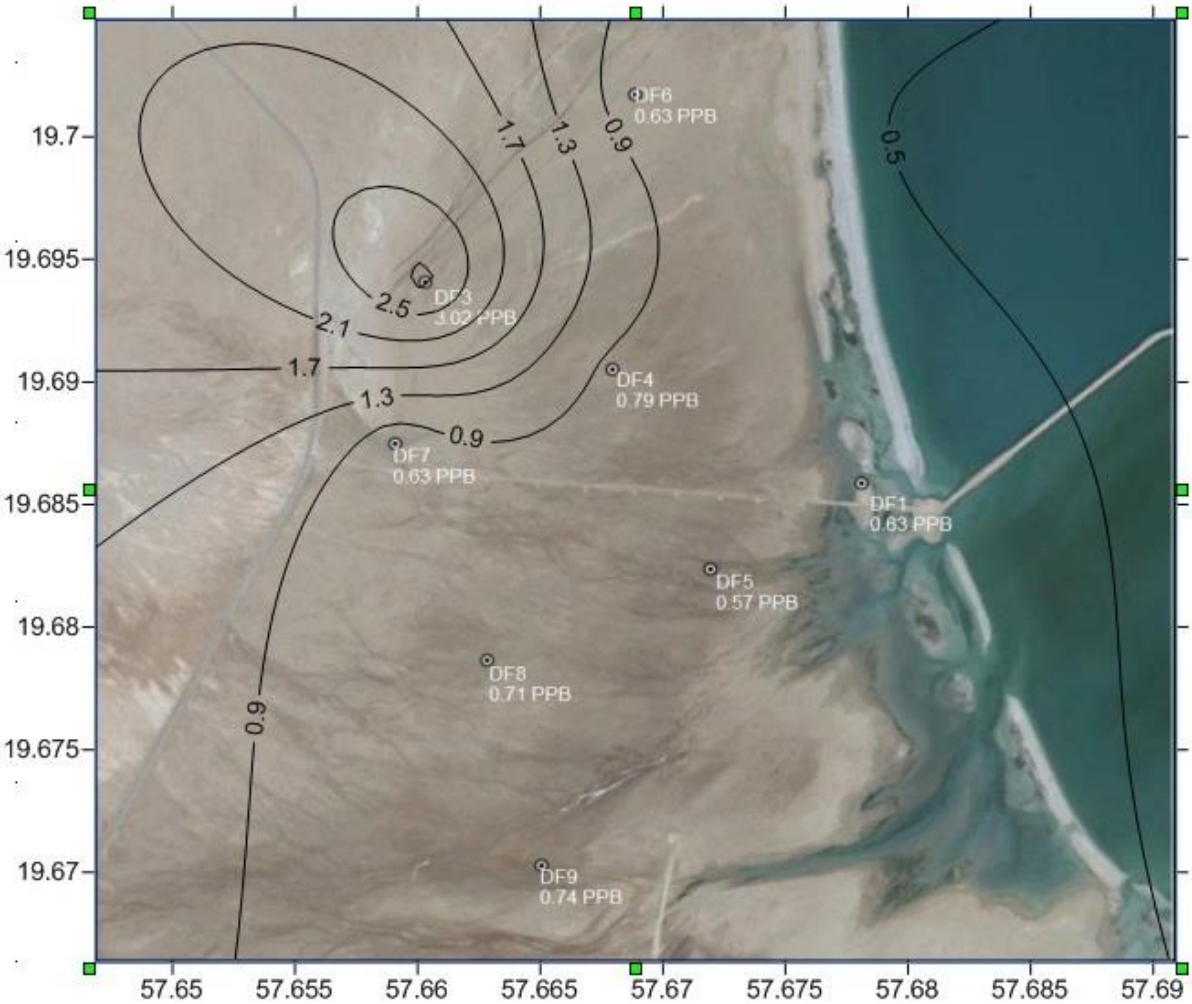

Figure 6-32: Contour Map for SO_2 in ppb *(6-Jan-2015 to 26-Jan-2015)*

Figure 6-32 above shows relatively higher levels of SO_2 in the north-western portion of the contour map. This area lies close to the main highway number 32 and the graded road from the highway to the fishing village, suggesting that the movement of vehicles contributes to the SO_2 in the area.

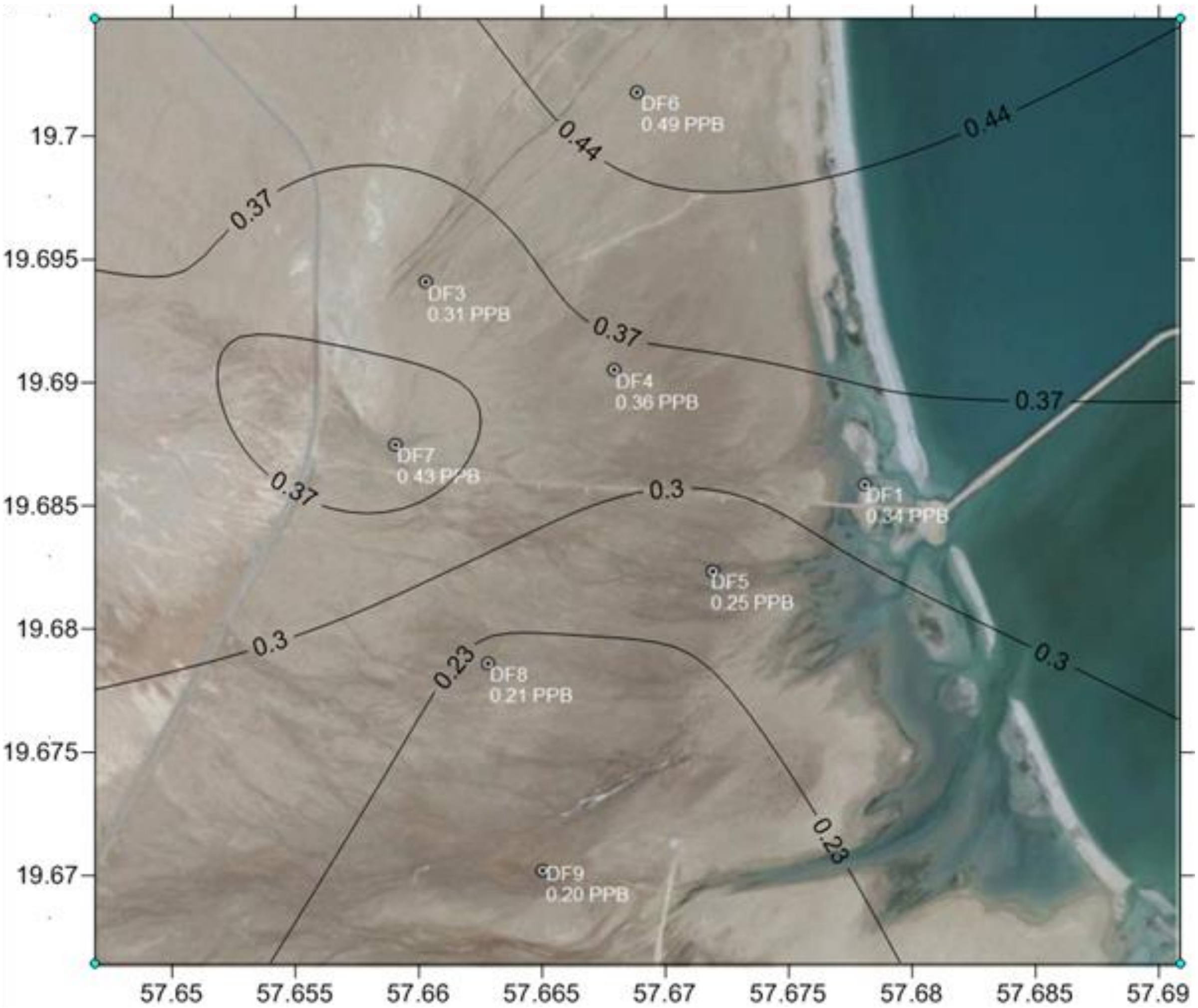

Figure 6-33: Contour Map for VOC (Benzene) in ppb *(6-Jan-2015 to 26-Jan-2015)*

Figure 6-33 above presents the contour map for benzene which has been identified as an indicator for VOC. The VOC levels to the northern portion of the figure appear to be slightly higher than the southern portion. The stratification for the VOC is apparent to be in the north-south direction rather than the east-west direction. No specific source or reason could be established for this particular variation in ambient VOC levels.

Figure 6-34 below presents a snapshot of the relative distribution of the identified VOCs at various sampling locations. From the figure it is apparent that acetophenone is the most common VOC, followed by benzaldehyde and benzonic acid. The presence of these VOCs in the area could be a result of both natural and anthropogenic sources.

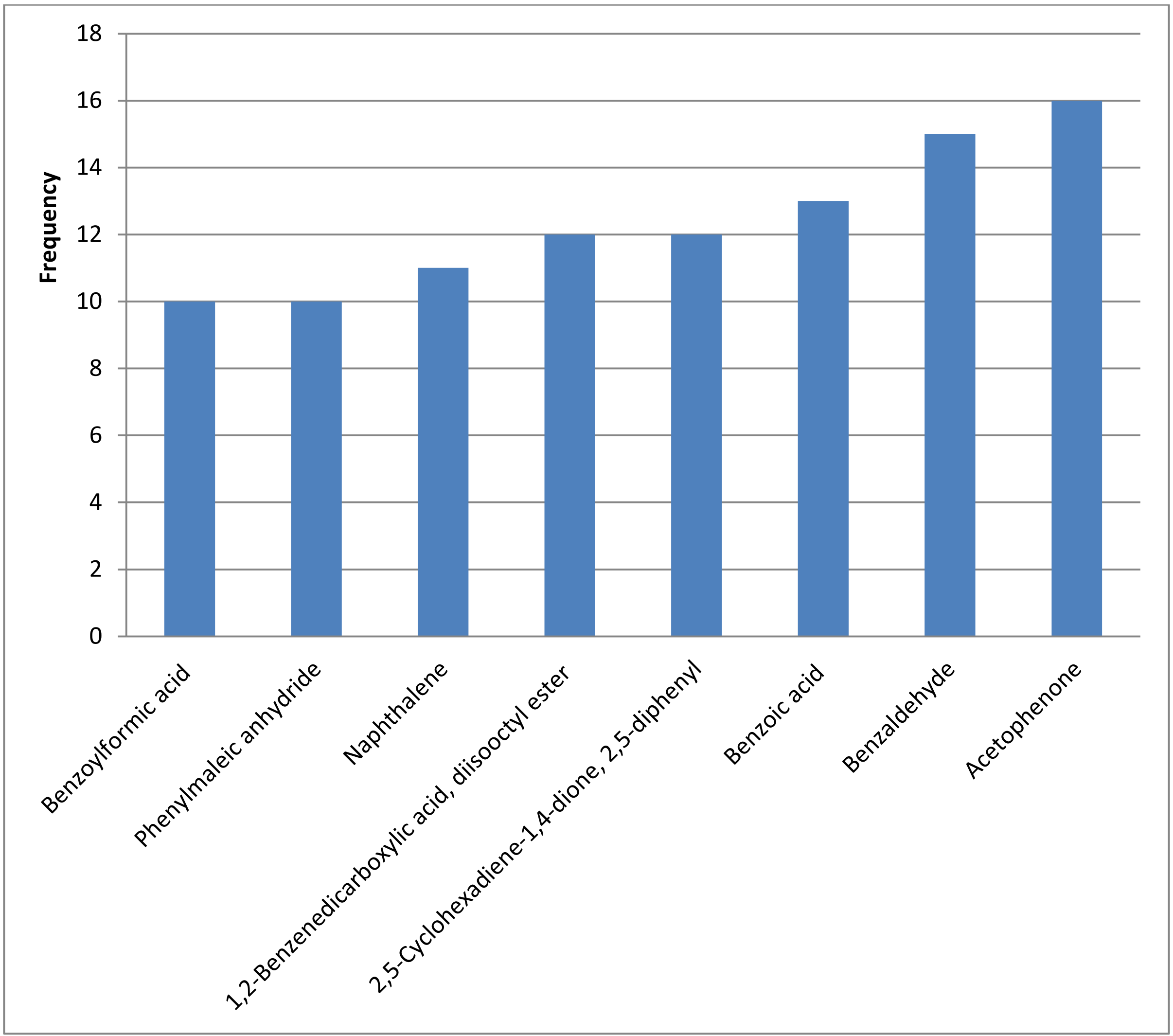

Figure 6-34: Sample of most common VOCs Identified *(Measured between 6 and 26-Jan-2015)*

Figure 6-35 below presents the contour map for ozone. From the figure it is apparent that the variation in ozone levels is in the east-west direction with higher levels of ozone towards the sea. Ground level ozone formation is related to topography, solar radiation intensity and meteorological conditions. No specific source or reason could be established for this particular east west variation in ambient ozone levels.

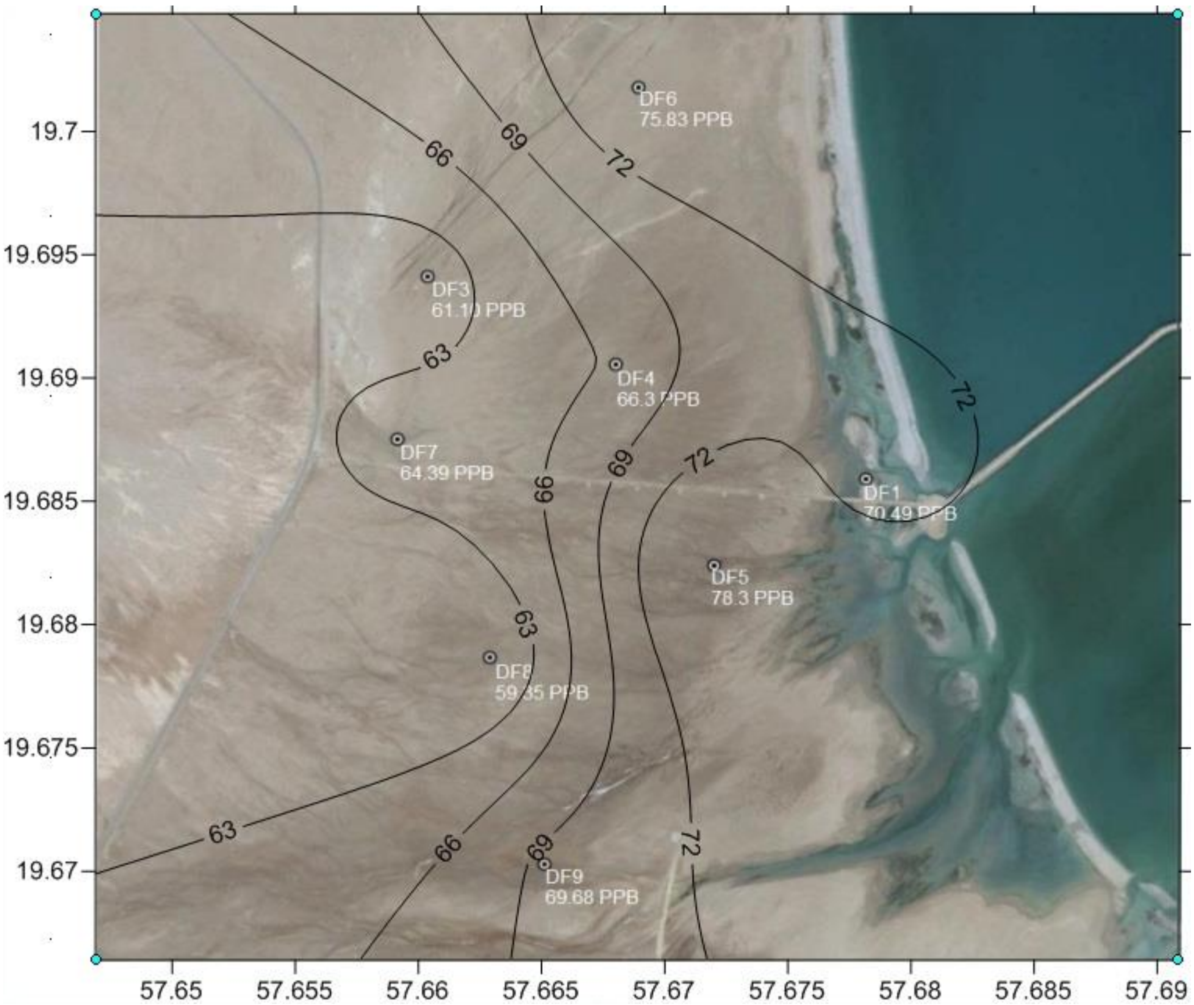

Figure 6-35: Contour Map for Ozone in ppb *(6-Jan-2015 to 26-Jan-2015)*

Figure 6-36 below presents the contour map representing the distribution of NO_2. From the figure it is apparent that the variation on levels of NO_2 is in the east-west direction with higher levels of NO_2 away from the sea, in contrast to what was observed for ozone. This could be because in the troposphere, ozone forms through the splitting of NO_2 molecules by sunlight. In other words, this is typical of the relationship between ambient NO_2 and O_3, i.e., in areas with higher levels of ozone typically lower levels of NO_2 is observed.

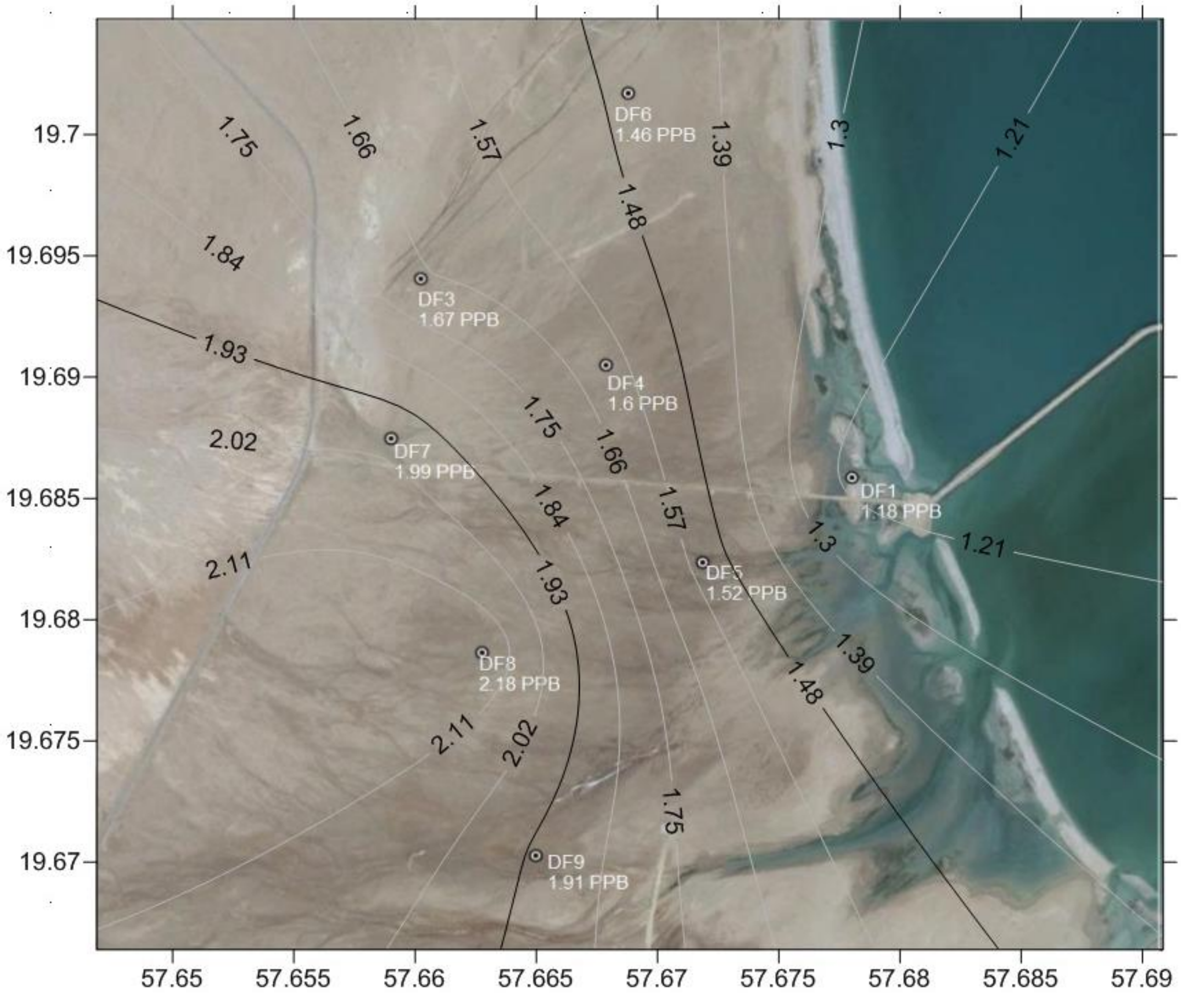

Figure 6-36: Contour Map for Nitrogen Dioxide in ppb *(6-Jan-2015 to 26-Jan-2015)*

On the whole the levels of NO_2, SO_2, VOCs, and O_3 measured are typical of a rural setting with limited industrial development.

6.14.3 Particulate Matter

Dust monitoring was undertaken at the nine ambient air quality monitoring locations and at Say Village (near the main road). Particulate Matter ($PM_{2.5}$ and PM_{10}) and Total Suspended Particulates (TSP) levels in the ambient air were monitored using the portable AEROCET 531 dust meter. Monitoring was undertaken for 15 minutes at each location. Ambient dust monitoring was carried out on three occasions – first when the diffusion tubes were installed on 5/6-Jan 2015, second when the tubes were retrieved on 26/27-Jan-2015, and third on 20-Aug-2015.

Table 6-11 presents the measured ambient dust levels at the DLBB Project site.

Table 6-11: Ambient Dust Levels

Location	5/6-Jan-2015			26/27-Jan-2015			20-Aug-2015		
	$PM_{2.5}$	PM_{10}	TSP	$PM_{2.5}$	PM_{10}	TSP	$PM_{2.5}$	PM_{10}	TSP
DF1	7	12	12	2	8	12	14	34	36
DF2	6	9	9	2	12	14	20	48	49
DF3	8	13	13	2	6	6	18	62	73
DF4	4	7	7	2	9	9	18	80	92
DF5	4	8	9	2	11	12	16	35	37
DF6	3	4	4	2	5	9	16	42	45
DF7	4	6	7	4	8	14	19	54	57
DF8	3	8	8	3	6	7	17	78	82
DF9	-	-	-	2	6	6	19	46	49
Say Village	16	52	52	-	-	-	20	54	92

***NOTE**: All readings measured in µg/m³*

From the above table, it can be seen that the dust levels during August 2015 is higher than that during January 2015. The primary reason for this is the presence of trucks transporting construction material (soil) around the monitoring locations (during January measurements, there were no trucks on the road connecting LBW to the Highway 32; and lesser number of construction vehicles at other locations). Further, the wind speed during August measurements were in the range of 6 to 9 m/s; while the wind speed during January measurements were between 3 and 4 m/s.

The USEPA NAAQS does not specify standard for TSP and regulates TSP through the quantities of $PM_{2.5}$ and PM_{10}. The NAAQS specifies the following limits for $PM_{2.5}$ and PM_{10}:

- $PM_{2.5}$ annual standard (primary) 12 µg/m^3 and (secondary) 15 µg/m^3
- $PM_{2.5}$ – 24-hr standard: 35 µg/m^3
- PM_{10} – 24-hr standard: 150 µg/m^3

Although, Table 6-11 represents the spot readings for a period of 15 minutes; comparison with USEPA NAAQS shows that the potential for exceedances in the present setting is low.

6.15 Noise

6.15.1 Past Noise Studies

A number of baseline studies have been undertaken in Duqm; and noise levels were assessed in two studies, available with WorleyParsons. The Duqm Industrial and Free Zone Master Plan – Final EIA Report, for Jurong, June 2011 and the Q3 Report Environmental Baseline Study for Duqm

Development and Surroundings, for SEZAD, March 2013, undertook noise monitoring at 3 locations. Figure 6-37 below presents the locations where daytime monitoring was undertaken. It should be noted that the entire DLBB Project area has been demarcated for industrial activity and hence comparison was made against the industrial standard

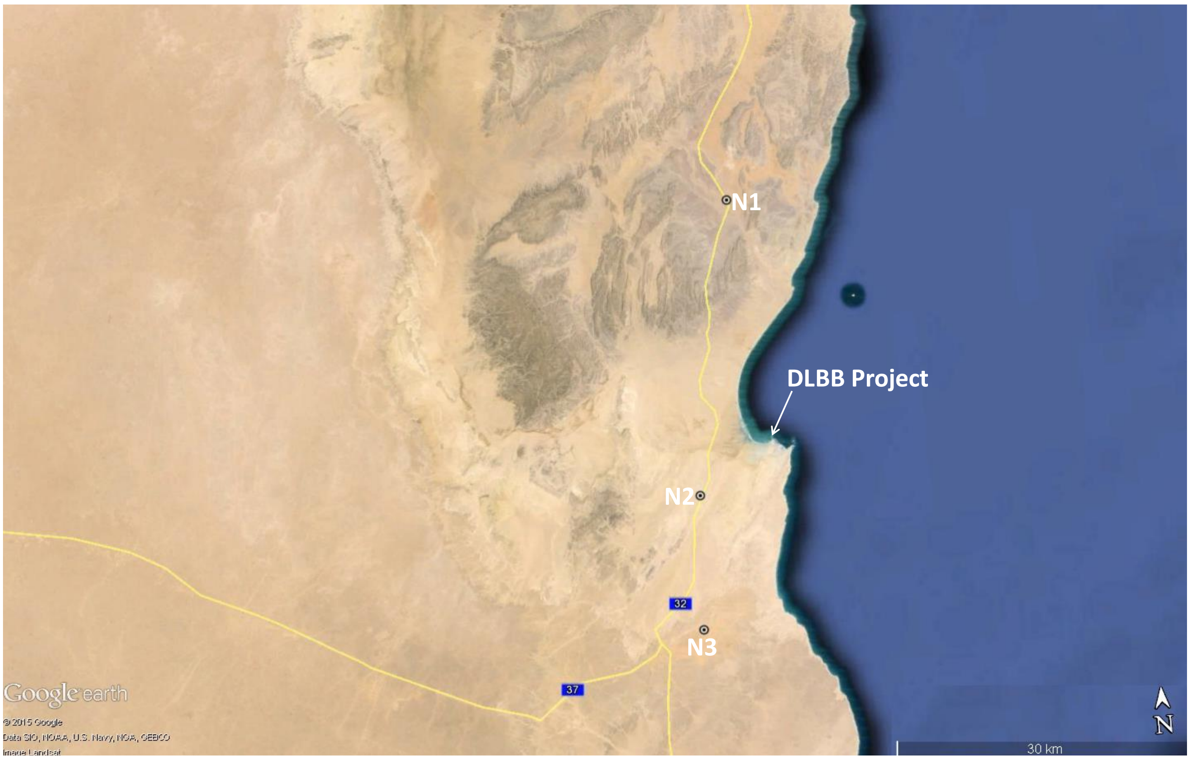

Figure 6-37: Historic Noise Monitoring Locations

It can be seen from the above figure, that monitoring was undertaken along roads (marked yellow in figure) and represents a measure of noise from road traffic in an industrial area. Table 6-12presents a summary of the comparison.

Table 6-12: Historic Noise Monitoring Locations

Location	October 2012	November 2012	Day Time Noise Level in Industrial Area from Road Traffic
	$L_{A\text{-}eq}$	$L_{A\text{-}eq}$	
DF1	41.3	45.5	70
DF2	55.1	52.4	
DF3	62.7	44.6	
Note: all readings measured in dBA			

A review of the above table shows that the noise levels are within the proposed standards.

6.15.2 Current Noise Studies

The noise survey were undertaken at the nine ambient air quality monitoring locations and at Say village (near the main road) to measure the equivalent continuous ($L_{A\text{-}eq}$), and maximum and minimum sound levels ($L_{A\text{-}max}$ and $L_{A\text{-}min}$) in the DLBB Project area. The survey was undertaken using the hand held Bruel & Kjaer Model 2250 sound level meter. Ambient noise survey was carried out on three occasions – first when the diffusion tubes were installed on 5/6-Jan 2015, second when the tubes were retrieved on 26/27-Jan-2015, and third on 19 and 20-Aug-2015.

It should be noted that the DLBB Project area has been designated for industrial development and hence deemed as an industrial area. As per MD 79/94 the permissible $L_{A\text{-}eq}$ are as presented in Table 6-13.

Table 6-13: Permissible $L_{A\text{-}eq}$ Limits as per MD 79/94

Type of Area	Source of Noise	Daytime Limit (7 am to 6 pm)	Evening Time Limit (6 pm to 11 pm)	Night Time Limit (11 pm to 7 am)
Industrial and commercial	Industrial plants and public works	70	70	70
	Road traffic	70	65	60
NOTE: All units in dB(A).				

Table 6-14 presents the ambient noise levels recorded at the measuring locations. In the last column of the table the applicable limit prescribed in MD 79/94 is mentioned for comparison. The noise levels were measured during day time. It must be noted that the current source of noise is road traffic. However, the future the main source of noise will be industrial plants. It is further understood that the Say village will be relocated to another location; thus, the monitoring location at Say village is also considered as industrial and commercial area. Accordingly, limit of 70 dB(A) applies to all locations.

Table 6-14: Ambient Noise Levels Measured at Site

Location	5/6-Jan-2015			26/27-Jan-2015			19-Aug-2015			20-Aug-2015		
	$L_{A\text{-}max}$	$L_{A\text{-}min}$	$L_{A\text{-}eq}$	$L_{A\text{-}max}$	$L_{A\text{-}min}$	$L_{A\text{-}eq}$	$L_{A\text{-}max}$	$L_{A\text{-}min}$	$L_{A\text{-}eq}$	$L_{A\text{-}max}$	$L_{A\text{-}min}$	$L_{A\text{-}eq}$
DF1	73.27	33.17	**51.60**	61.62	39.00	**42.49**	53.7	49.2	**51.3**	61.6	58.0	**59.9**
DF2	52.51	33.30	**38.37**	67.09	39.52	**43.61**	59.1	54.5	**57.3**	64.0	59.3	**62.0**
DF3	-	-	**-**	70.99	30.81	**46.27**	47.5	39.9	**43.1**	47.3	44.2	**45.5**
DF4	69.74	35.95	**42.81**	74.10	37.33	**43.85**	54.4	47.7	**50.2**	56.2	50.8	**53.2**
DF5	76.92	47.91	**58.14**	70.64	29.16	**42.72**	61.4	50.3	**55.0**	49.1	42.2	**46.2**
DF6	64.75	33.12	**44.47**	74.39	31.19	**42.14**	60.5	52.3	**55.6**	44.6	42.2	**43.5**
DF7	75.51	28.67	**48.40**	66.18	43.73	**46.82**	56.7	47.8	**50.5**	53.2	49.6	**51.5**
DF8	58.22	27.94	**40.72**	59.12	38.77	**43.57**	54.7	44.0	**50.7**	51.8	48.0	**50.0**
DF9	65.28	29.01	**44.74**	63.85	38.41	**42.96**	64.4	56.5	**60.3**	52.9	48.3	**50.2**

Location	5/6-Jan-2015			26/27-Jan-2015			19-Aug-2015			20-Aug-2015		
	$L_{A\text{-}max}$	$L_{A\text{-}min}$	$L_{A\text{-}eq}$	$L_{A\text{-}max}$	$L_{A\text{-}min}$	$L_{A\text{-}eq}$	$L_{A\text{-}max}$	$L_{A\text{-}min}$	$L_{A\text{-}eq}$	$L_{A\text{-}max}$	$L_{A\text{-}min}$	$L_{A\text{-}eq}$
Say*	75.00	44.38	**56.75**	-	-	**-**	64.2	60.7	**62.4**	63.3	60.0	**61.6**
NOTE*: All units in dB(A); *Say means the Say Village*												

From the above table it can be seen that the ambient $L_{A\text{-}eq}$ levels measured around the LBW and near the main road in Say village during January as well as August are below applicable standard limits. However, the $L_{A\text{-}eq}$ levels measured in August are mostly higher than the $L_{A\text{-}eq}$ levels measured in January. This is because there are more construction vehicles plying the road connecting LBW to the Highway 32 in August than in January (when there were no trucks moving on this road). Further, the wind speed during measurements in August were higher the wind speed during measurements in January.

6.16 Terrestrial Ecology

The study of ecology and biodiversity is an important part of any baseline survey as it sustains the basic needs of the society. The most ecologically important areas in Oman, on account of the highest species diversity and concentration of endemic species, are in the mountains of Dhofar and the Al Hajar Mountains of Northern Oman.

The Duqm region is important from the perspective of biological diversity which needs to be conserved for its productivity, regulation of climate and ecosystem services. The main objective of the ecological baseline study is to collect adequate ecological information of the proposed development and its vicinity to establish a baseline ecological status of the area.

This section provides a characterization of the ecological conditions in the study area, based on primary survey data and secondary supporting literature of the area. Secondary data has been collated from for the study area previous environmental impact assessment studies carried out and academic research relevant to this areas. This sections deal with the habitat types in the study area, prevalent flora and fauna found during the site survey and their present status as per the Red List from International Union for Conservation of Nature (IUCN). The major factors that influence the distribution of flora and fauna in this biome are topography, elevation, distance from the sea and the extent of salt water intrusion.

As highlighted in the EIA Scoping report for the DLBB Project (Doc. No. SEZAD-DPTC-00-WP-EV-REP-0001) the study area for the terrestrial ecological study was restricted to 1 km radius around the LBW. Figure 6-38 below presents the extent of the study area.

Figure 6-38: Terrestrial Ecology Survey Area

6.16.1 Flora

Vegetation was mostly found in patches immediately around the LBW, and no vegetation was observed near the root or base of the LBW. Figure 6-39 presents a sketch of vegetation observed at site within the study area.

Figure 6-39: Sketch of Vegetation (in green) observed in the Study Area

The flora in the study area is dominated by halophyte plant community. The plant species identified during the survey includes *Suaeda moschata*, *Suaeda vermiculata*, *Zygophyllum qatarense*, *Arthrocnemum macrostachyum*, *Halopeplis perfoliata*, *Limonium stockcii* and grasses such as *Halopyrum macrostachyum*. Table 6-15 presents a list of plant species observed in the study area.

Table 6-15: List of Plant Species Identified in the Study Area

Scientific Name	Family	IUCN Status
Suaeda moschata	Chenopodiaceae	Not Assessed
Limonium stockcii	Plumbaginaceae	Not Assessed
Halopeplis perfoliata	Chenopodiaceae	Not Assessed
Arthrocnemum macrostachyum	Chenopodiaceae	Not Assessed
Zygophyllum qatarense	Zygophyllaceae	Not Assessed
Heliotropium kotschyii	Boraginaceae	Not Assessed
Halopyrum macrostachyum	Poaceae	Not Assessed
Cistanche tubulosa	Orobanchaceae	Not Assessed

Typical photographs of the vegetation observed in the study area by WorleyParsons are presented below (Figure 6-40 to Figure 6-47)

Figure 6-40: Halophytic Vegetation

Figure 6-41: *Cistanche chebulosa*

Figure 6-42: ***Sueada moschata***

Figure 6-43: ***Arthrocnemum macrostachyum***

Figure 6-44: ***Halopiplils Perfoliata***

Figure 6-45: ***Zygophyllum Qatarance***

Figure 6-46: ***Limonium stockcii***

Figure 6-47: ***Halopyrum macrostachyum***

From the discussion in the previous section it is seen that most of the study area is barren and the flora in the study area is not rare or endemic to the region.

6.16.2 Avifauna

Despite its arid nature, Oman is home to a variety of fauna and of particular interest it the avifauna. The seventh edition of the Oman Bird List (October 2013) lists 513 species that are currently accepted by the Oman Bird Records Committee with a further 30 species considered escapes. From this total, about 85 are considered resident species while the rest are visitors for certain period of the year. There are no species endemic to Oman

Duqm is known for its avifauna and the area has been identified as an Important Bird Area (IBA) by BirdLife International (Figure 6-48). Duqm lies as the middle of internationally important bird sites in Oman with Bar Al Hikman about 100 km to the north and Khawr Ghawi about 120 km further south. In terms of numbers of wintering birds Duqm is also in the middle with Bar Al Hikman having more birds on a much larger area. Duqm is of the stopover point in a chain of sites along the Oman coast for migratory bird species (gulls and waders) on their journey between Asia and Africa.

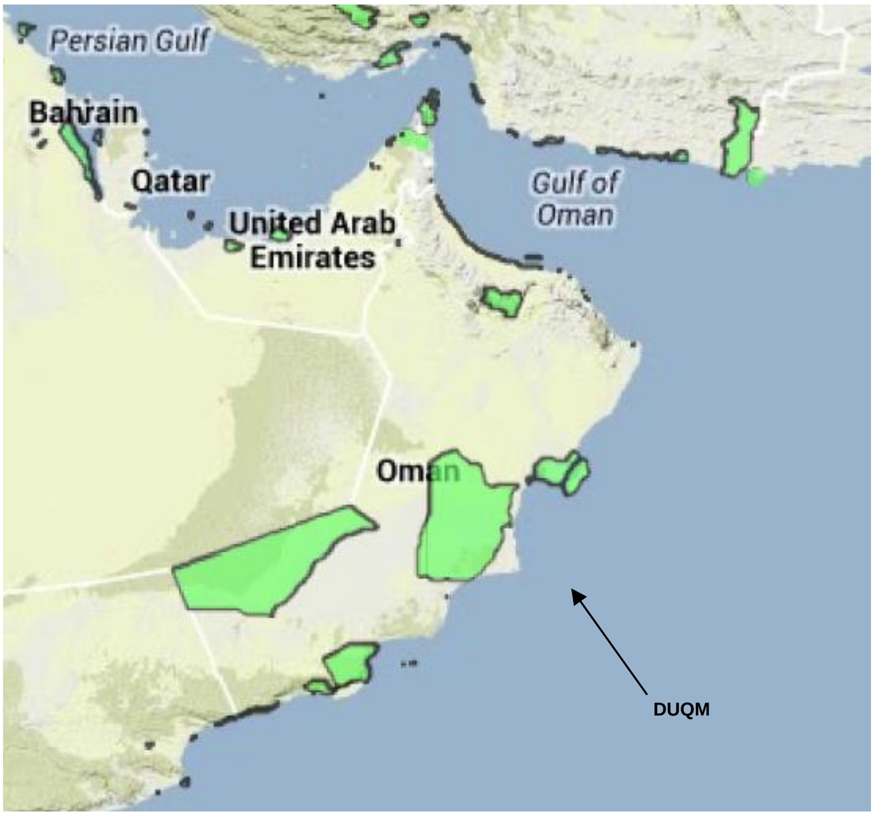

Figure 6-48: IBAs (in green) in Oman *(Source: BirdLife International)*

Essentially all the birds at Duqm are migratory and none, with the exception of a few Crested Larks, use the area as a breeding site. The majority of the overwintering and passage birds pass through Duqm between the end of September and mid-May although exact timings are species dependent. The Omani coastline acts as a bridge between Asia and Africa. Birds tend to avoid flying over the open sea or inland due to limited food sources and therefore move along the coastlines.

Table 6-16 below presents the population of IBA trigger species at Duqm and Figure 6-49 (overleaf) presents the extent of the IBA as identified by BirdLife International (approx. 1,000 ha).

Table 6-16: Population of IBA Trigger Species

Species	Season	Period	Population Estimate	IUCN Category
Egretta gularis	Non-breeding	1989-1992	99-250	Not Recognised
Grey Heron (*Ardea cinerea*)	winter	1989-1992	192-268	Least Concern
Socotra Cormorant (*Phalacrocorax nigrogularis*)	non-breeding	1989-1991	8,467-15,000	Vulnerable
Pied Avocet (*Recurvirostra avosetta*)	winter	1990-1992	127-175	Least Concern
Lesser (*Sandplover Charadrius mongolus*)	winter	1989-1992	279-500	Least Concern
Sooty Gull (*Larus hemprichii*)	non-breeding	1989-1992	720-1,220	Least Concern
Lesser Black-backed Gull (*Larus fuscus*)	winter	1993	2,000	Least Concern
Slender-billed Gull (*Larus genei*)	winter	1989-1992	2,349-5,275	Least Concern
Caspian Tern (*Hydroprogne caspia*)	winter	1989-1992	89-196	Least Concern
Greater Crested Tern (*Thalasseus bergii*)	non-breeding	1989-1992	234-620	Least Concern
Sandwich Tern (*Thalasseus sandvicensis*)	winter	1989-1992	1,073-2,300	Least Concern
Source: BirdLife International				

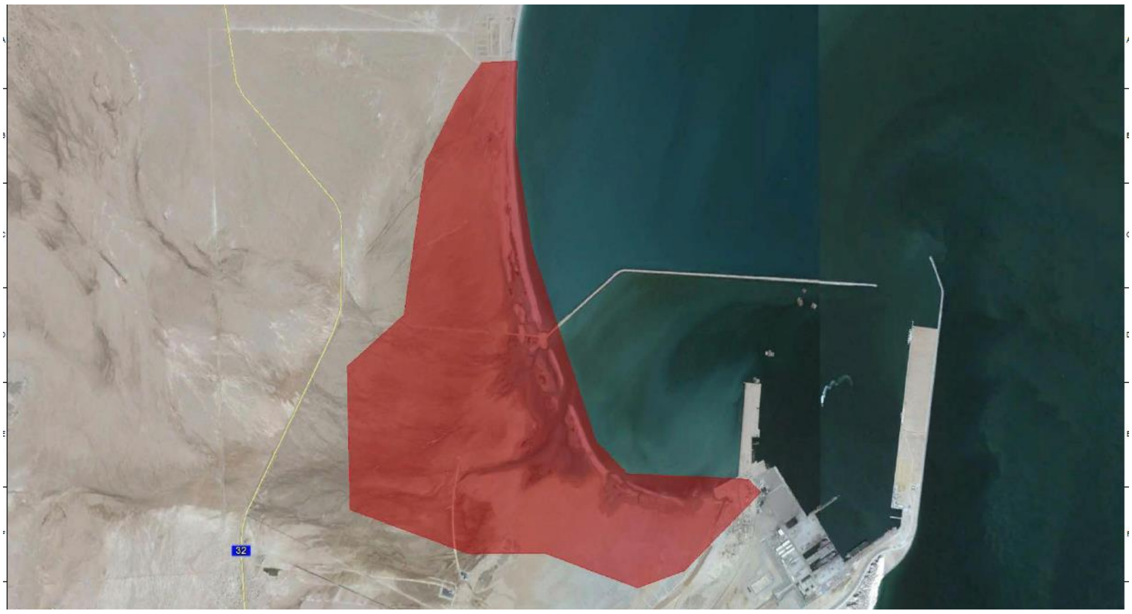

Figure 6-49: Extent of the IBA adjacent to the LBW *(Source: BirdLife International)*

Three past bird surveys have been undertaken in the port area the first on the 3 and 4-Oct-2013, the second from the 29-Nov to 2-Dec-2013 and the third from the 12 to 15-Jan-2014.

During the third survey (mid-winter), the number of Pallas's Gull, a highly prized bird for foreign birdwatchers, was well over 1,500, representing one of the highest counts ever in Oman. New bird species recorded during the third survey were single observations of Peregrine Falcon, Common Kingfisher, White Wagtail and Asian Desert Warbler.

The bird activity in the study area varies according to habitat use. Table 6-17 describes the various areas by bird activity.

Table 6-17: Bird Activity by Area

Bird Activity	Description
Greater Flamingo Feeding Area	Comprises of fine sand and mud flats, often covered in green algal mats with standing pools of water. The flamingos feed on the crustacean within the pools.
Gull and Tern Roosting Area	This comprises of the sand spits and bars along the coastal frontage
Tern and Osprey Area	This is the sea area where the terns and gulls sit on the water whilst resting and use the area as the Osprey's do to feed on fish within the waters below.
Waders Feeding Area	Waders such as Dunlin, Broad-billed Sandpiper, godwits, curlew use the sand and mudflats surrounding the tidal lagoons and *khawrs* for feeding on the crustaceans and small fish in the lagoons (e.g. flamingos), polychaetes and bivalves (e.g. Oystercatcher and even crabs (e.g. Crab Plover)

From the table above it is apparent that the bird habitat immediately around the root of the LBW is the Gull and Tern Roosting Area, Tern and Osprey Area and Waders Feeding Area.

During the visit between the 4 and 9-Jan-2015 by WorleyParsons the distribution of birds were seen to be similar to that described in Table 6-17. Gulls and Terns were seen to the north of the LBW, with the Great Cormorant to the south of the LBW. Flamingos were not noted in the vicinity of the LBW, but rather 2 km southwest of LBW. Figure 6-50 to Figure 6-59 presents photographs taken during the site visit.

Figure 6-50: Gulls and Terns Roosting

Figure 6-51: Great Cormorant

Figure 6-52: Lesser Sand Plover

Figure 6-53:Stint Bird

Figure 6-54: Greater Flamingos

Figure 6-55: Caspian terns

Figure 6-56: Eurasian curlew

Figure 6-57: Heuglin's Gull

Figure 6-58: Sooty Gull

Figure 6-59: Western Reef Heron

Table 6-18 below presents a list of birds observed at the site by WorleyParsons and their IUCN status.

Table 6-18: List of Birds Observed and IUCN Status

Common Name	Scientific Name	Observation during site survey	Conservation Status (IUCN)
Greater Flamingo	*Phoenicopterus roseus*	Observed	LC
Great Cormorant	*Phalacrocorax carbo*	Observed	LC
Grey Heron	*Ardea cinerea*	Observed	LC
Western Reef-Heron	*Egretta gularis*	Observed	LC
Pacific Golden-Plover	*Pluvialis fulva*	Observed	LC
Lesser Sandplover	*Charadrius mongolus*	Observed	LC
Eurasian Curlew	*Numenius arquata*	Observed	NT
Bar-tailed Godwit	*Limosa lapponica*	Observed	LC
Little Stint	*Calidris minuta*	Observed	LC
dunlin	*Calidris alpina*	Observed	LC
Slender-billed Gull	*Larus genei*	Observed	LC
Black-headed Gull	*Larus ridibundus*	Observed	LC
Heuglin's Gull	*Larus fuscus heuglini*	Observed	LC
Sooty Gull	*Ichthyaetus hemprichii*	Observed	LC
Great Black headed Gull (pallus gull)	*Larus ichthyaetus*	Observed	LC
Caspian Gull	*Larus cachinnans*	Observed	LC

Common Name	Scientific Name	Observation during site survey	Conservation Status (IUCN)
Gull-billed Tern	*Gelochelidon nilotica*	Observed	LC
Caspian Tern	*Hydroprogne caspia*	Observed	LC
Common Tern	*Sterna hirundo*	Observed	LC
Greater Crested Tern	*Sterna bergii*	Observed	LC
Sandwich Tern	*Sterna sandvicensis*	Observed	LC

As seen in the above table, all birds, except one, observed at the site are listed as Least Concern by IUCN, which means that these bird species are widespread and abundant, and are at lowest risk.

Eurasian Curlew is listed as Near Threatened, which means that this bird species is likely to become endangered in the near future. Earlier this species was listed as Least Concern, however, following revaluation during 2008 the status was changed as it was observed that its population was declining. One of the major non-breeding threats to this species, as per the IUCN, is the disturbance on intertidal mudflats (e.g., from construction work), development on high-tide roosting sites, and the degradation of migration staging areas owing to land reclamation, human disturbance, etc.

6.16.3 Terrestrial Fauna

The terrestrial faunal elements in the study area were not observed directly at the time of site survey but indirect observation of their pugmarks, dropping, and burrows indicated presence in the study area. Table 6-19 presents the terrestrial fauna present in the study area.

Table 6-19: List of Terrestrial Fauna

Vernacular Name	Species	Field Survey observation	As per IUCN red data book
Red Fox	*Vulpes vulpes*	Indirect observation (pug marks seen near study area)	LC
Cheesman's Gerbil	*Gerbillus cheesmani*	Indirect observation Likely to be present in the study area	LC
Camel	*Camelus dromedarius*	Indirect observation (Dropping and pugmarks)	LC
Domestic Dog	*Canis familiaris*	Direct observation Seen, during site visit	LC

The animals that were identified from indirect evidence are listed as Least Concern by IUCN.

6.16.4 Herpetology

Reportedly, total of 39 species of herpetofauna are available in the region, including 8 species with doubtful occurrence. The rarest group representation in this region is of amphibian, on account of the arid nature of the region. Reptiles are well represented in the area with high abundance and distribution, which includes lizards. A total of 26 lizard species have been documented out of which many have rare occurrence, and few have high abundance. Literature suggests that the most abundant species in the area are *Mesalina adramitana*, *Acanthodactylus boskianus*, and *Acanthodactylus opheodurus.* However, no snakes were recorded during the survey around the LBW.

6.17 Marine Environmental Baseline

6.17.1 Literature Review

Marine Reserves

A number of Marine Nature Reserves were declared in the 1990s by the then Ministry of Regional Municipalities, Environment & Water Resource to protect vulnerable marine areas (Figure 2 1). All are located outside the Gulf of Masirah and a significant distance from Duqm Port. These include:

- Ra's Al-Hadd Nature Reserve (Turtle nesting), approximately 350 km to the northeast of Duqm;
- Daymaniyat Islands Nature Reserve (Turtle nesting), approximately 450 km north of Duqm; and
- The Khawars (Lagoons) of the Salalah Coast Reserve, approximately 480 km to the southwest of Duqm.

Figure 6-60: Protected areas and other regions of conservation interest Oman (Source: Environment Society of Oman)

Area of Conservation

A number of internationally recognised conservation areas exist in the region of the Port, but do not have full protected status within Oman. All are located outside the Gulf of Masirah and a significant distance from Duqm Port. Conservation areas closest to the Port include the following.

- *Masirah Island* - Although globally recognised as an area of conservation significance, Masirah Island, located approximately 100 km to the northeast of Duqm is not currently declared a formal protected area under Oman legislation. However it has been proposed as a candidate Marine Protected Area (MPA) (Holt 2012). Fishing is also banned within the eastern nearshore area of the island (NATO 2013).
- *Barr Al Hikman* - To the northern end of the Gulf of Masirah, Barr al Hikman, located approximately 90 km to the northeast of Duqm, is one of the largest coastal wetlands in the Middle East, providing 148 km^2 of inter-tidal mudflats. In winter the area attracts up to half a million predominantly shorebirds (waders), gulls, terns, and herons. Barr al Hikman also supports approximately 30 km^2 of Coral Reef, uniquely consisting of a single coral species, the Oman cabbage coral (*Montipora foliosa*).
- *The Halaaniyat Islands* - The Halaaniyat Islands, approximately 300 km to the south of Duqm, are a significant seabird nesting site for masked boobies (*Sula dactylatra*), red-billed tropic birds (*Phaethon aethereus*), jouanin's petrel (*Bulweria fallax*), roseate terns (*Terna dougallii*) and others. The islands are also noted for supporting pods of sperm whales (*Physeter Macrocephalus*). Long-Beaked Common Dolphins (*Delphinis capensis tropicalis*) are also recorded schooling in the thousands.
- *Ras Madrakah* - The Ras Madrakah region of beaches, approximately 70 km from Duqm, on the southern end of the Gulf of Masirah is known for high incidents of turtle nesting (ESO 2009).

No protected areas are located in close proximity to the Project Area. The closest protected area, Ras Madrakah, is located 70 km to the southeast followed by Barr al Hikman 90 km to the northeast and Masirah Island 100 km in the same direction. All other marine protected areas are located over 300 km from the proposed Project.

Turtles

There is evidence that turtles feed and nest on beaches along the coast immediately surrounding the Duqm area, such as green and loggerhead turtles (Ross, 1979, Salm, 1991, Siddeek and Baldwin 1996) (Figure 6-61). Although their abundance is relatively low compared to other nearby areas such as Masirah Island, the area around Duqm is considered a critical feeding and breeding habitat for certain turtle species, as well as being on a migratory pathway.

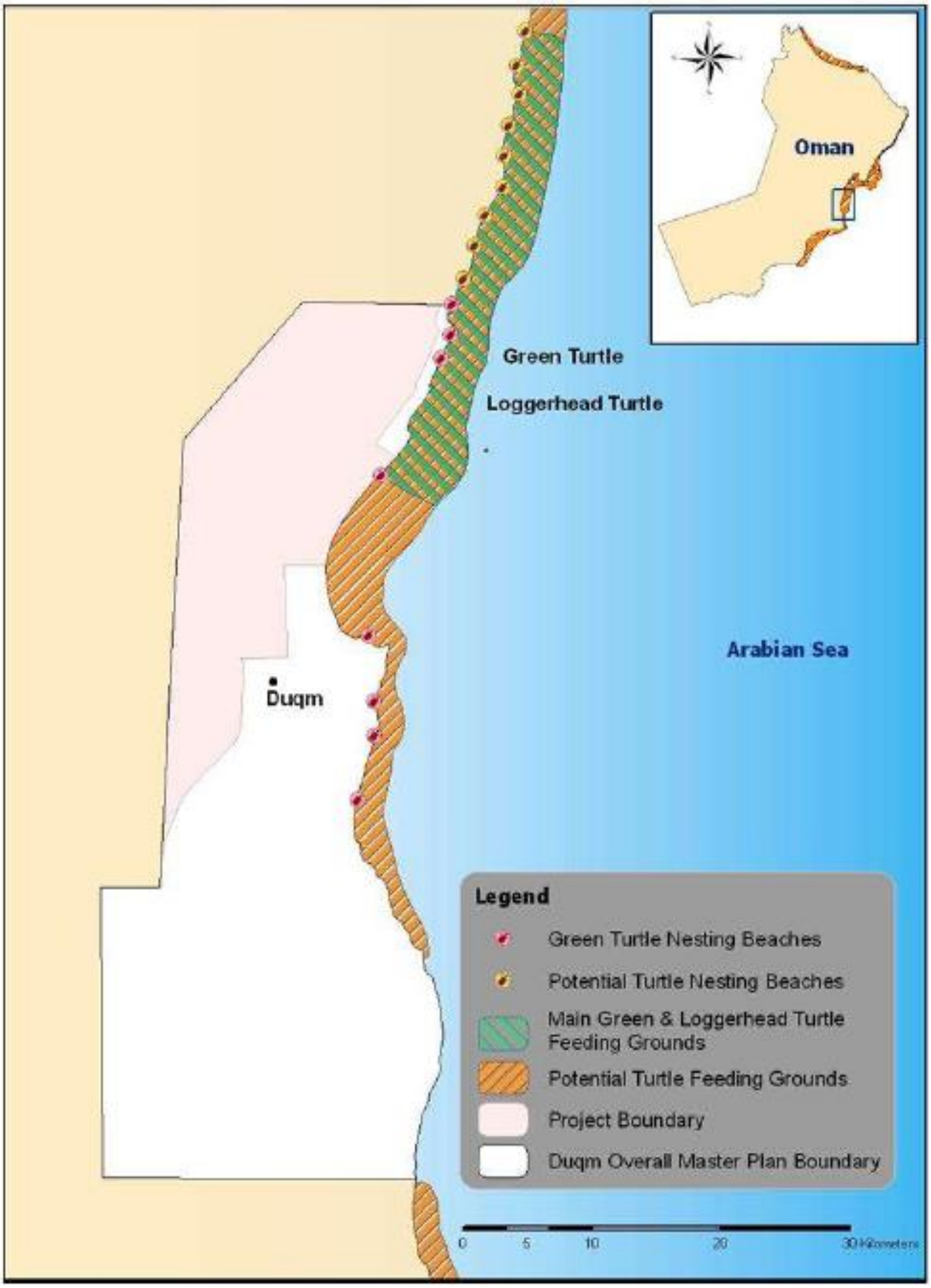

Figure 6-61: Main nesting beaches and feeding grounds for turtles *(Source: Duqm Port IDZ EIA Report 2011, based on Salm 1991)*

The main area of conservation concern for turtles in proximity to Duqm Port is Masirah Island, approximately 100 km away. Masirah Island is a key turtle nesting location of global significance. Four species of marine turtle nest on Masirah's beaches: the loggerhead turtle (*Caretta caretta*), green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*) and olive ridley turtle (*Lepidochelys olivacea*) (Table 6-20). Masirah Island is internationally known for its loggerhead nesting population, considered one of the largest in the world, with tens of thousands of loggerheads estimated to nest annually (Ross 1998).

Each species nests on specific beaches at varying times throughout the year. Hawksbill and olive ridley turtles nest in the winter and spring months whereas the loggerhead and green turtles nest in the summer and autumn (Ross and Barwani 1982).

Table 6-20: Summary of Masirah Island's marine turtle species

Species	Nesting season	IUCN Red List Status as of Jan-2015
Loggerhead (*Caretta caretta*)	July to September	Endangered – needs updating
Green Turtle (*Chelonia mydas*)	July to September	Endangered - population trend decreasing
Hawksbill Turtle (*Eretmochelys imbricata*)	February to April	Critically endangered - population trend decreasing
Olive Ridley (*Dermochelys coriacea*)	February to April	Vulnerable - population trend decreasing

In 2011 a tracking study undertaken by the Ministry of Environment and Climate Affairs (MECA) and Environment Society of Oman (ESO) showed that post nesting movements of loggerhead turtles from Masirah Island, included southwards through the Gulf of Masirah and nearshore areas around Duqm Port (MECA and ESO 2011). Olive ridley turtles have also been shown to migrate through coastal areas around Duqm (MTRG 2008).

ESO has signed two memoranda of understanding with the OOC and the Port of Duqm to support marine turtle conservation on Masirah Island. All turtle species are protected by both Omani national legislation and international agreements to which Oman is a signatory, such as the Convention on the Conservation of Migratory Species of Wild Animals (CMS Convention).

Cetaceans

There are 21 species of cetaceans recorded in Oman (Hoyt 2012). Following is a focussed summary of information on key species recorded specifically around the Gulf of Masirah and Duqm Port.

Figure 6-62 presents sightings data for cetacean in the Gulf of Masirah over the last 20 years (ESO 2010). This data should only be viewed as indicative to cetacean presence, as it does not show density over time. The most commonly recorded nearshore species in Duqm area are Arabian Sea

Humpback Whales and various species of the Delphinidae family, such as dolphins, pilot whales and killer whales.

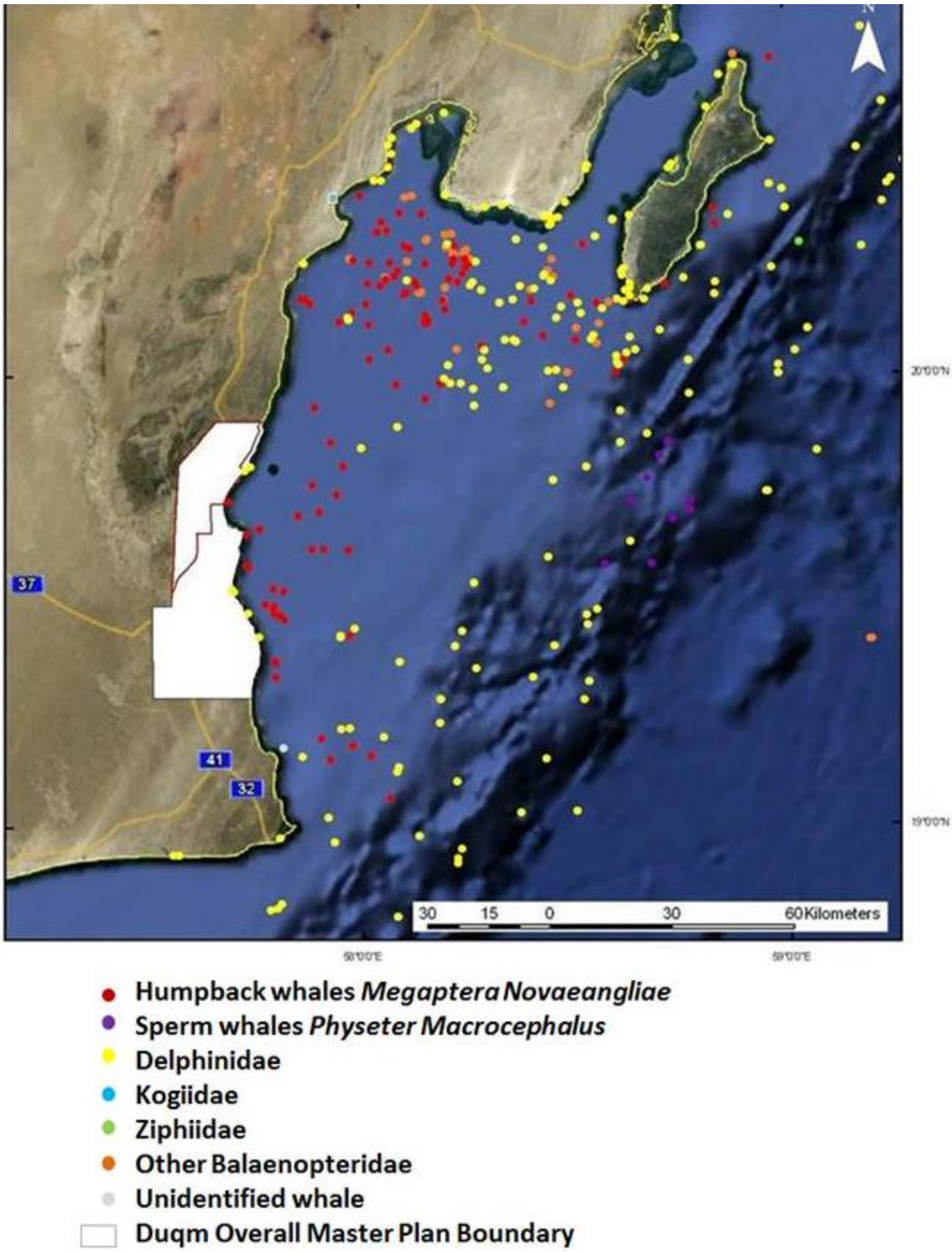

Figure 6-62: Live Sightings and Stranding in Proximity to Duqm Port (*Source: Environmental Society of Oman, 2010*)

Listed below is discussion on key species:

- Arabian Sea Humpback Whale (*Megaptera novaeangliae*) **–** The Arabian Sea Humpback Whales are the only known non-migratory population of humpback whales, with the current population estimated to number less than 100 individuals (Corkeron et.al 2011). The Arabian Sea Humpback Whales were designated as an endangered subpopulation in the 2008 revision of the IUCN Red List for cetacean species and are listed as Endangered. Data from photo-identified individuals (Minton et al. 2010) and genetics (Pomila et al. 2014) demonstrate this population is genetically isolated from the nearest neighbouring Indian Ocean populations. Arabian Sea Humpback Whales are geographically and demographically rare, with a unique year-round residency in sub-tropical waters of the Arabian Sea. This group are therefore of significant conservation interest. An almost continuous survey between 2007-2008 of the Oman Marine Science and Fisheries Centre recorded multiple humpback whales around Duqm Port (Gheilani 2008). Survey sightings occurred mainly between August to November (60 %) and February to April (40 %). No humpback whales were recorded between May to July. A 2012 vessel survey in the Gulf of Masirah also recorded three sightings of the Arabian Sea Humpback Whales (Willson et al. 2013). Two humpbacks were recorded within 5 km of Duqm Port. When the Port becomes active, vessel traffic passing to the east of Masirah Island may be diverted inshore across potential Humpback Whale habitat. Minton et al. (2010) concluded the nearshore areas of the Gulf of Masirah to be a critical habitat for humpback whales.
- *Bryde's Whale (Balaenoptera edeni)* – The Bryde's whale is also known to be found in the Gulf of Masirah (ESO 2009), attracted by the high productivity and fish abundance in the area. The area acts as an important calving habitat for the Bryde's and humpback whales. Additional whale species, including the sperm whale (*Physeter macrocephalus*) and rarer blue whale (*Balaenoptera musculus*) have been recorded in the Gulf of Masirah, but seasonality to the sighting data suggests a migratory route through the area (Baldwin 2003).
- *Long-beaked Common Dolphin (Delphinis capensis tropicalis)* – Willson *et al*. (2013) recorded the long-beaked common dolphin as present in the Gulf of Masirah. It is recognised as the second most common cetacean species in Oman. The 2007-2008 Ghelaini survey recorded a number of sightings in and around the Gulf of Masirah (Figure 6-63). Sightings occurred in March, May and November, 60% were found between Masirah and Daymaniyat Island. *Delphinis capensis tropicalis* is not currently listed under the IUCN Red List.

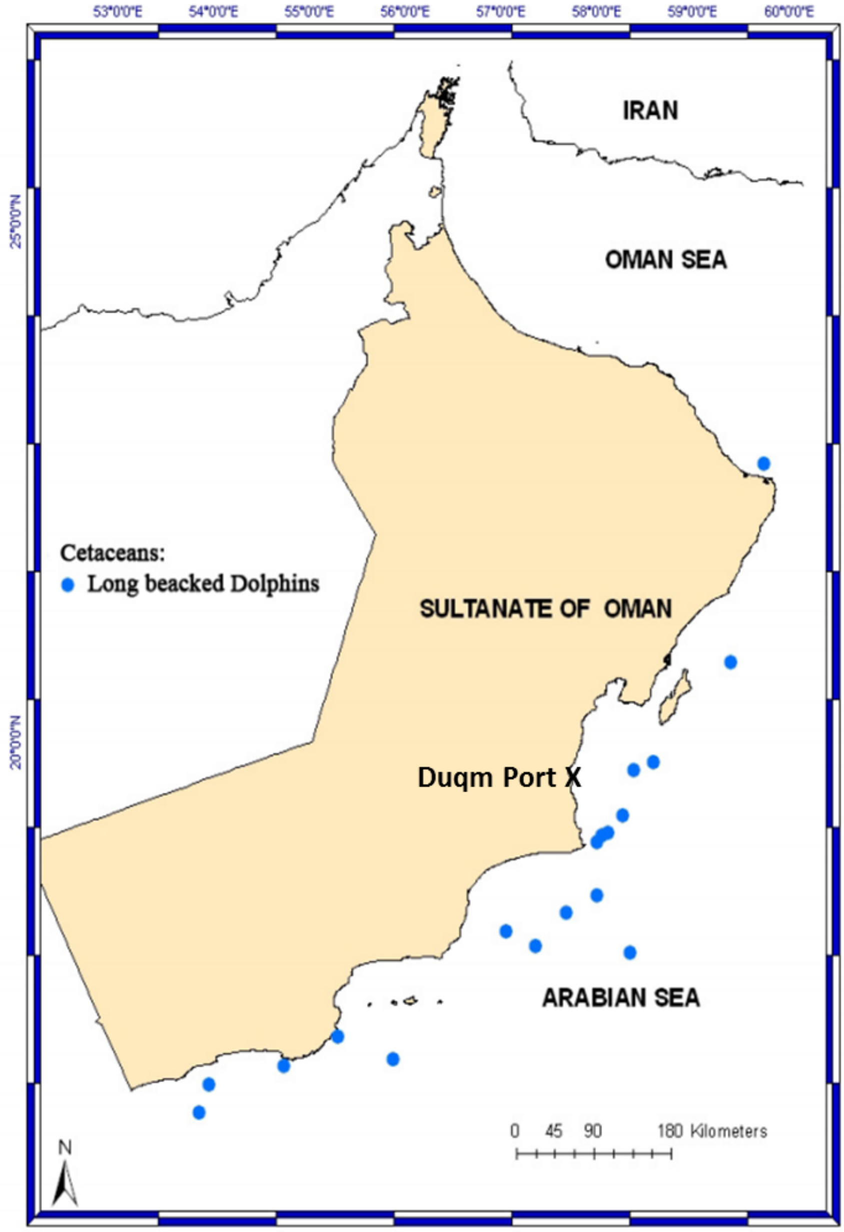

Figure 6-63: Long beaked common dolphin sightings around Duqm Port (*Source: Gheilani 2007-2008)*

- *Indo-Pacific Humpback Dolphins (Sousa chinensis)* - The range of *Sousa chinensis* appears to be continuous along the coast of Oman (Baldwin and Salm 1994). A study conducted between 2000 and 2003 demonstrated that the nearshore areas of the Gulf of Masirah are a concentration zone for the Arabian Sea's population of *Sousa chinensis* (Minton et al. 2010). The IUCN Red List currently lists the status of *Sousa chinensis* as 'Near Threatened' with a decreasing population trend.

- *Bottlenose Dolphin (Tursiops* sp.*)* - Willson et al. (2013) recorded two sightings of bottlenose dolphin species in the Gulf of Masirah. Specifically the Indo-Pacific bottlenose dolphin is found in Omani waters. A 2012 study suggests they feed primarily in shallow, inshore waters along the Gulf of Masirah and over the continental shelf (Ponnampalam et al. 2012). The IUCN red list provides its current status as data deficient, with population trend unknown.
- *Spinner Dolphin (Stenella longirostris)* - Spinner dolphins are commonly recorded along the coastal waters of Oman coast including the Gulf of Masirah (Gallagher 1991). It is concluded that Omani spinner dolphins should be treated as a discrete population, morphologically distinct from all known spinner dolphin subspecies (Warebeek et al. 1999). The IUCN red list provides its current status as data deficient.

Fisheries

Abundant fisheries and marine resources are found throughout Omani waters of the Arabian Sea, including the Al Wusta Governorate surrounding Duqm Port. Duqm is therefore an ideal location for fish-processing, aquaculture, and other fisheries related activities (Figure 6-64).

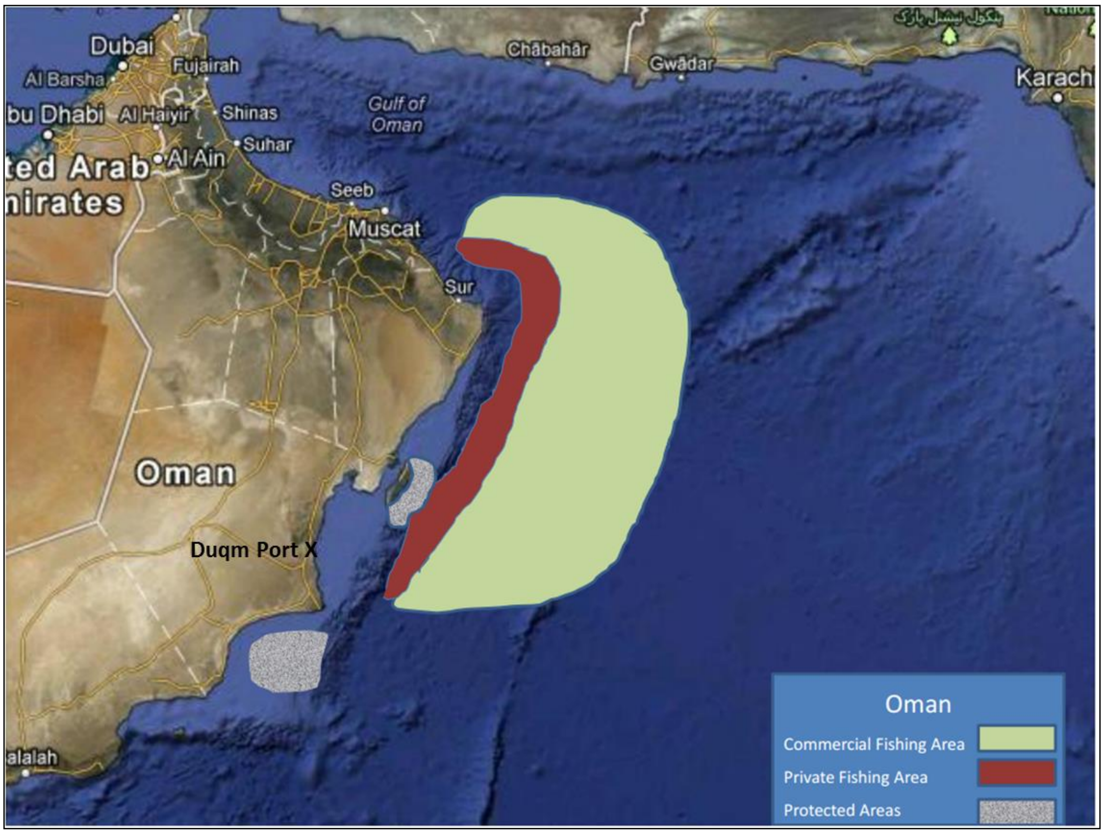

Figure 6-64: Key Fishing Area around Duqm (Source: NATO Shipping Centre 2013)

Oman's fishery is largely for personal consumption or export to countries such as Jordan and landlocked African countries. Seasonal variations in fishing effort are affected by the South West Monsoon between May and September. Predominant fishing methods include purse seines, beach seines, hand lines, gill nets, trolls, long line and traps (NATO 2013). Small fiberglass boats operate up to 6 Nautical Miles (NM), artisanal boats fish beyond 6 NM, the coastal fleet operates beyond 8 NM. Demersal industrial trawlers are allowed to operate deeper than 50 m or at least 10 NM from shore, whichever is further. They are restricted to sea areas between latitude 20º 00' N and longitude 55º 45' E (FAO 2001).

Key commercial target species included tuna, sardine, large jacks, mackerel, sailfish, barracuda, snappers, groupers, sea breams, sharks, rays, shrimp, lobster, cuttlefish, and abalone (NATO 2013). Among crustaceans, two species of shrimp, *Penaeus indicus* and *Penaeus semisulcatus*, contribute over 99 % of the shrimp landings in Gulf of Masirah, Oman (FAO 2001). The four small pelagic species mainly found in the Omani Exclusive Economic Zone (EEZ) are Indian oil sardine (*Sardinella longiceps*), Indian scad (*Decapterus russelli*), horse mackerel (*Trachurus indicus*) and bigeye scad (*Selar crumenophtalmus*) (FAO 2001). Figure 6-65 presents examples of commercially caught species, photographed at the fish landing area to the north of the LBW.

Figure 6-65: Examples of Commercially Caught Species *(Photograph 3-Sep-2014)*

Demersal and pelagic artisanal fishing occurs throughout the Gulf of Masirah, typically up to 50 m (FAO, 2012). Methods include skiff and *dhow* vessel hand-lines and trolling lines, nets and trap fisheries. Beach seining is also common. Artisanal fishing takes place all year round. Typical target species include emperors (*Lethrinidae*), tiger perches (*Terapontidae*), long tail tuna (*Thunnus tonggol*), yellow fin tuna (*Thunnus albacares*), barracudas (*Sphyraenidae*), hammerhead sharks

(*Sphyrnidae*) and multiple grouper species e.g. brown spotted grouper (*Epinephelus chlorostigma*) (FAO 2012). Figure 6-66presents examples of skiffs and *dhow* that were observed operating in the study area.

Figure 6-66: Examples of Skiff and *Dhow* *(Photograph by WorleyParsons)*

In response to this abundance of resources, one of Oman's largest fishery harbours is to be constructed at Duqm Port. The project will support the development of a major fishery hub, planned as part of an ambitious Special Economic Zone (SEZ) at Duqm.

This will encompass:

- A fishing harbour at -6 m depth with all facilities required to accommodate small and medium size fishing boats;
- Retail, wholesale and export markets;
- Land area to house fish processing, canning, fish oil and animal feed industries.
- Fish and shrimp farming;
- A training centre and extension services;
- A marine research centre; and
- An international standards quality assurance centre for fresh and processed fish exports.

6.17.2 Field Survey

In response to the EIA Scoping report (WorleyParsons, 2014) approved by MECA, the following methodology was developed to survey the marine environmental conditions of the study area. The study area was subdivided into five areas:

- The intertidal area of the adjacent shoreline;
- The proposed location of the liquid berths within the Port;

- The nearshore area outside of the Port, northwest of the LBW and east of the Main Breakwater;
- The Borrow area, located 40 km offshore; and
- The Disposal area, located 18 km offshore

Water quality and benthic habitat data were collected over a thirteen-day period from 31-Mar to 12-Apr-2015. Ghost fishing nets abandoned along the outside of the LBW caused damage to the camera equipment, towfish frame and winch during the survey. As a consequence, a second survey was required from 12 to 16-May-2015 to complete habitat mapping data collection.

Nearshore conditions consisted of generally calm weather with very high turbidity. Offshore conditions also consisted of generally calm weather. Two days were met with a regional dust storm, strong winds, 1 to 2 m swell and reduced visibility. The average day time air temperature was 40 ºC with no precipitation.

Physicochemical water quality profiles and water quality samples were collected from a total of 27 sites, six sites inside of the Port and eleven sites outside of the Port (Figure 6-67), five sites at the disposal area (Figure 6-68) and five sites at the borrow area (Figure 6-69).

A subtidal benthic habitat assessment was completed using video footage from underwater towed video transects. A total of 33 transects were completed, covering approximately 80 km of seabed at locations inside and outside of the Port (Figure 6-67), and at disposal and borrow areas (Figure 6-68 and Figure 6-69 respectively).

Appendix 2 presents the methodology and the detailed findings of the adopted for the marine environmental baseline study. The subsequent sections summarise the same.

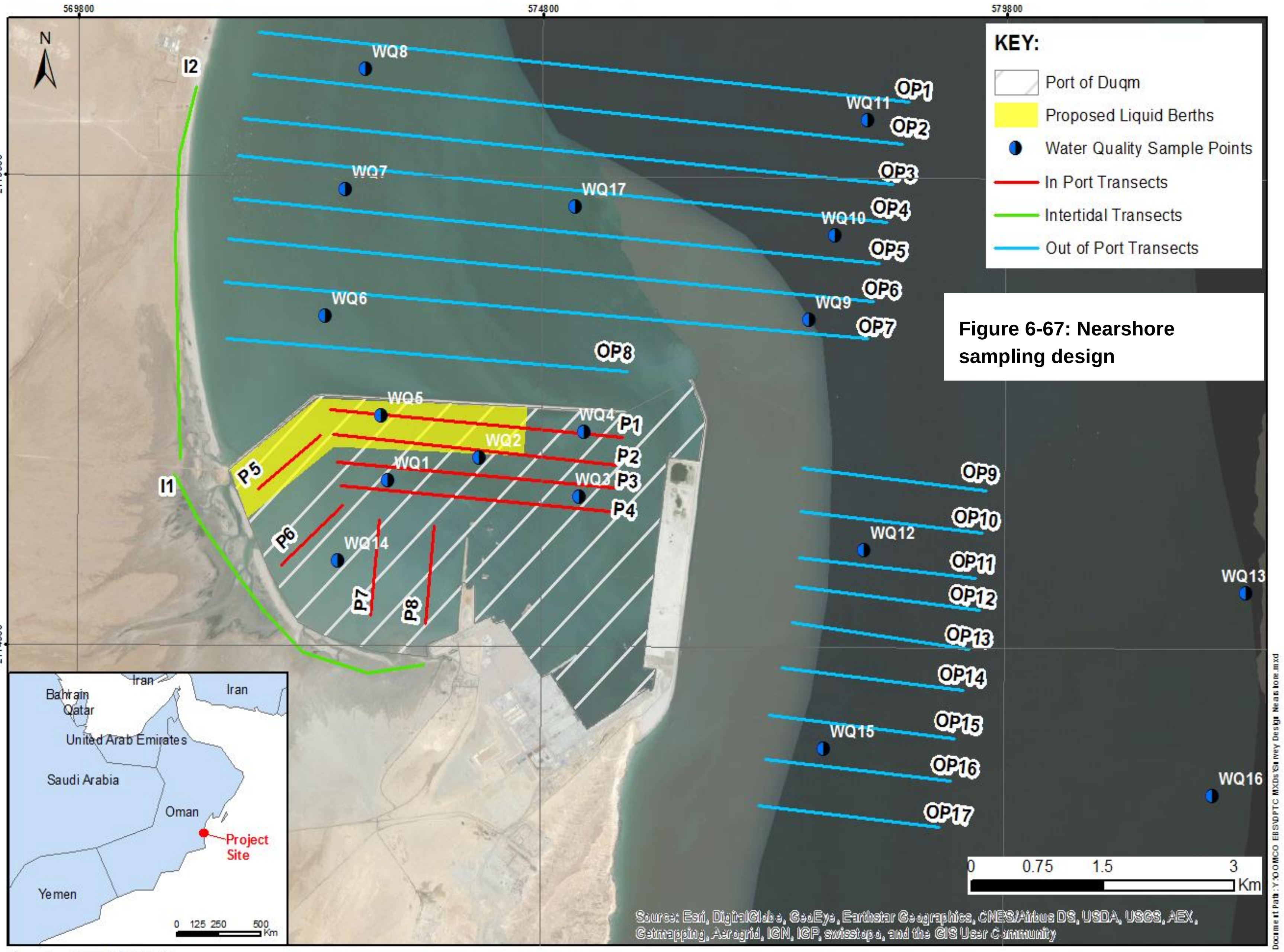

Figure 6-67: Nearshore sampling design

Projection: UTM40N WGS84

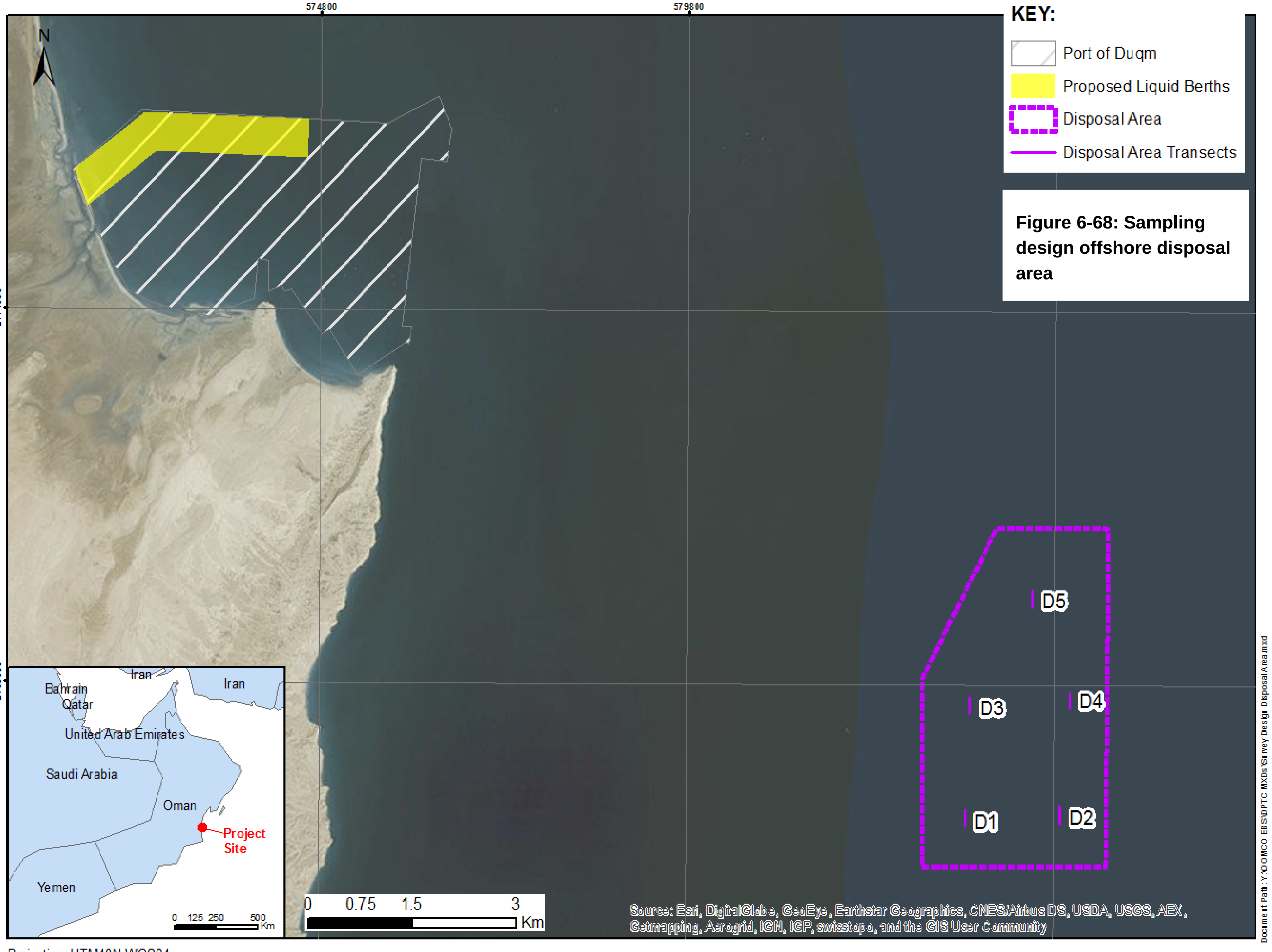

Figure 6-68: Sampling design offshore disposal area

Projection: UTM40N WGS84

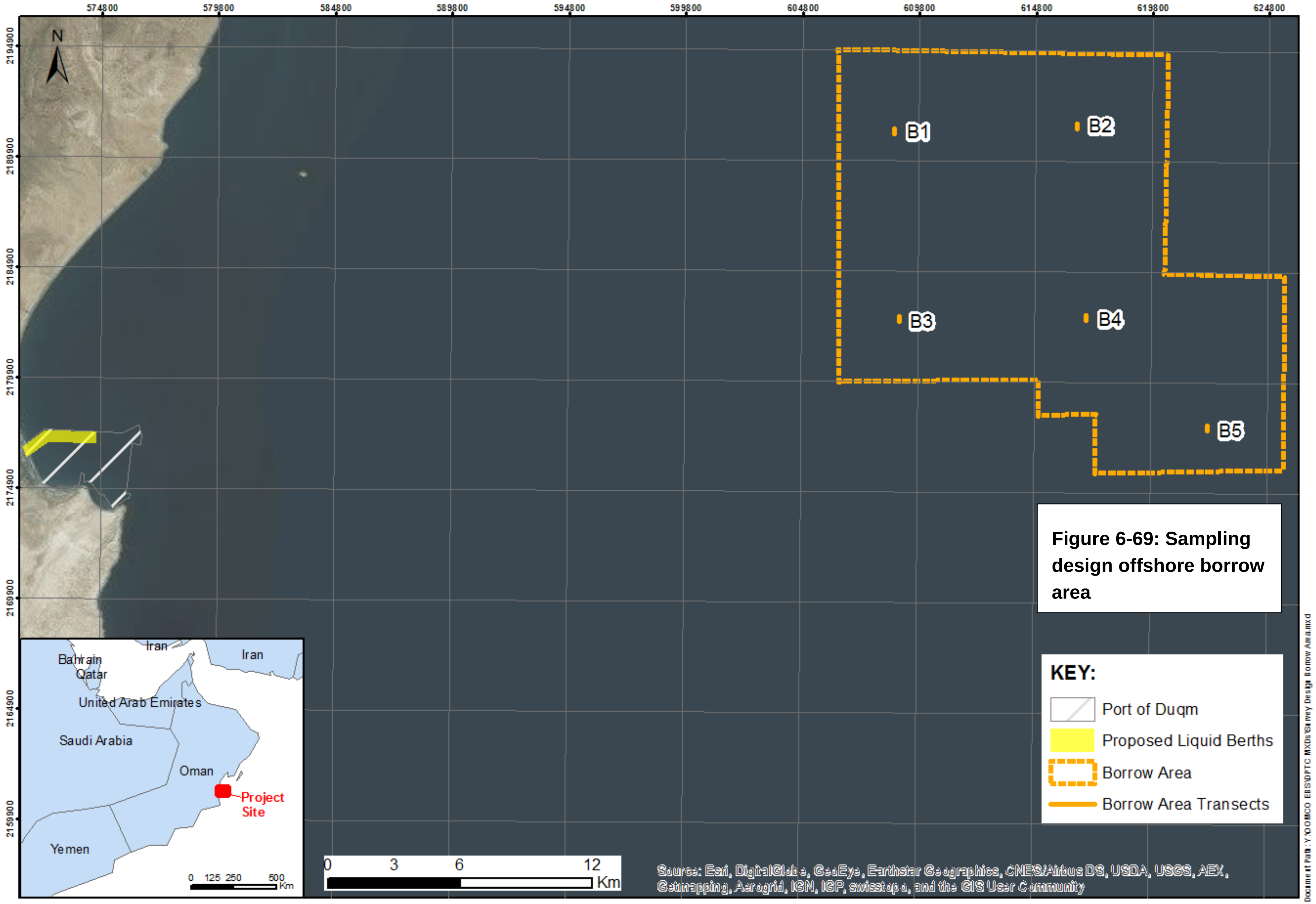

Figure 6-69: Sampling design offshore borrow area

Projection: UTM40N WGS84

Physicochemical Water Quality – Inside the Port

Maximum depths at sites sampled inside the port ranged from 2 m to 19 m. Depth was greatest in the shipping channel that runs through the centre of the Port and shallowest nearshore. Depth decreased rapidly outside of the shipping channel and then gradually towards shore.

Temperature varied between sites and over depth, ranging from 24.5 ºC to 25.6 ºC. Surface temperatures were generally warmer at shallower sites and decreased with distance from the breakwater. Temperature decreased with depth at all sites. This was most noticeable at the deepest site in the shipping channel. In the shipping channel, clear stratification was observed between 4 m and 6 m forming a thermocline.

Mean turbidity ranged from 2.3 to 9.1 Formazin Nephelometric Units (FNU). Turbidity was lowest in the deeper water of the shipping channel and increased nearshore with decreasing depth. Turbidity was highest towards the seabed at all sites.

Salinity values were similar between sites and over depth, ranging from mean values of 36.4 to 37.3 Practical Salinity Units (psu). A slight halocline can be observed in the profile of WQ 03 in the shipping channel at 4 – 6 m depth. Salinity is also higher at WQ 01 than at other stations.

Dissolved Oxygen (DO) values range from mean values of 97.9 % to 59.3 % (Table 4 1). DO levels reduced with depth at all sites. An oxycline can be seen at WQ03 in the shipping channel, DO levels drop at between 4 and 6 m.

Mean values for pH range between of 7.7 and 7.8. pH generally reduced with depth at all sites.

Table 6-21: Summary of Water Profile inside the Port

Site	Depth (m)	Temperature (^{0}C)		Turbidity (FNU)		DO (%)		pH		Salinity (psu)	
		Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
WQ 01	3.6	25.3	0.0	7.5	2.1	86.7	3.1	7.8	0.0	37.2	0.0
WQ 02	5.4	25.2	0.0	3.4	0.5	81.2	1.6	7.8	0.0	37.2	0.0
WQ 03	18.7	24.7	0.3	2.3	0.7	59.3	14.7	7.7	0.1	37.1	0.0
WQ 04	10.8	24.9	0.1	4.5	1.7	67.4	10.2	7.7	0.0	37.2	0.0
WQ 05	4.4	25.3	0.0	9.1	1.5	97.9	0.3	7.8	0.0	37.3	0.0
WQ 14	2.2	25.6	0.0	8.2	0.3	86.3	1.2	7.7	0.0	36.4	0.8

Physicochemical Water Quality – Nearshore Area outside the Port

Depth outside the Port in the nearshore area ranged from 3.6 m at WQ 07 closest to shore to 22.6 m at WQ 16 located furthest offshore of the outer Port sites. Depths at all sites followed this trend, with shallow sites located nearshore and deeper sites offshore.

Mean temperature values were largely comparable at all sites, ranging from 24 ºC to 24.8 ºC. Temperature decreased with depth at all sites and there is evidence of a thermocline between 1.5 m and 4.5 m depth.

Mean turbidity levels ranged from 1.3 to 3.1 FNU. Turbidity increased with depth at all sites and increased at depths near to the seabed. Sites closest to shore had higher surface and water column turbidity values than deeper offshore sites.

Salinity values of 37 psu were recorded across all sites and depths.

Mean DO levels ranged from 66.2 % to 85.3 %. DO levels were lowest at sites opposite the mouth of the Port and highest at nearshore shallow sites to the north of the lee breakwater. DO levels decreased with depth at all sites.

Values of pH were comparable at all sites and depths at around pH 7.7.

No unexpected differences were observed between control sites (WQ 13 and WQ 16) and other sites.

Table 6-22: Summary of water quality profile data nearshore outside of the Port

Site	Depth (m)	Temperature (^{0}C)		Turbidity (FNU)		DO (%)		pH		Salinity (psu)	
		Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
WQ 06	3.6	24.8	0.2	3.1	1.3	81.8	4.3	7.7	0.0	37.1	0.0
WQ 07	4.0	24.8	0.2	2.0	0.6	83.6	3.9	7.7	0.0	37.1	0.0
WQ 08	5.5	24.7	0.1	2.1	0.4	85.3	3.6	7.7	0.0	37.1	0.0
WQ 09	13.1	24.1	0.2	3.1	1.3	66.2	2.5	7.7	0.0	37.0	0.0
WQ 10	12.3	24.3	0.4	2.6	0.7	67.8	3.9	7.7	0.0	37.1	0.0
WQ 11	16.9	24.1	0.3	2.0	0.9	70.1	6.3	7.7	0.0	37.0	0.0
WQ 12	14.4	24.1	0.4	1.9	0.6	78.8	8.8	7.7	0.0	37.1	0.0
WQ 13	14.9	24.1	0.3	1.3	0.3	77.2	4.2	7.8	0.0	37.1	0.0
WQ 15	15.6	24.1	0.4	1.6	0.7	79.5	8.1	7.7	0.0	37.1	0.0
WQ 16	22.6	24.0	0.2	1.3	0.6	76.9	5.0	7.8	0.0	37.1	0.0
WQ 17	7.0	24.5	0.3	2.0	0.7	77.5	3.9	7.7	0.0	37.1	0.0

It should be noted that WQ 13 and WQ16 represent the control points for the sampling during dredging.

Physicochemical Water Quality – Offshore Disposal Area

Depths at the offshore disposal area were largely comparable, ranging from 25.3 m to 26.7 m.

Mean temperature values were similar at all sites at around 23.8 ºC. Temperature decreased with depth at all sites.

Mean turbidity values ranged from 0.6 to 2.2 FNU. Throughout the water column turbidity values were comparable at below 1 FNU increasing from around 10 m depth to the sea bed.

Salinity was comparable between stations and at all depths at around 37.4 psu.

Mean DO values ranged from 72.2 % to 85.9 %. DO levels decreased with depth and were comparable between sites in the bottom waters.

Values of pH were comparable between sites and over depth, with mean values of around pH 7.8.

Table 6-23: Summary of water quality profile data at the offshore disposal area

Site	Depth (m)	Temperature (^{o}C)		Turbidity (FNU)		DO (%)		pH		Salinity (psu)	
		Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
DA 01	26.2	23.8	0.4	0.6	0.4	85.9	15.9	7.8	0.1	37.4	0.0
DA 02	26.7	23.8	0.4	1.1	1.2	80.6	12.0	7.7	0.0	37.4	0.0
DA 03	25.8	23.8	0.2	1.5	1.3	77.2	11.9	7.8	0.0	37.4	0.0
DA 04	25.6	23.7	0.1	0.9	0.9	76.2	6.4	7.8	0.0	37.4	0.0
DA 05	25.3	23.8	0.0	2.2	1.4	72.3	3.2	7.8	0.0	37.3	0.0

Physiochemical Water Quality – Offshore Borrow Area

Depth at the offshore borrow area was largely consistent, ranging from between 29 m and 33.2 m.

Mean temperature values were similar at all sites at approximately 25 °C. Temperature decreased with depth at all sites. A thermocline was identified between a depth of 22 m and 28 m.

Mean turbidity values were similar at all sites ranging from 0.1 to 0.3 FNU. Throughout the water column turbidity values were comparable at below 1 FNU increasing slightly from 15 m depth to the sea bed.

Salinity was largely comparable between stations and at all depths at around 37.3 psu.

DO values showed good levels with some minor variation between sites in the surface waters. DO levels decreased with depth and were comparable between sites in the bottom waters. An oxycline was identified between a depth of 22 m and 28 m.

Values of pH were largely comparable between sites and over depth, with mean values of around 7.8.

Table 6-24: Summary of water quality profile data at the offshore borrow area

Site	Depth (m)	Temperature (^{o}C)		Turbidity (FNU)		DO (%)		pH		Salinity (psu)	
		Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
BA 01	29.3	24.9	0.8	0.3	0.4	76.7	23.0	7.8	0.1	37.3	0.0
BA 02	33.2	25.1	0.9	0.2	0.2	84.9	20.6	7.8	0.1	37.3	0.0
BA 03	29.0	25.1	0.4	0.3	0.3	87.5	9.9	7.8	0.0	37.3	0.0
BA 04	31.4	24.8	0.7	0.1	0.1	83.5	19.2	7.8	0.1	37.3	0.0
BA 05	32.2	24.8	0.4	0.1	0.0	90.4	12.9	7.9	0.0	37.2	0.0

Chemical Water Quality

Chemical water quality results derived from physical sampling and laboratory analysis reveal no exceedances against identified guideline values, with some very minor exceptions in copper and zinc. In addition, there was no discernible difference in chemical water quality between sites located inside the port or outside of the port. These results reveal chemical water conditions that are homogenous and unpolluted.

Compared to past data collected before the Port's construction (Royal Haskoning, 2007), chemical water quality concentrations show no substantial differences. Compared to a recent study during construction of the dry dock yard inside the existing Port (Five Oceans, 2012) our results show no substantial differences.

Subtidal Benthic Habitat

The subtidal benthic habitats identified during the survey were largely homogenous unconsolidated sediments with no biological cover. The vast majority of the benthic habitat surveyed inside the Port was unconsolidated fine sediment with no biological cover. Outside of the port in the nearshore area, the surveyed benthic habitat was entirely homogenous unconsolidated sand sediments with no biological cover.

At the offshore disposal area, sediments were fine sand but included rock rubble. This is expected as the site has been previously used to dispose consolidated sediment dredged during development of the port.

The offshore borrow area comprised fine sand sediment throughout. The sediment type was homogenous and supported no biological cover.

No coral, seagrass or substantial areas of macroalgae were identified as part of this survey. It is likely that neither coral nor macroalgae were observed due to the absence of hard substrates, which is required for recruitment, settlement and colonisation. All benthic communities including seagrass species require sunlight for survival, a means of primary production known as photosynthesis. Photosynthetic rates vary depending on the level of Photosynthetically Active Radiation (PAR) at the seabed, which is in turn dependent on depth and turbidity levels. Increased turbidity was observed throughout the Port and nearshore areas. This is likely to have caused a decrease in PAR at the seabed which may have resulted in PAR being below the threshold for survival (Kaiser et al., 2011).

Similarly, light and substrate type are likely to be the main limiting factors at both offshore areas. Light is attenuated through the water column and as a consequence PAR decreases with depth. Additionally, recent disposal material within the disposal area will have likely smothered any previously existing benthic habitat.

A recent environmental study conducted inside the Port revealed very similar conditions to those encountered on this survey, infauna holes were observed inside the Port (WorleyParsons, 2015). One difference is that some of the sediment inside the Port was described as fine mud, the location of that study was on the opposite side of the Port however and close to the main breakwater. Another previous study collected infauna and sediment data before the Port's construction (Royal Haskoning, 2007). The report describes the seabed as relatively flat and featureless, consisting of a large shallow coastal plain that extends for 10 km offshore before rapidly increasing in depth.

Anecdotal evidence gathered from a local dive operator revealed that no coral or seagrass habitat was known in proximity to the study area, inside the Port or along the adjacent coastline.

Intertidal Habitat

The intertidal habitat of the study area comprised soft sediment muddy sand and fine sands. Intertidal sediment within the Port was finer than sediments along the adjacent coastline to the north of the Port. No evidence of cetacean stranding or turtle nesting was observed during the intertidal surveys. Although no direct observations were made, the fine sand sediment along the adjacent northern coastline may be suitable habitat for nesting turtles.

One turtle sighting was made from the survey vessel close to the Government Quay. The sighting was only fleeting as the animal surfaced momentarily before disappeared back in to the highly turbid waters of the Port. It is thought that due to the relatively small size and oval shape of the carapace that it was either a hawksbill or Olive Ridley turtle.

It was evident that a large number of seabirds use the intertidal area of the Port and adjacent coastline. Exposed sandbanks in particular were frequented by large numbers of terns, gulls and other unidentified bird species. Inside the Port the main area of bird activity appeared to be a large sandbank immediately north of the Government Quay. Bird footprints were clearly visible throughout the intertidal area of the Port.

Outside of the Port, a section of wadi inlet close to LBW was populated by a modest number of flamingos and other wading birds. Gulls were evident throughout the sandy intertidal of the adjacent coastline and concentrated around the fishing village close to the desalination plant north of the Port

Key Findings

Aside from the visible presence of the Port's infrastructure there is further evidence of the effects of the Port. Nearshore depths were greater inside the shipping channel due to dredging work undertaken to accommodate vessel drafts. DO levels were reduced in the bottom layers of the Port and this influence has spread to bottom waters outside of the Port and close to the mouth. Turbidity levels were elevated inside the Port and remained high in the nearshore areas adjacent to the Port. Chemical water quality was good throughout the study area, with only very minor exceedances of some adopted guideline values for copper and zinc outside of the Port.

No significant sensitive benthic habitat was found as part of this survey. The majority of the benthic habitat within the Port was found to be unconsolidated sediments of fine sand with no epifauna or flora cover. Outside the Port, the benthic habitat was homogenous unconsolidated sand with no epifauna or flora. The disposal area revealed evidence of past disposal with rock rubble visible with fine sand sediment.

No cetaceans were seen during the course of this baseline survey. One olive ridley or green turtle was seen in the Port close to the Government Quay. Although no tracks or signs of nesting were recorded, it is possible that the fine sand sediment of the adjacent coastline north of the Port is considered to be suitable for turtle nesting.

The intertidal area of the Port and the adjacent coastline is an important habitat for seabirds. In particular exposed sandbanks were populated with large number of small birds including terns and gulls.

Turtles have been shown to nest and feed on the coastline to the north of the Port, and certain cetacean and turtle species are known to transit through waters offshore from the Port, on route to breeding and feeding grounds in the region. However, these species are not known to concentrate in the nearshore area that the Project will operate in. It is possible that increased marine traffic during the construction phase will disturb marine mammals and turtles. However, this level of disturbance is not considered to be significant above background levels of existing marine traffic in the Port and will result in little disturbance outside of the Port.

6.18 Socio-economic Setting

6.18.1 Background

The DLBB Project is located on the LBW within Duqm Port on the coast of Oman in the Duqm Wilayat in Al Wusta Governorate. The nearest inhabited village is the Say village located on the banks of Wadi Say. The name Say village is often used in synonym with Duqm Town and is the administrative headquarters of Duqm Wilayat.

The Al Wusta Governorate is located in the centre of the Sultanate and borders the Dhofar Governorate to the south, the Arabian Sea to the east, the Kingdom of Saudi Arabia to the west and the Governorates of Adh Dhahirah, Ash Sharqiyah and Ad Dakhliyah to the north. Al Wusta is dominated by a flat, featureless, barren rock desert. It has an un-spoilt desert and beautiful quiet beaches. Majority of the population within the Al Wusta region lives in the coastal zone in small towns or villages. The Governorate is divided into four Wilayats, viz., Mahout, Al Jazer, Duqm and Haima (in the order of the population number). Traditionally, during the monsoon season, when the coastal area along Duqm is too rough for fishing, the local populace migrates to villages south of the mountain ranges, mainly in the Adam, Sinaw and Mudhaibi areas. There they live in palm-frond shelters (*rishah*) and stay there for the date harvest. Many have invested in date palms and collect their crops for storage to supply their families and livestock through the upcoming winter. Locals also derive income from livestock growing (goats, sheep and camels) and by working in government and the private sector. Some families receive financial support from the Ministry of Social Development.

The local people rely heavily on fishing for its income. However, a number of Government-planned initiatives for industrial and tourism developments in Al Wusta are expected to supplant the traditional reliance on agriculture and fisheries.

The Al Wusta Governorate makes up 25.8 % of the land area of Oman, however only represents about 1 % of the population in the Sultanate with population density of 0.5 persons/km^2.The population of Al Wusta rose from 30,624 in 2011 to 40,151 in 2013 representing a 31 % increase (Statistical Year Book 2014 by National Centre for Statistics and Information). This population increase could be attributed to Government development schemes.

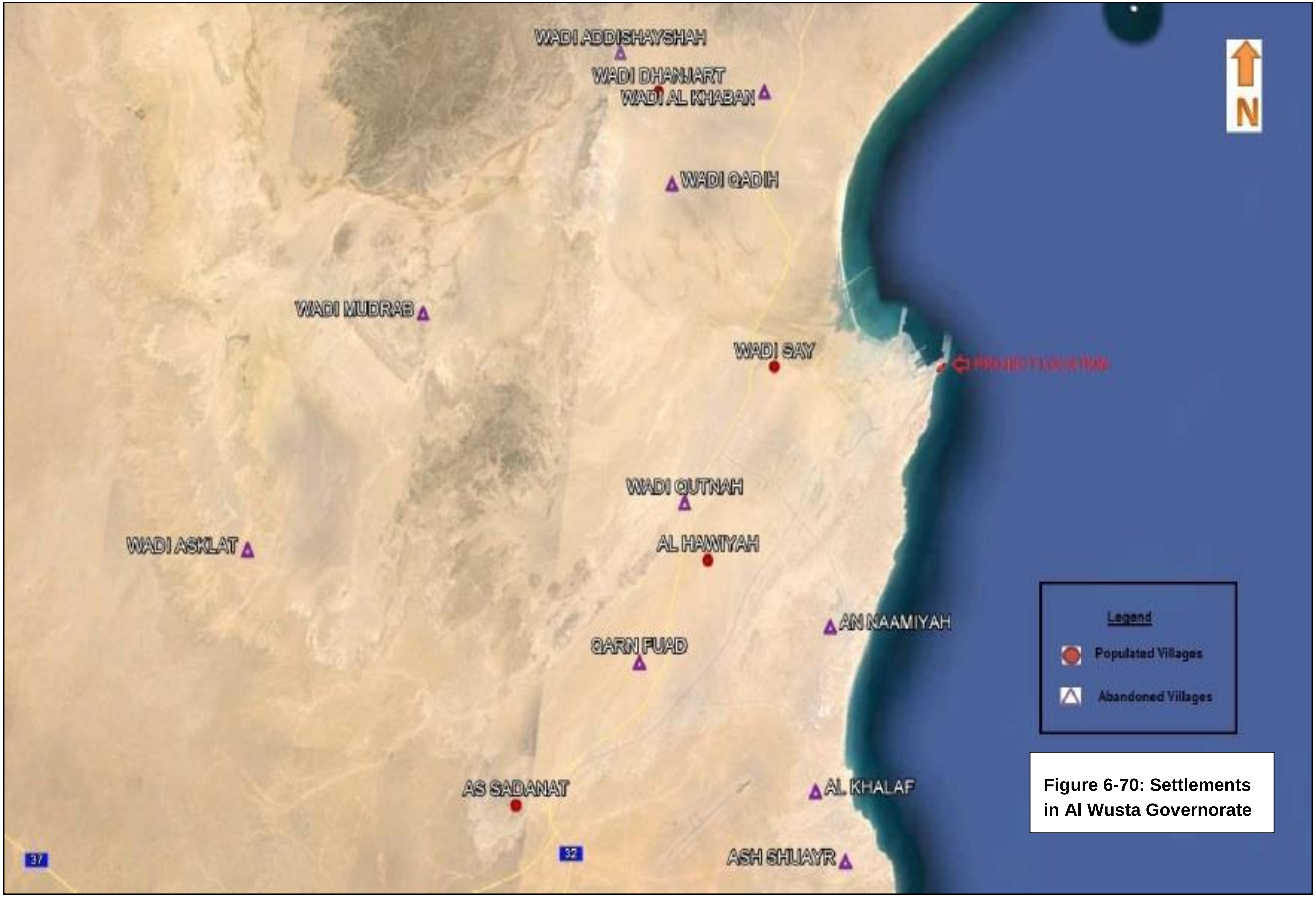

Figure 6-70: Settlements in Al Wusta Governorate

6.18.2 Demographic Profile

Among all the villages in Duqm Wilayat, Say village is the largest with a population of 6,183 followed by As Sadanat and Al Hawiyah (Census of Oman 2010). The rest of the villages within the study area are sparsely or seasonally populated. The population of the identified localities within the study area is presented in Table 6-25, overleaf

Figure 6-71 presents the population in Duqm Wilayat between 2011 and 2013 as published in the Statistical Year Book 2014 by National Centre for Statistical & Information.

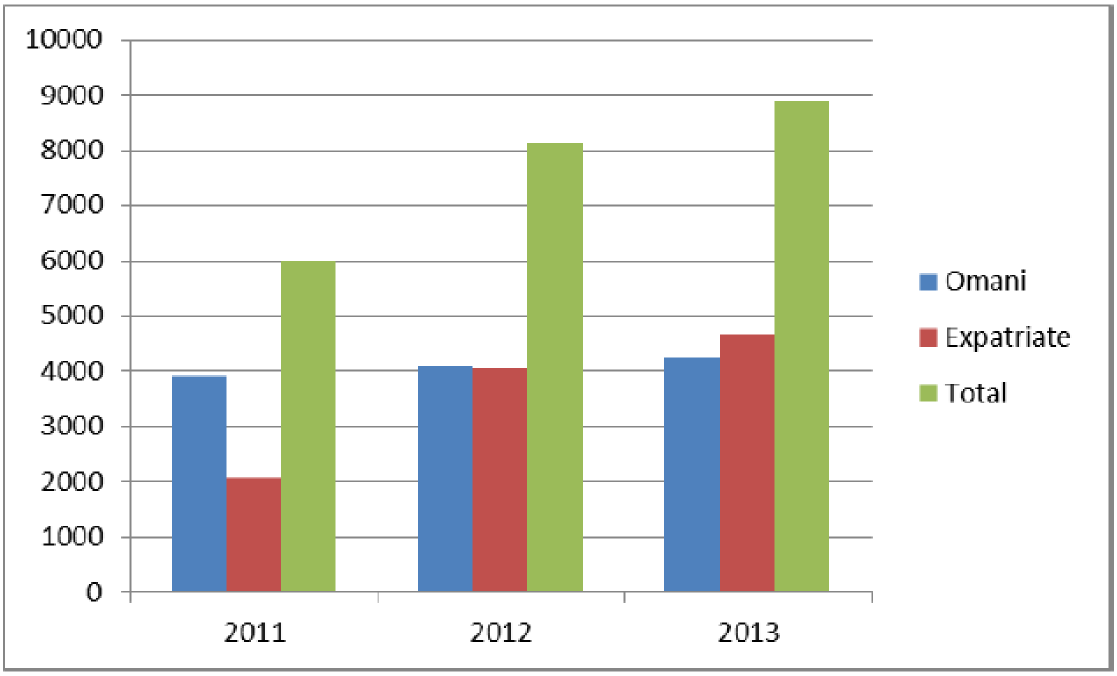

Figure 6-71: Population in Duqm Wilayat *(Source: Statistical Year Book 2014 by National Centre for Statistics and Information)*

The above figure shows a rapid increase in the population in Duqm Wilayat as a result of development activities. The majority of the expatriates in Duqm Wilayat are expected to be construction workers, building infrastructure for the SEZD development. As development in the SEZD area intensifies a large increase in the population of the Wilayat is expected followed by a drop as the construction work force are demobilised from the site. As the SEZD development lies adjoining the Say village, the population of the village is expected to vary due to mobilisation and demobilisation of the construction workers; unless separate accommodation camps are built within the SEZD area.

Table 6-25: Population of Identified localities in Duqm Wilayat

Locality Name	Population				Total	Number of Households			Number of Houses		Water Supply	Electricity	Phone Land Line	Hospitals	Schools	Farms
	Omani		Expatriate			Omani	Expatriate	Total	Occupied	Total						
	Male	Female	Male	Female												
Wilayat Duqm																
WADI SAY(DUQM TOWN)	558	533	4990	102	**6183**	146	123	**269**	287	**511**	×	✓	×	1	2	0
AS SADANAT	0	0	1123	1	**1124**	0	1	**1**	2	**13**	×	✓	×	0	0	0
AL HAWIYAH	0	0	498	2	**500**	0	0	**0**	1	**36**	×	✓	×	0	0	0
WADI DHANJART	5	5	0	0	**10**	1	0	**1**	1	**27**	×	✓	×	0	0	0
WADI QADIH	0	0	0	0	**0**	0	0	**0**	0	**0**	×	×	×	0	0	0
WADI AL KHABAN	0	0	0	0	**0**	0	0	**0**	0	**0**	×	×	×	0	0	0
WADI AD DISHAYSHAH	0	0	0	0	**0**	0	0	**0**	0	**3**	×	✓	×	0	0	0
WADI MUDRAB	0	0	0	0	**0**	0	0	**0**	0	**0**	×	×	×	0	0	0
WADI ASKLAT	0	0	0	0	**0**	0	0	**0**	0	**0**	×	×	×	0	0	0
ASH SHUAYR	0	0	0	0	**0**	0	0	**0**	0	**51**	×	✓	×	0	0	0
AL KHALAF	0	0	0	0	**0**	0	0	**0**	0	**35**	×	✓	×	0	0	0
QARN FUAD	0	0	0	0	**0**	0	0	**0**	0	**0**	×	×	×	0	0	0
AN NAAMIYAH	0	0	0	0	**0**	0	0	**0**	0	**0**	×	×	×	0	0	0
WADI QUTNAH	0	0	0	0	**0**	0	0	**0**	0	**0**	×	×	×	0	0	0
Total	**563**	**538**	**6611**	**105**	**7817**	**147**	**124**	**271**	**291**	**676**				**1**	**2**	**0**

Notes: 1- Most of the populations of the towns and villages located within the study area, are working in the companies within Duqm.
2- Census data might include Bedouin families who move between Wilayat in Sultanate according to the seasons.

Source: Socio economic 2010 Census data, National Center for Statistics and Information (2012)

6.18.3 Omani and Non-Omani Population

Table 6-25 (overleaf) shows that the expatriate population in Say village is approximately 10 times the size of the Omani population. Due to the upcoming economic development in SEZ it is expected that the number of expatriate working force will increase over time peak and then gradually decline.

Figure 6-72: Expatriates Working at the Fish landing Area *(Photograph taken on 3-Sep-2014)*

6.18.4 Gender Ratio

The gender ratio in the Omani population within the study area can be described as almost 1:1. However, the gender ratio among the non-Omani population of the study area cannot be defined because only males were counted which signifies immigration of male workforce without families.

6.18.5 Family Size

The family pattern in Duqm is typical for Oman. Average number of people in each household is 8, while average family size is 5. Few appear to marry before the age of 20 and multiple wives are rare.

6.18.6 Land Use

Animal husbandry is practiced by some of the local people in Say village. Produce from the animal husbandry is mostly for household consumption, though occasionally it may be used as a secondary source of income.

Although there are areas within the villages that supports grazing (natural vegetation in the form of shrubs and small trees), animal fodder is usually purchased from the local market and livestock are fed in temporary sheds (either in homes or *azbah*).

As per the 2010 census the number of houses in Say village has increased between 2003 and 2010. The majority of the settlements locate themselves after 7 to 9 km far from Project location.

There are several open areas and vacant lands scattered within Duqm Wilayat. These are either owned by the government sector, private companies, community or individuals. Open areas and vacant lands within settlements act as assembly grounds for elders or play playgrounds for children.

6.18.7 Future Economic Development in Duqm

The Government of Oman is developing the coastal area of Duqm into a fully integrated export centre, complete with supporting urban facilities for balanced national developments. This development began in 2001 with the Government of Oman selecting Duqm as the location for a new shipyard and port complex.

The Port of Duqm will be one of the major ports in Oman due to its strategic geographical location, situated midway between Muscat and Salalah, on the Arabian Sea. This makes it an attractive destination for commercial shipping and route between Asian, European and Middle Eastern ports. The project is a catalyst for development locally and regionally within the Al Wusta region. The port and shipyard is expected to enhance the Omani economy in terms of diversification and creation of job opportunities for Omani citizens.

Already operational within the port area is the world-scale ship repair yard operated and managed by Oman Dry-dock Company (ODC), enterprise owned by the Omani government. While ODC has operational control over dry-dock complex, PDC is responsible for providing navigational assistance. An aerial photograph of the Port of Duqm and Dry-dock complex is shown in Figure 6-73

Figure 6-73: Aerial Photographs of the Port of Duqm

Conceived as a multipurpose facility, Port of Duqm will cater to a wide range of cargoes and vessels. Envisioned in the master-plan are dedicated terminals for General Cargo, Containerized Cargo, Liquids and Petroleum Products, and Bulk Commodities. Construction of the marine substructure of a 2.2-km-long commercial quay has been completed.

There is a plan to add a further 10 km of commercial berths during Phase 2 of the port's development. Depending upon specific demand, these additional berths will be earmarked for general container, liquids and bulk cargo as the case may be.

In addition to the sea port, the area will be developed to include an industrial area, new town, fishing harbour, tourist zone, a logistics centre and an education and training zone, all of which are supported by a multimodal transport system that connects Duqm to other economic hubs.

The socio-economic setting in the study area is expected to go through a drastic change with the continued development of the study area.

6.18.8 Infrastructure in Study Area

Solid Waste Management

At presents, there is no engineered landfill operating in Duqm. Non-hazardous waste generated in Duqm is disposed at a dumpsite operated by the Duqm Municipality. The dump site is approximately 15 ha and about 12 km NW from the DLBB Project. The coordinates of the dump site are E-567291 and N-2188213. The dumpsite is accessible from Highway # 32 and is adjoining the Municipal STP. The dumpsite is almost full and in order to provide service into the future, an engineered non-hazardous landfill is being constructed in Duqm. SEZAD and be'ah have proposed an Integrated Waste Treatment, Storage and Disposal Facility in Duqm, which will include a new engineered NHW landfill. The integrated facility will be located in an area adjoining the existing dumpsite. The new

NHW landfill will be developed in phases with the first phase being 1 landfill cell, approximately 170 m × 490 m. The new NHW landfill will be ready in Dec-2016. Residents dispose solid waste in community garbage collection bins, provided by the Municipality. The frequency of garbage collection from the community bins is between 3 and 4 times a week.

At presents there is no infrastructure for the management of hazardous waste in Duqm and generators are expected to store hazardous waste onsite until a suitable facility becomes operational. SEZAD and be'ah have proposed an Integrated Waste Treatment, Storage and Disposal Facility in Duqm, which will include a new engineered HW landfill and storage area. The first phase of the engineered HW landfill is approximately 100 m × 100 m and is located close to the exiting dumpsite. The new HW landfill will be ready by 2016. Operation of this Integrated Waste Treatment, Storage and Disposal Facility in Duqm, will be by be'ah.

Despite having an operational waste management system litter was observed at a number of locations in and around the project. Figure 6-74 presents one such area.

Figure 6-74: Litter around the DLBB Project area *(Photograph on 3-Sep-2014)*

Wastewater Management

A new STP has been constructed in Duqm. The STP is located close to the existing landfill and has a capacity of 2,000 m^3/day. Additionally, two 5,000 m^3/d wastewater treatment facilities have been proposed by SEZAD. It should be noted, that the DLBB Project will use onsite STP for both the construction and operation phase of the DLBB Project.

Roads

Duqm is about 550 km from Muscat and almost equidistant from Salalah. Road access to Duqm is through:

- Muscat – Salalah Road via Hayima
- Muscat - Sinaw – Mahout
- Muscat - Sur– Mahout-Duqm

A high-standard arterial road network has been planned and is under implementation to link Duqm to all the major towns and cities within Oman as well connecting it with the United Arab Emirates and the Kingdom of Saudi Arabia.

Construction on two main roads within Duqm; the first is a 17 km primary dual-carriageway with three lanes in each direction, is complete. This road will connect the port, airport, and tourist areas with local residential and social amenities. The second is a 22.5 km, 4-lane road beltway around the city that will connect the residential areas within the city with the beach is also complete. In addition, another 37 km of roads are under construction in and around the port, dry dock, and government quay; these will connect the port with the airport, the city, and the main roads linking Duqm to other cities in Oman.

Power and Water

At present power is Duqm is generated by a temporary diesel power station at Jaluni with a total installed capacity of 67 MW. Power is generated at 11 kV and stepped up to 33 kV using three step-up transformers for transmission. Power is distributed throughout Duqm via an underground cable network. Seven substations have been built to serve the port, airport, city north, city south, light industry and the hotel complex areas. All the villages are connected with power supply network. However, not all villages have street lights on internal roads.

At present a reverse osmosis (RO) water desalination plant, with an initial daily capacity of 6,000 m^3, provides water in Duqm. Based on current levels of water consumption in Oman, this amount would be sufficient for a city with a population of 35,000. Further expansion of the RO plant along with the water distribution network is underway to meet the expected rise in demand. Two large reservoirs are nearing completion and a third is in the design stage

CUC intends to build, own and operate a “captive” Combined Cycle Power Plant and a Seawater Reverse Osmosis Desalination Plant to serve tenants in SEZD.

1. A greenfield combined cycle power plant of approximately 300 MW of gross power generation capacity based on N+1 configuration as a minimum.
2. A greenfield seawater reverse osmosis desalination plant of approximately 8 to 8.5 million imperial gallons per day of net water desalination capacity.

It is expected that most of the capacities will be commissioned by Q3-2018. It should be noted the DLBB Project will have a RO plant on the LBW to meet its operational water requirements.

Accommodation

The villages have varied type of housing units, depicting the economic and social status of each individual. The government provides Buyut Sahabiyah (social housing) for Omanis who need support from the government. The housing typology ranges from small traditional Omani house to a contemporary building with modern amenities. Expatriates typically rent houses or stay in hotels in Say village. Construction workers are housed in purpose built project related construction camps.

An area of 23 km^2 has been designated for the new frontier town at Duqm. This will be the backbone of the development area and initially will accommodate up to 67,000 people with further provisions to extend it to 111,000 residents. Duqm's new town will be a sustainable community, a model of contemporary urban planning with due consideration given to Omani culture and the local environment and the catalyst for the envisioned urbanisation and commercialisation of the Wusta region. Along with town mosques, a variety of indoor-outdoor sport facilities and a youth stadium are proposed in and around Duqm. The proposed town centre will boast a regional hospital, a business district, administrative offices, parks and a public library, as well as malls and other facilities. During the operation phase personnel working with the DLBB Project will be housed in the new frontier town.

Access to Market

The main market is located in Say village and provides shopping facilities for the local community. Other villages have small petty shops which cater to daily household requirements.

Health Facilities

There is a 12-bed local hospital in Say village (Refer Figure 6-75), with health centres at Heytam and Ra’s al Madrakah. The hospital is currently being expanded to include a dental clinic and the current national 5-year development plan has proposed a health care centre at Al Aja’iz. The hospital at Say village has two ambulances to attend to emergencies. During the *Khareef* season, to cater to increased accidents as a result of increased road traffic towards Salalah, an ambulance from Haima is redeployed to serve the area.

Figure 6-75: Signboard Pointing to MOH Hospital *(Photograph on 4-Sep-2014)*

Education Facilities

Say village has separate girls and boys Government Schools providing education to Grade XII. These schools are adequate to meet the educational needs of the Omani population. There are no education facilities for the expatriates living in the area.

Transportation

Most households have cars to fulfil their transportation needs. Local transport is also available in the form of a taxi service. Additionally, bus services to Muscat and Salalah are available. School buses ferry school children to and from school.

6.18.9 Stakeholder Consultation

Methodology

The development of the DLBB Project is a part of the Duqm Port development and the larger SEZD development of Duqm. As part of the DLBB Project there will be no relocation or displacement of the local population, however it is understood that access of locals to the DLBB Project area will be restricted as consequence of operations of the Duqm Port and hence the DLBB Project. Additionally the local community could be impacted as a result of influx of migrant labour and accidents. In order to assess the impact to the local community consultation was held with village heads and local government representative with regard to the DLBB Project. Stakeholder consultations were conducted in Duqm on 24-Mar-2015. Appendix 3 presents the Report prepared on the Socio-Economic Setting and Stakeholder Consultation.

Table 6-26 summarises the list of consulted stakeholders, completed questionnaires collected and interviews.

Table 6-26: Consulted Stakeholders, Completed Questionnaires Collected and Interviews

Stakeholders	Number of Completed Questionnaires	Questionnaire Code
COMMUNITY MEMBERS		
Duqm School for girls	2	(SG-1), (SG-2)
Duqm School for boys	9	(SB-1) to (SB-9)
Oman Women Society –Duqm participants	6	(OWS-1) to (OWS-6)
Wali office participants	11	(WO-1) to (WO-11)
Sub Total	28	
INSTITUTIONS		
Majlis Ash –Shura member of Duqm	1	Questionnaire- 1
Wali of Duqm -Deputy	1	Questionnaire- 2
Royal Oman Police (ROP) Duqm Wali office meeting	1	Questionnaire- 3.1

Stakeholders	Number of Completed Questionnaires	Questionnaire Code
ROP Duqm station	1	Questionnaire- 3.2
Duqm Municipality –Deputy Director	1	Questionnaire- 4.1
Duqm Municipality – Head of Administration and Finance	1	Questionnaire- 4.2
be'ah (Muscat)-Department Head of Environment and Sustainability	1	Questionnaire- 5*
Ministry of Manpower-Duqm, Wali office meeting	1	Questionnaire- 6
Directorate of Agriculture and Fisheries-Duqm, Wali Office Meeting	1	Questionnaire- 7
Sub Total	9	
CIVIL SOCIETY ASSOCIATION		
NGO -Oman Women Society- Duqm	1	Questionnaire- 8
Sub Total	1	
Grand Total	**38**	
Note: Consultation with be'ah was conducted through e-mail communication		

The total number of filled questionnaires and interviews is 38. Figure 6-76 presents photographs of the stakeholder consultation.

Figure 6-76: Photographs of Stakeholder Consultation

Socio-Economic Profile

The surveyed group consisted of 66 % participants of age between 26 to 35 years. 55 % of the whole group had university education. Family status shows 72% of married participants, 54 % of them lived in family of 1 to 5 members. 37 % of all participants lived in families with one employed member. 89 % of respondents depend on employment as a source of income. 85 % of all participants work in government sector.

Duqm Development and Project Perception of Participants

Of all participants, 70 % already recognize positive impact on their livelihood due to Duqm Port activities. 56 % of them think that their livelihood has been impacted by existing development. 85 % of participants perceive this change as a positive one. In relation to the DLBB Project, 52 % of all survey participants have already heard about the DLBB Project. 92 % of respondents expect the improvement in living after project completion. Better infrastructure, utilities, services, school and hospitals are expected by 89 % of all respondents. 61 % of them expect employment opportunities from DLBB Project.

Gender-wise Results for the Survey

The respondents group consisted of 71 % of men and 29 % of women.

Socio-Economic Profile (Female Participants)

The 61 % of women were between 26 to 30 years of age, 67 % of them were single and 75 % of them had primary school education. 57 % of women participants lived in average family of 6 to 10 members. In 50 % of families 3 members were employed while in 25 % of families 2 members were employed. The source of income was employment in 100 % responses and it was with government in 100 % of responses.

Duqm Development and Project Perception of Female Participants

85 % of all female participants recognize already positive impact on their livelihood due to Duqm Port activities. 71 % of them think that their livelihood has been impacted by existing development. 75 % of participants perceive this change as positive one. In relation to DLBB Project, half of the participants (50 %) have already heard about the DLBB Project. 100% of respondents expect the improvement in living after project completion. Better infrastructure, utilities, services, school and hospitals are expected by 100 % of all respondents. 70 % of them expect employment opportunities and 20 % of them contract opportunities from DLBB Project.

Socio-Economic Profile (Male Participants)

The 42 % of men were between 31 to 35 years of age and 21 % of 26 to 30 years of age, 84 % of them were married and 71 % of them had university and above education. 63 % of men participants lived in average family of 1 to 5 members. In 47 % of families, one member was employed while in 21 % of families two members were employed. The source of income was employment in 87 % responses and it was with government in 80 % of responses.

Duqm Development and Project Perception of Male Participants

63% of all male participants recognize already the positive impact on their livelihoods due to Duqm Port activities. 50% of them think that their livelihood has been impacted by exiting development. 89% of participants perceive this change as positive one. In relation to DLBB Project, 53% of the participants have already heard about the DLBB Project. 89% of respondents expect the improvement in living after project completion. 84% of all male respondents expect better infrastructure, utilities, services, school and hospitals. 56% of them expect employment opportunities and 22% of them contract from DLBB Project.

Consultation with Oman Women Society

Oman Women Society (Duqm), a Non-Governmental Organization (NGO), was included in the consultation process. The meeting took place in the NGO's office premises in Duqm. The discussion was constructive and various questions were posed. The participants were pleased with this consultation and the information received on the DLBB Project.

The NGO as a representative of civil society recognizes the positive impact of future developments on society, overall better future, and more jobs for local population, increased land prices and better contracts for local people / companies. The challenge will be to introduce better and appropriate education to young people of Duqm to match market requirements. However there were concerns in relation to local culture, customs and safety related to living and traffic in Duqm once the expat labour force moves in Duqm.

Overall findings of the consultation with this NGO match pretty well with response of community members who participated in the survey.

Consultation with Government Institutions

During constructive discussion in Wali office, many representatives of institutions as well as community members, raised questions about the storage tanks safety and firefighting measures, types of liquid and bulk materials to be handled, whether risk assessment was conducted for the DLBB Project, whether H_2S gas will be generated in this facility, environmental study of the projects, type of contractors to be mobilized for DLBB Project and employment opportunities, materials to be processed in refinery and how they will be transferred to vessels. Participants highlighted previous (smaller) projects when they were not consulted in advance but could have provided good advice. Overall response was positive and participants were pleased that these consultations were carried out to inform them about the upcoming project. A summary of the discussion with institutions are presented below:

- Institutions see the upcoming developments in Duqm as highly positive for overall economic and social development in Duqm
- They expect / require from companies coming to the SEZD to provide job opportunities for people of Duqm in the long term and more contracts to be awarded to Duqm companies. These requirements were imposed to authorities in Duqm already by local population.
- They expect / require more information about the upcoming developments, promotion of industry requirements in order to plan education curricula for young generation to match the local professional requirements. This should involve education authorities
- Participants expect development and upgrade of all city facilities, infrastructure, utilities and services
- The challenge of the development will be not to impact environmental quality and to protect the fish wealth and fish stock
- By law, SEZAD is going to take over all municipal competencies in Duqm. Municipality will help during hand over and will remain in charge for municipal area out of Duqm

- Fishing and animal growth has been impacted since construction of port started (last seven years). Fishery people are upset by frequent change of available location for fish landings on the coast
- It is expected that government will compensate for the loss of grazing land to the affected population and that vulnerable families will be supported
- The institutions are concerned about overall safety once the massive expat labour force moves in. To prepare for this, the ROP is going to move into new office. Safety wise, the ROP requires companies to organize induction programs for expats about living in the interior of Oman and about local culture and customs, and to prevent interference to local culture, etc.
- No complaints were recorded on environmental quality in Duqm
- Institutions have neither specific expectations nor potential conflicting issues from DLBB Project. Overall expectations and some recorded issues are related to the whole development in SEZD.
- The opinion about the overall development in Duqm is positive and the projects are very welcome, and
- be'ah did not express any expectations from this Project related to the waste management (industrial or communal) nor has identified any advantages / issues/challenges in this context that might result from the upcoming development.

6.19 Archaeological Facilities

A number of archaeological studies have been carried out in the proximity of the Duqm area. The first study was completed by Biagi in 1994. This study carried out a survey of coastal sites, as well as in the Huqf escarpment that is located around the Wilayat Duqm boundary. The latter contained flint sites containing hand axes from the Acheulian Period (Biagi, 1994). Biagi (1994) singled out the bay of Duqm as giving the best evidence of prehistoric occupation between Ra's Halat and Ra's al Aqit. This study was followed by unpublished field survey by Macumber (1997), resulting in northward expansion of the boundaries of the Arabian Oryx Sanctuary. In 2002, Whelan studied Lower Palaeolithic sites in the Huqf area (Whelan, 2004). Central Oman Palaeolithic Survey (COPS), which was organised by the Institute for Prehistory and Archaeological Science (IPAS) of the University of Basel (Switzerland) under the patronage of the Ministry of Heritage and Culture. It was sponsored by Petroleum Development Oman LLC and Bank Muscat SAOG, and subsidised by the University of Basel. The study was carried out during 2007 – 2008 in the Huqf-Al Haushi area of Oman recording over 1,400 archaeological sites. The survey area is delineated by the towns of Al Ghaba, Mahut and Hay in the north, Duqm and Al Ajaiz in the south of Oryx Station at Al Jaaluni.

The area around Duqm can be regarded as a kind of interface between the coast and the interior, and an integral part of the sector south of Djebel Khufai and adjacent heights. The survey was primarily conducted in the northern section of the "Duqm-Valley", i.e. the alluvial plain between the hills west of Al Duqm and the ridge of Ra's Duqm. Unfortunately, bulldozing in spring 2008 heavily destroyed a big site located opposite Ra's Duqm. However, the bay of Shuwayr has a rich archaeological legacy. More than forty burial mounds and at least six extensive shell midden sites, most of them extending over several hundred metres were observed along the sandy beach at a stretch of around nine kilometres. Ceramic artefacts were discovered in exceptional numbers that hint at Bronze Age settlements. In addition, unexpected numbers of diverse burial structures were uncovered. In total more than 170 prehistoric tombs were located. Along the eastern side of the Wadi at Duqm over a distance of more than three kilometres, 97 individual features were mapped. This high density of burial sites within a space of less than one square kilometre demonstrates the presence of human population in the late prehistory.

As the DLBB Project will be established on reclaimed/backfilled land within the existing port it is unlikely the DLBB Project will interact with any archaeological resources. However, should any archaeological resources be identified during the construction phase the same will be reported to SEZAD and the Ministry of Heritage and Culture.

7 IMPACT ASSESSMENT

7.1 Overview

This chapter presents impact assessment process for DLBB Project highlighting potential environmental, social, and ecological impacts. Potential impacts were identified through a systematic process whereby DLBB Project activities were considered with respect to their potential to interact with an environmental or social receptor. The likely impacts activities were identified considering the following:

- Scoping Environmental Impact Assessment;
- Project information;
- Baseline information and reconnaissance visits of the DLBB Project area;
- Applicable legislations;
- Standard international environmental management practices;
- WorleyParsons past experience in similar projects;
- Inputs from DPTC on the DLBB Project and its impacts.

Impact could result for planned and unplanned/accidental events. Planned impacts identified have been assessed qualitatively considering the area of influence of the impact, duration, intensity, and type of impact. While unplanned/accidental impacts are assessed considering the likelihood and severity of the impact.

The significance to planned and unplanned impacts have been assessed as “High”, “Medium” or “Low”, where impacts with significance as “High” have been considered as unacceptable, while impacts with significance as “Low” are considered to have reached “as low as reasonably practicable” or ALARP. Impacts with “Medium” significance need the use of mitigation measures presented in Chapter 8 to reduce their impact to ALARP.

7.2 Impact Assessment Methodology

Impacts have been assessed as planned and unplanned impacts. Planned environmental impacts are those which result from routine operation and maintenance, while unplanned are those which will result from accidents or non-routine operation and maintenance.

7.2.1 Planned Impacts

The evaluation of impact significance has been completed using following guidelines to identify the area of influence, duration, intensity (or magnitude) and type of impact.

Significance = Severity of Impact × Consequence

Impact severity is driven by a range of factors including the geographic extent of the impact and the duration of the impact. Consequence or intensity is driven by receptor vulnerability / sensitivity to any given impact and the ecological functional value of the receptor. Consequence can be measured in terms of percentage loss of a species' population, total area of habitat lost or damaged and restoration / regeneration times for ecological and human receptors, impacts on health and wellbeing and positive or negative effects on livelihood and living standards. Both severity and consequence will be denoted as ranging from low to high as illustrated in Table 7-1.

The impacts will be rated 'Low', 'Medium' or 'High' significance based on the area of influence, spread duration of the impacts. Further, mitigation measures will be proposed based on rated significance.

Table 7-1: Impact Assessment Matrix – Planned Impacts

Area

Duration	Regional Spread			Moderate Spread			Local Spread		
Long	H	H	H	H	H	M	H	M	M
Medium	H	H	M	H	M	M	M	M	L
Short	H	M	M	M	M	L	M	L	SS
	High	Moderate	Low	High	Moderate	Low	High	Moderate	Low

Intensity

Area of Influence

The area of influence refers to spatial or geographical extant of impact due to DLBB Project activities. For the DLBB Project, area of influence is classified as below:

- **Local Spread:** when an impact is restricted to immediate surroundings, i.e., within the DLBB Project boundaries;
- **Moderate Spread:** when the impact from the DLBB Project extends from the DLBB Project to about 10 km from the DLBB Project site; and
- **Regional Spread:** extends beyond a distance of 10 km from the DLBB Project site.

Duration

The duration of impact considers whether the impact would be short-term, medium-term or long term. Impacts were classified on their existence in the temporal scale as follows:

- **Short term (low duration)** when impacting for a duration of a few days to few weeks;
- **Medium term (medium duration)** when impacting for a few months to a year ; and
- **Long term (high duration)** extends beyond a year.

Intensity

Indicators of the intensity of an impact, whether it is insignificant, minor, moderate, or major, was based on the following criteria for impact intensity:

- **Low Intensity** – within statutory or prescribed criterion; Single complaint. No damaging toxic effects recorded only irritable and behavioural avoidance related effects by animals. Damage sufficient to produce a noticeable but short-lived effect on the environment or community; No permanent effects to the environment or the ecosystem services and resources it supplies. Change in ecosystem services, habitats and species which can be seen and measured but at a same scale as natural variability;
- **Moderate Intensity -** exceedance of statutory or prescribed limit and/or with possible toxicity effects over short term; causing localized nuisance both on and off site. Noticeable effects on the environment are recorded and reversible over the following medium duration; moderate degradation of ecosystem services, resources and habitats restricting potential for usage. Moderate decline in profit in local businesses and livelihoods as a result of the impact;
- **High Intensity -** Constant, high exceedance of statutory or prescribed environmental quality limits, and/or of a toxicity level representing a very severe and widespread threat to human health and the environment chronically and/ or acutely; and in terms of commercial impact and reputation, a major economic loss for the company due to the persistence and bioaccumulation of the pollutants causing the environmental impact. Such intensity is likely to cause an irreversible environmental effect, direct loss of ecosystem services, resources and protected habitats, and species mortality. Business livelihoods of communities will be lost.

Type of Impact

The type of impact refers to whether the effect is considered beneficial or adverse:

- **Beneficial impacts** would improve resource conditions.
- **Adverse impacts** would deplete or negatively alter resources.

7.2.2 Unplanned/accidental impacts

Unplanned impacts have been assessed considering the severity of the impact and likelihood of the impact. Table 7-2 presents the criteria used to judge the impact likelihood. Table 7-3 is the impact assessment matrix.

Table 7-2: Impact Likelihood

Likelihood	Definition
Very Unlikely	Never heard of in the industry
Unlikely	Heard of in the industry
Likely	May occur at the location
Very Likely	May occur several times a year at the location
Certain	Will occur several time a year at the location

Table 7-3: Impact Assessment Matrix (Unplanned)

Severity: Social & Health	Severity: Environmental	Likelihood: Very Unlikely	Unlikely	Likely	Very Likely	Certain
No Adverse Impact	No Adverse Impact	LOW	LOW	LOW	LOW	LOW
Negligible	Slight	LOW	LOW	LOW	MEDIUM	MEDIUM
Minor	Minor	LOW	MEDIUM	MEDIUM	MEDIUM	MEDIUM
Moderate	Localised	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM
Major	Major	MEDIUM	MEDIUM	HIGH	HIGH	HIGH
Massive	Massive	MEDIUM	HIGH	HIGH	HIGH	HIGH

7.3 Assessment of Impacts – Construction Phase

Table 7-4 presents overview environmental impacts as a result of construction of the DLBB Project.

Table 7-4: Potential Environmental Impacts – Construction Phase

Aspect	Soil Quality	Hydrology	Terrestrial Ecology	Air Quality	Noise	Marine Water Quality & Ecology	Socio-economical
Land take for construction and laydown	■	■	■				■
Earthwork	■	■		■	■		
Transport of workforce, material and equipment to and from the site				■	■		
Use of construction equipment including DGs, tug boats , dredging vessels etc.				■			
Integrity testing (including hydrotesting)						■	
Dredging & Reclamation				■	■	■	■
Offshore borrowing				■		■	■
Offshore disposal of dredged material				■		■	■

Aspect	Soil Quality	Hydrology	Terrestrial Ecology	Air Quality	Noise	Marine Water Quality & Ecology	Socio-economical
Waste management							
Employment of local workforce							
Employment of expatriate workers							
Lighting and noise of the construction sites							

It should be noted that the above table only provides a summary of impacts and the subsequent sections present detail on impacts related to each environmental elements such as soil quality, ground water, terrestrial ecology, air quality, noise, marine water quality and ecology and socio-economy.

7.3.1 Soil Quality – Construction

As discussed in Section 6.12, the soil in the study area is of poor quality and is unsuitable for agriculture. However, soil around the DLBB Project has ecological value and could be impacted as a result of land take, earthworks, and waste management.

Land Take

The term land take of the project relates to the area taken for the construction, operation or use of the project. The total permanent DLBB Project area including the portion reclaimed along the LBW is approximately 860,000 m^2 or 86 ha, which will be reclaimed land along the LBW. It should be noted that much of the DLBB Project land take is completed as part of the construction of the LBW. In addition to the long term land take, related to permanent structures, there could be some temporary land take for laydown or stockpiling equating to about 12 ha. Hence total temporary land take associated with the DLBB Project is expected to be about 100 ha, amongst which most of the land take will be from reclaimed land along the LBW.

Hence it may be concluded that the impact to soil quality as a result of land take has a *Local Spread*, *Long Term* and *Low Intensity* having an overall *Medium Impact*.

Table 7-5: Construction Phase – Impact to Soil Quality from Land take

Area of Influence	Duration	Intensity	Significance
Local Spread	Long Term	Low Intensity	Medium Impact

The above *Medium Impact* represents as low as reasonably practicable (ALARP), as the impact to soil quality as a result of land take for the DLBB Project is defined and cannot be reduced further. However, the impact to soil quality as a result of land take needs to be monitored and managed, to prevent creep of the beyond the demarcated boundaries and ensure restoration of areas affected by the land take. The details of mitigation and monitoring measures are presented in Chapter 8 Table 8-1.

Earthworks

Majority of the impact to soil quality as a result of earthworks will be at the quarry, operated by 3rd party contractors. To manage the potential impact from these activities DLBB Project will ensure that the same has been permitted or licensed by the relevant local government authorities and will define environmental norms that need to adopted. The impact to soil quality as a result of earthworks will be limited as the land take of the DLBB Project is limited and much of the earthworks will be on the area being reclaimed along the existing LBW and the exiting root/base of the LBW, with only about 12 ha used for temporary construction works. The impact to soil quality as a result of earthworks will have *Local Spread*, *Long Term* and *Low Intensity* resulting in an overall *Medium Impact*.

Table 7-6: Construction Phase – Impact to Soil Quality from Earthworks

Area of Influence	Duration	Intensity	Significance
Local Spread	Long Term	Low Intensity	Medium Impact

The above Medium Impact represents ALARP and will be managed as described in Chapter 8.

7.3.2 Hydrology – Construction

Wadis in the study area could be impacted by the earthworks, land take, and poor waste management practices.

Storm Runoff Water Quality

The major wadis in the vicinity of the DLBB Project are Wadi Jurf and Wadi Say. Runoff in these wadis is limited to that generated by local precipitation which may cause temporary ponding in depressions. Runoff contaminated by sediment from earthworks and waste material as a result of poor waste management practices could affect the quality of wadi water, during infrequent rain events. As the potential impact to wadi water quality is temporary or *Short Term*, of *Local Spread* and of *Low Intensity* the overall impact is *Slight Significance*. It should be also noted that these wadis and the overall drainage in the study area is expected to undergo drastic change as part of development of SEZD, which is external to the DLBB Project.

Table 7-7: Construction Phase – Impact to Wadi Water Quality from Storm Runoff Water Quality

Area of Influence	Duration	Intensity	Significance
Local Spread	Short Term	Low	Slight Significance

Although, the significance of the impact to wadi water quality as a result of earthworks and waste is Slight, though the implementation of good practices for waste and spoils management the likelihood of such events occurring can be further reduced. Section 8.2.5 presents management measures for spoils and waste.

Waste Management

HW and NHW will be generated by the DLBB Project during the construction phase. NHW will be initially disposed at the government dumpsite in Duqm. In Q4 2016, when the new engineered landfill becomes operational, NHW will be then disposed in the new landfill. be'ah's HW facility will become operational in Q4 2016, hence HW generated during the first year of construction will be stored onsite in a temporary HW storage area. All HW after commissioning of be'ah's HW facility generated by the DLBB Project will be transferred to the HW facility. As all waste generated by the DLBB Project will be managed as part of the licensed government waste management system (Refer Section 4.2.3, and 6.18.8). Further, temporary waste storage at the DLBB Project will be on backfilled made ground and at no time on the natural ground surface, hence the potential for impact on groundwater as a result of poor waste management practices is considered to be of *Low* significance.

Table 7-8: Construction Phase – Impact to Groundwater from Waste

Area of Influence	Duration	Intensity	Significance
Local Spread	Medium Term	Low Intensity	Low Impact

7.3.3 Terrestrial Ecology – Construction

The DLBB Project area is adjacent to an IBA and the flora and fauna and other natural elements contribute to the sustainability of the IBA. Land take for the DLBB Project, lighting and noise during the construction phase could impact the bird habitat and the birds. Further temporary land take during construction will result in a direct loss of habitat for the birds. As discussed in Section 7.3.1, the land take for the DLBB Project is limited, with majority of the DLBB Project being constructed on reclaimed land along the existing LBW (area of 86 ha), with about 12 ha developed in the IBA.

The total area of the bird habitat is 1,000 ha and the permanent and temporary land take represents about 0.1% of the total area. Further, it should be noted that the IBA has been demarcated by PDC and SEZAD for development as part of development of the Duqm Port and SEZD.

As a result of land take the area of influence is *Local*, the duration *Long Term*, and intensity will be *Moderate* as the area is categorised as IBA, which would equate to *Medium* significance.

Table 7-9: Construction Phase – Impact to Terrestrial Ecology from Land Take

Area of Influence	Duration	Intensity	Significance
Local Spread	Long Term	Moderate	Medium Impact

The impact to terrestrial ecology from land take will be managed as described in Section 8.2.5, Table 8-8. It should be noted that the cumulative impact as a result of construction and operation of associated facilities in the area is discussed in Section 7.5.

Lights and noise from the DLBB Project construction would disturb the birds and animals around the DLBB Project site. Construction at the site will typically be undertaken during the day with work occasional undertaken at night. It is expected that the light and noise would cause disorientation in among the fauna and result in avoidance behaviour i.e. the fauna move away from the source of light and noise and returning when light and noise disturbance is gone, however noise and light would be repetitive during the entire construction phase, hence the impact is considered to be *Medium Term*. The impact of noise and light from the DLBB Project will be restricted to the immediate surrounding, i.e., *Local Spread* and of *Moderate* intensity on account of the area being an IBA. The impact significance is *Medium*.

Table 7-10: Construction Phase – Impact to Terrestrial Ecology from Light and Noise

Area of Influence	Duration	Intensity	Significance
Local Spread	Medium Term	Moderate	Medium Impact

Mitigation measures to manage these impacts are specified in in Section 8.2.5, Table 8-4 and Table 8-8.

7.3.4 Air Quality – Construction Phase

The most significant sources of air emissions during the construction phase will be combustion emissions from the operation of tug boats, dredging vessels, earthmoving equipment, DGs, small and large vehicles etc. The emissions will consist of SO_2, NOx, CO_2, PM, and unburnt hydrocarbons. Additionally, fugitive air emissions (VOC) may also result from fuel handling and storage. The distribution of air emissions will be same as the distribution activities, which is mostly around the LBW. In the marine offshore areas there would be some emission along the routes to and at the offshore borrow area and disposal area. Additionally, emissions will also be released by vehicles along the route used for transporting material, it should however be noted that the movement of vehicles along the road will be intermittent.

The nearest receptors to the DLBB Project are the fish landing area located 4 km to the north of the LBW and Say Village located approximately 5.5 km to the South-West of the LBW. The regional wind pattern is dominated by the northeast (Nov-Jan) and southwest (April-Oct) monsoons with negligible wind activity from other directions. The winter northeast monsoon is characterized by wind speeds of 4m/s whereas the summer southwest monsoon is stronger with typical wind speeds of 7m/s. It is expected that as a result of a combination of distance of receptors from the LBW and wind velocity it is expected that the air emissions will disperse. However to account for the intermittent emissions from the vehicles moving along the route the area of influence is considered to be *Low* for a *Medium Term* (on and off during the construction period) and the intensity of the impact will be *Moderate*. Hence, the overall significance of the impact will be *Medium*.

Table 7-11: Construction Phase – Impact to Air Quality from Combustion Emissions

Area of Influence	Duration	Intensity	Significance
Moderate Spread	Medium Term	Low	Medium Impact

Mitigation measures to manage these impacts are specified in Section 8.2.5, Table 8-3.

Dust emission as a result of earthworks, material handling and stockpiling. The dust or PM will be the most in the area immediately around the soil storage and handling area i.e. the LBW. Any dust suspended will reduce as the distance to the handling/storage area increases. Hence, the area of influence is considered to be *Local*, for a *Short Term* (on and off during the earthworks and material handling) and the intensity of the impact will be *Low* intensity. Hence, the overall significance of the impact will be *Low*.

Table 7-12: Construction Phase – Impact to Air Quality from Dust

Area of Influence	Duration	Intensity	Significance
Local Spread	Short Term	Low	Low Impact

The impact due to dust can be further mitigated through the use of the measures specified in Section 8.2.5, Table 8-3.

7.3.5 Noise Impact

The noise impact from the DLBB Project can be categorised as noise from construction activities at the construction site and noise from the movement of DLBB Project related vehicles on public roads.

At the construction site there will be variety of noise sources at the site (Refer Table 4-4) among these the most significant source is that attributed to piling at the site. All noise sources at the site are temporary and the noise levels will increase and decrease as activities at the site vary. MD 80/94 regulates the noise level in working environment and states that, ear protection and shielding is to be used to manage excessive noise levels locally. Considering this requirement it is expected that noise attenuation measures will be necessary at the site during certain activities. MD 79/94 regulates noise level in public environment. The regulation defines a limit of 70 dB(A) for industrial, plants and public works industrial and commercial areas. Sound level falls as the distance from the source increases. The principle reason for this is the wave front spreading, for a point source the inverse square law applies and doubling the distance from a point source produces a reduction in sound level by 6 dB(A). Hence, a point source producing 70 dB(A) will reduce to less 40 dB(A) in about 35 meters. The nearest receptors to the DLBB Project are the 4 km away followed by Say Village which is approximately 5.5 km away. Baseline noise levels at Say Village along the road was measured to be about 56 dB(A). Hence, its unlikely noise from the construction site would significantly contribute to the current noise level at Say village. The noise from construction site is considered to have a *Local Spread* and *Medium term* spread over the entire construction period. The intensity of the impact will be *Low*. The overall, significance of the impact is expected to be *Low*.

Table 7-13: Impact to Ambient Noise from Construction Site

Area of Influence	Duration	Intensity	Significance
Local Spread	Medium	Low	Low Impact

The impact due to noise can be further mitigated through the use of the measures specified in Chapter 8 Table 8-4

7.3.6 Solid Waste Management

As discussed in Section 6.18.8, at present, waste management in the study area is basic and the same will be upgraded to an appropriate engineered facility in Q4 2016, which means that the NHW from the DLBB Project will be sent to the existing dumpsite for one year. At the same time HW will be stored onsite for the first one year, after which it will be transferred to the new landfill be'ah for treatment and disposal. As part of its mandate be'ah will also be responsible for restoring the existing dumpsite. Furthermore, the appropriate management of waste by the Project will be overseen by both SEZAD and PDC. As all waste generated by the DLBB Project will be managed as part of the licensed government waste management system, hence the potential to soil and groundwater for impact as a result of poor waste management practices is considered to be of *Low* significance.

Table 7-14: Construction Phase – Impact to Soil Quality from Waste Management

Area of Influence	Duration	Intensity	Significance
Local Spread	Medium Term	Low Intensity	Low Impact

The waste however in line with local regulatory requirements will need to be periodically monitored and tracked. The details of which are presented in Table 8-2 in Chapter 8.

7.3.7 Marine Ecology

During the construction phase the DLBB Project will interact with the marine environment in 3 distinct areas, which are in the port basin, offshore borrow area and offshore dredge disposal area (Refer Section 3.5.1). Construction activity will continue for a period of 2.5 years, which includes dredging, reclamation and disposal.

It should be noted that all the areas (i.e. the port basin, offshore disposal and offshore borrow) have been disturbed earlier during the previous construction of the port breakwater and berths. The marine ecological studies found no significant sensitive benthic habitat as part of this survey. The majority of the benthic habitat within the port was found to be unconsolidated sediments of fine sand with no epifauna or flora cover. Outside the port, the benthic habitat was homogenous unconsolidated sand with no epifauna or flora. The disposal area revealed evidence of past disposal with rock rubble visible with fine sand sediment. However, the area is sensitive on account of the cetaceans endemic to the region (Refer Section 6.17). It is expected that during the dredging, reclaiming and disposal activity the cetaceans will demonstrate avoidance behaviour and will return to the area once activity is complete.

Preliminary sediment plume modelling within the port basin shows that it is unlikely that the sediment plume, from dredging, will exceed 10 mg/l above the ambient at a distance of 500m from the dredging activity. Sediment plume for the offshore borrow and disposal areas are still under investigation. Additionally, the EPC Contractor will be required to undertake a sediment plume modelling exercise prior to outset of marine activities.

The area of influence of is expected to be *Moderate*. The activity is expected to be Medium Term as the marine related construction work is expected to be completed in 6 months and the intensity is considered to be *Short* Term and the intensity is considered to be *high* on account of the endemic cetaceans.

Table 7-15: Construction Phase – Impact to Marine Ecology

Area of Influence	Duration	Intensity	Significance
Moderate Spread	Medium Term	High	Medium Impact

It should be noted that during the construction phase additional mitigation measures and monitoring will need to be instituted in order to protect the endemic cetaceans and constantly identify potential of interaction between the cetaceans and construction related activity.

7.3.8 Marine Water Quality

During the construction phase the DLBB Project will interact with the marine environment in 3 distinct areas, which are in the port basin, offshore borrow area and offshore dredge disposal area (Refer Section 3.5.1). Construction activity will continue for a period of 2.5 years, which includes dredging, reclamation and disposal. The water quality showed the following characteristics:

- **Inside the Port:** Mean turbidity ranged from 2.3 to 9.1 Formazin Nephelometric Units (FNU). Turbidity was lowest in the deeper water of the shipping channel and increased nearshore with decreasing depth. Turbidity was highest towards the seabed at all sites.
- **Nearshore Area outside the Port:** Mean turbidity levels ranged from 1.3 to 3.1 FNU. Turbidity increased with depth at all sites and increased at depths near to the seabed. Sites closest to shore had higher surface and water column turbidity values than deeper offshore sites
- **Offshore Disposal Area:** Mean turbidity values ranged from 0.6 to 2.2 FNU. Throughout the water column turbidity values were comparable at below 1 FNU increasing from around 10 m depth to the sea bed.
- **Offshore Borrow Area:** Mean turbidity values were similar at all sites ranging from 0.1 to 0.3 FNU. Throughout the water column turbidity values were comparable at below 1 FNU increasing slightly from 15 m depth to the sea bed.

Preliminary sediment plume modelling within the port basin shows that it is unlikely that the sediment plume, from dredging, will exceed 10 mg/l above the ambient at a distance of 500m from the dredging activity. Sediment plume for the offshore borrow and disposal areas are still under investigation. Additionally, the EPC Contractor will be required to undertake a sediment plume modelling exercise prior to outset of marine activities.

The area of influence of is expected to be *Moderate*. The activity is expected to be Medium Term as the marine related construction work is expected to be completed in 6 months and the intensity is considered to be *Short* Term and the intensity is considered to be *high* on account of the endemic cetaceans.

Table 7-16: Construction Phase – Impact to Marine Water Quality

Area of Influence	Duration	Intensity	Significance
Moderate Spread	Medium Term	High	Medium Impact

7.3.9 Socio-economical

The consultation with stakeholder found that they see the upcoming developments in Duqm as highly positive for overall economic and social development in Duqm. The primary impact during the construction phases, to the socio-economy of the region and is through the influx of expatriate construction workers to the region. It is expected that at the construction phase will extend for a period of 2.5 years and at the peak will involve the employment of approximately 5,000 expatriate labourers. The labourers will be brought to the construction site through official means subject to the approval of the SEZAD, Ministry of Manpower and Ministry of Health. It should be noted that the socio-economy has experienced similar surges of expatriate labour in the past during the construction of the port, dry-dock and associated infrastructure. The expatriate labour will be housed in purpose built construction camps located in designate area separate and independent from the local population. Furthermore as discussed in Section 6.18.8, the existing and proposed infrastructure in the area is adequate to cater to the local population and the expatriate labour. The area of influence of the impact will be *Moderate Spread* as it is unlikely to spread beyond the Say Village and duration of the impact will be *Medium Term* for the entire construction period (i.e. 2.5 years) and the intensity of the impact will be considered to be *Moderate* as it will cease on completion of construction.

Table 7-17: Construction Phase – Impact to Socio-Economy

Area of Influence	Duration	Intensity	Significance
Moderate Spread	Medium Term	Moderate	Medium Impact

The socio-economic impact will be managed through the measures presented in Chapter 8 and Table 8-10.

7.3.10 Accidental Releases

Accidental releases during the construction phase could result from spills of chemicals/ fuel or hydrotest water to the environment. Spills of hydrotest water may result around the construction area, while fuel/chemical spillage may occur around the storage and handling area or during the transport of fuel by third party contractors to DLBB Project site.

Hydrotest Water

Hydrotesting of pipes, pipelines and vessels is performed to expose defective materials that have missed prior detection, ensure that any remaining defects are insignificant enough to allow operation at design pressures, expose possible leaks and serve as a final validation of the integrity of the constructed system. During the construction phase it is expected that about 85,000 m^3 of hydrotest water will be handled at site. At any time the amount of water that will be handled will be much less, with the quantity of water depending on the section of pipeline or container being tested. The hydrotest water will be reuse between containers or sections of pipeline. Hydrotest water may contain Chemical additives (corrosion inhibitors, oxygen scavengers, and dyes) may be added to the water to prevent internal corrosion or to identify leaks. To prevent sudden large discharge of hydrotest water gradual pressurisation will be done and if leaks are encountered the hydrotest will be stopped, the leaks will be fixed and the test will begin again. Thus, the potential of spills of large quantities of hydrotest water to the environment will be *Unlikely*. In the event of a large spill the hydrotest water will enter the marine environment and will mix with marine water and disperse. On account of the dilution and dispersion the impact to the marine environment is considered to be *Localised*. The overall impact as a result of hydrotest water is considered to be *Low*.

Table 7-18: Construction Phase – Hydrotest Water

Likelihood	Severity	Significance
Unlikely	Localised	Medium Impact

Measures to manage hydrotest water are specified in Chapter 8.

On-land Chemical/Fuel Spills

Chemical/Fuel spills could occur during transport, storage and handling of chemicals. Transport of chemical to the site will be by licensed third party contractors to ensure that only trained personnel are involved in the transport of chemicals. EPC Contractors will be required to comply with Oman's Traffic Regulations and packaging requirements. The use of licensed contractions will reduce the potential for spills during transport to *Unlikely*. Response to spills if any will be along with the local emergency response. As spills, if any, could occur at any point in the journey the environmental impact from the spills is classified as *Major* and the overall impact is classified as *Medium*.

Table 7-19: Construction Phase – Chemicals/Fuel

Likelihood	Severity	Significance
Unlikely	Major	Medium Impact

Chemicals/Fuel will be stored in dedicated bunded storage area, as required by the chemical Material Safety Data Sheets (MSDS) and MD 25/2009. Furthermore access to such storage areas will be restricted and only trained personnel will be allowed to handle chemicals/fuel. Should any spill occur, clean-up and emergency protocols will be initiated to contain the spill and clean any contamination that may occur. The use of skilled personnel and handling of chemicals/fuel in bunded area will result in the likelihood of the spills being *Unlikely*. As some chemical/fuel spills will not disperse immediately the impact as a result of spills will be *Major* on account of the sensitive nature of the habitat surrounding the DLBB Project.

Table 7-20: Construction Phase – Chemicals/Fuel

Likelihood	Severity	Significance
Unlikely	Major	Medium Impact

Marine Refuelling

During the construction phase there will be marine refuelling of the various barges and dredging vessels used. The refuelling is expected to be undertaken by the EPC Contractor in coordination with PDC. Refuelling will be undertaken within the harbour under the supervision of trained and experienced staff, trained to respond to emergencies if any. Furthermore, adequate spill response equipment will be made available to mitigate the impact of any spill. As the refuelling will be undertaken under the supervision of trained and experienced staff the will result in the likelihood of the spills being *Unlikely.* The impact as a result of spills will be *Major* on account of the sensitive nature of the marine habitat surrounding the DLBB Project.

Table 7-21: Construction Phase – Fuel

Likelihood	Severity	Significance
Unlikely	Major	Medium Impact

7.4 Assessment of Impacts – Operation Phase

Table 7-4 presents overview environmental impacts as a result of construction of the DLBB Project Terminal.

Table 7-22: Potential Environmental Impacts – Operation Phase

Aspect	Soil Quality	Hydrology	Terrestrial Ecology	Air Quality	Noise	Marine Water Quality & Ecology	Scio-economy
Land use by the DLBB Project							
Emission of VOCs and combustion emissions from flares							
Lights and Noise from operation of the DLBB Project							
Wastewater discharges							
Waste management							
Employment of local workforce							
Employment of expatriate workers							

It should be noted that the above table only provides a summary of impacts and the subsequent sections present detail on impacts related to each environmental elements such as soil quality, ground water, terrestrial ecology, air quality, noise, marine water quality and ecology and socio-economy.

7.4.1 Land Use

During the operation phase of the DLBB Project the total land use will be restricted to 86 ha. At this stage no additional land use is envisaged from the DLBB Project and material will be stored in designated storage area. The impact from the continued land footprint is considered as *Local*, *Long term* as it is permanent and of *low intensity*.

Table 7-23: Operation Phase – Impact from Land Use

Area of Influence	Duration	Intensity	Significance
Local Spread	Long term	Low	Medium Impact

The overall impact is rated as *Medium* and this impact is considered to be ALARP and mitigation will centre on ensuring that there is no additional unplanned land take.

7.4.2 Air Quality

Air emissions from the operation of the DLBB Project terminal are expected to be fugitive VOC, fugitive dust and combustion emissions. Fugitive VOC emissions will be from the storage tanks, flanges, pumps etc., while fugitive dust will result from handling and storage of Pet Coke and Sulphur Stockpiles. Combustion emissions will result from periodic operation of DGs/pumps and the emergency flare.

VOC Emission

VOCs will be emitted during the storage of various crude oil products at the facility. Emissions of VOCs may result from evaporative losses during storage (typically referred to as “breathing, storage, or flash losses”), from operational activities such as filling, withdrawal, and loading / unloading of transport links (referred to as “working losses”), and due to leaks from seals, flanges, and other types of equipment connections (known as “fugitive losses”). In order to minimise the VOC emissions from the Project, DPTC has adopted a number of BAT measures, which are listed in Table 5-3 (Section 5.5). The key measures adopted to reduce VOC emissions include:

1) Tank colour reflecting about 70 % of the light
2) Internal floating roof
3) Dedicated systems (products stored in dedicated tanks)

The closest receptors to the DLBB Project are the fish landing area located 4 km to the north of the LBW and Say village located approximately 5.5 km to the South-West of the LBW. The regional wind pattern is dominated by the northeast (Nov-Jan) and southwest (April-Oct) monsoons with negligible wind activity from other directions. The winter northeast monsoon is characterized by wind speeds of 4m/s whereas the summer southwest monsoon is stronger with typical wind speeds of 7m/s. It is expected that as a result of a combination of BAT measures, distance from the LBW and wind velocity it is expected that the air emissions will disperse. This however will need to be monitored all through the DLBB Project life. The area of influence is considered to be *Moderate*, the duration *Long Term* and the intensity is *Low*.

Table 7-24: Operation Phase – Impact from VOC Emissions

Area of Influence	Duration	Intensity	Significance
Moderate Spread	Long Term	Low	Medium Impact

Fugitive Dust

Fugitive dust will arise from the storage and handling of Pet Coke and Sulphur. To minimise dust emissions BAT measured as described in Section 5.5 Table 5-4 will be implemented, key among these are:

1) Covered storage
2) Wetting of the PET Coke and Sulphur stockpiles
3) Enclosed conveyors to load vessels

As discussed earlier closest receptors to the DLBB Project are the fish landing area located 4 km to the north of the LBW and Say Village located approximately 5.5 km to the South-West of the LBW. The regional wind pattern is dominated by the northeast (Nov-Jan) and southwest (April-Oct) monsoons with negligible wind activity from other directions. The winter northeast monsoon is characterized by wind speeds of 4 m/s whereas the summer southwest monsoon is stronger with typical wind speeds of 7 m/s.

It is expected that as a result of a combination of BAT measures, distance of the village from the LBW and wind velocity it is expected that the air emissions will disperse. This however will need to be monitored all through the DLBB Project life. The area of influence is considered to be *Local* as dust if any is unlikely to be carried over large distance, the duration *Long* Term and the intensity is *Low*.

Table 7-25: Operation Phase – Impact from Fugitive Dust

Area of Influence	Duration	Intensity	Significance
Local Spread	Long Term	Low	Medium Impact

Combustion Emissions

Combustion emissions may result from:

1) Use or testing of diesel powered emergency equipment such as pumps, generators etc
2) Use of heavy equipment (cranes, trucks etc) during maintenance
3) Flaring under emergency situations

During the operation phase there will be periodic testing of diesel powered emergency equipment such as pumps and generators. It is expected that onsite there will be 1 MW of Emergency Generators. The frequency of testing of these equipment will vary with the DGs being tested for 30 minutes per week.. Testing of the diesel power equipment will be associated with the emission of combustion emissions (NO_X, CO_2, SO_2 and particulates). Section 4.3.1 presents air emissions from operation.

The closest receptors to the DLBB Project are the fish landing area located 4 km to the north of the LBW and Say Village located approximately 5.5 km to the South-West of the LBW. The regional wind pattern is dominated by the northeast (Nov-Jan) and southwest (April-Oct) monsoons with negligible wind activity from other directions. The winter northeast monsoon is characterized by wind speeds of 4m/s whereas the summer southwest monsoon is stronger with typical wind speeds of 7m/s.

It is expected that as a result of only periodic emissions and combination distance from the LBW and wind velocity it is expected that the impact from Testing of the diesel power equipment is considered *Moderate Spread*, *Short Term*, and *Low intensity*, making the overall impact as *Low.*

Table 7-26: Operation Phase – Impact from Combustion (Testing Emergency Equipment)

Area of Influence	Duration	Intensity	Significance
Moderate Spread	Short Term	Low	Low Impact

During the operation there may be periodic maintenance activity requiring the use of heavy construction equipment. Use of heavy construction equipment will be associated with emission of combustion emissions (NO_X, CO_2, SO_2 and particulates). These activities are expected to be infrequent.

As the use of heavy equipment will not be regular and the receptors are located away from the LBW and the wind velocity and direction will promote dispersion of emission the impact from periodic maintenance is considered to be *Moderate* Spread, *Short* Term, and *Low* intensity, making the overall impact as *Low*.

Table 7-27: Operation Phase – Impact from Combustion (Heavy Equipment Maintenance)

Area of Influence	Duration	Intensity	Significance
Moderate Spread	Short Term	Low	Low Impact

The function of the flare system is to combust flammable, toxic or environmentally damaging substances into safer material. The flare system will be designed for emergency operations in accordance with API 537. The flare for the DLBB Project will be a refectory lined enclosed ground flare. Further the flare will be designed for smokeless operation. The operation of the flare will be intermittent and only during emergency condition, however the pilot flame will operate continuously.

As the use of the flare will not be regular and the receptors are located away from the LBW and the wind velocity and direction will promote dispersion of emission the impact from periodic maintenance is considered to be *Moderate* Spread, *Short* Term, and *Low* intensity, making the overall impact as *Low*.

Table 7-28: Operation Phase – Impact from Combustion (Heavy Equipment Maintenance)

Area of Influence	Duration	Intensity	Significance
Moderate Spread	Short Term	Low	Low Impact

7.4.3 Noise Impact

Noise will be controlled both for employees within the facilities and for the community outside of the site boundary. The best practicable means of noise control measure shall be followed at any location within the plant area to which personnel may have access, except for noisy equipment housings which are specifically designated as requiring ear protection devices to be worn. Individual equipment items (located outside without noise abatement) shall be designed with a maximum noise level of 85 dB(A) at 1.0 m during operation at full load. The noise exposure that an employee will receive, during one day's work at the site is dependent on the noise levels that the employee is exposed to and also the duration of exposure to each noise level. Plant areas are not generally manned continuously. Operators will normally circulate a variety of areas checking equipment and instrumentation, and their overall daily exposure will therefore be an accumulation of exposures in a variety of areas. Individual equipment shall be designed with a maximum noise level of 85 dB(A) at a 1 m distance during operational full load.

Based on equipment noise, noise levels within plant areas shall be estimated under operational full load and shall not exceed 85 dB(A). If area noise levels are estimated to exceed 85 dBA, the levels shall be controlled to below 85 dB(A) using elimination/modification, substitution and engineering controls. Employees' noise exposure shall also be controlled by demarcating "restricted" areas of the plant, that exceed 85 dB(A), as "Noise Hazard Areas". If employees enter these areas, they are required to wear hearing protection indicated by warning signs.

As noise within the facility will be restricted and managed the external noise from the facility will be high. The noise level at the DLBB Project fenceline will meet MD 79/94. Sound level falls as the distance from the source increases. The principle reason for this is the wave front spreading, for a point source the inverse square law applies and doubling the distance from a point source produces a reduction in sound level by 6 dB(A). Hence, a point source producing 70 dB(A) will reduce to less 40 dB(A) in about 35 meters. The nearest receptors to the DLBB Project are the 4 km away followed by Say Village which is approximately 5.5 km away. The Baseline noise level at Say Village along the road was measured to be about 56 dB(A). Hence, its unlikely noise from the construction site would contribute to the noise at say village. The noise from construction site is considered to have a *Local Spread* and *Long term* spread over the entire operation period. The intensity of the impact will be *Low*. The overall, significance of the impact is expected to be *Medium.*

Table 7-29: Operation Phase – Noise Impact

Area of Influence	Duration	Intensity	Significance
Local Spread	Long Term	Low	Medium

7.4.4 Solid Waste Management

SEZAD and be'ah have proposed an Integrated Waste Treatment, Storage and Disposal Facility in Duqm, which will include a new engineered NHW landfill and HW landfill. The integrated facility will be located in an area adjoining the existing dumpsite and will be ready in December 2016. Hence all the waste generated by the DLBB Project during the operation phase will be diverted to this facility. As all waste generated by the DLBB Project will be managed as part of the licensed government waste management system, hence the potential to soil and groundwater for impact as a result of poor waste management practices is considered to be of *Low* significance

Table 7-30: Operation Phase – Impact to Soil Quality from Waste Management

Area of Influence	Duration	Intensity	Significance
Local Spread	Long Term	Low Intensity	Medium

The waste however in line with local regulatory requirements will need to be periodically monitored and tracked. The details of which are presented in Table 8-2 in Chapter 8.

7.4.5 Terrestrial Ecology

The DLBB Project area is adjacent to an IBA and the flora and fauna and other natural elements contribute to the sustainability of the IBA. Lights and noise from the DLBB Project operation would disturb the birds and animals around the DLBB Project site. It is expected that the light and noise would cause disorientation in among the fauna and result in avoidance behaviour i.e. the fauna move away from the source of light and noise and returning when light and noise disturbance is gone. The impact is considered to be *Long* Term. The impact of noise and light from the DLBB Project will be restricted to the immediate surrounding, i.e., *Local* Spread and of *Moderate* intensity on account of the area being an IBA. The impact significance is *Medium*.

Table 7-31: Operation Phase – Impact to Terrestrial Ecology from Light and Noise

Area of Influence	Duration	Intensity	Significance
Local Spread	Long Term	Moderate	Medium Impact

7.4.6 Marine Ecology

The marine ecology surrounding the Duqm port is sensitive (Refer Section6.17). During the operation phase the interaction of the DLBB Project with the environment will be in the form of discharges to the marine environment. Refer Section 4.3.2 for wastewater discharges during operation.

Discharges to the marine environment are expected to meet quality requirements specified in MD 159/2005. Excluding the brine discharge from the proposed RO plant, all other discharges will be intermittent in nature and for a limited period. On the whole the impact to marine ecology is considered to be of *Local* Spread, *Long* term and of *Low* intensity making the overall impact as *Medium*. Cumulative impact to ecology is discussed in Section 7.5.

Table 7-32: Operation Phase – Impact to Marine Ecology

Area of Influence	Duration	Intensity	Significance
Local Spread	Long Term	Low Intensity	Medium Impact

7.4.7 Marine Water Quality

During the operation phase the interaction of the DLBB Project with the environment will be in the form of discharges to the marine environment. Refer Section 4.3.2 for wastewater discharges during operation.

Discharges to the marine environment are expected to meet quality requirements specified in MD 159/2005. Excluding the brine discharge from the proposed RO plant, all other discharges will be intermittent in nature and for a limited period. On the whole the impact to marine ecology is considered to be of *Local* Spread, *Long* term and of *Low* intensity making the overall impact as *Medium*.

Table 7-33: Operation Phase – Impact to Marine Water Quality

Area of Influence	Duration	Intensity	Significance
Local Spread	Short Term	Low Intensity	Medium Impact

7.4.8 Socio-economic

The consultation with stakeholder found that they see the upcoming developments in Duqm as highly positive for overall economic and social development in Duqm. During the operation phase the DLBB Project will employ 60 personnel. In line with the DPTC's commitment to Omanisation, the company will encourage the training and recruitment of Omani's, which will be in excess of the mandatory requirement by Omani Law. Facility personnel will live within residential areas within SEZD, which will be self-sustaining. Thus no negative impact is expected from the DPTC personnel living and working within Duqm. On the whole the DLBB Project will have a positive impact to the economy of Oman.

7.4.9 Accidental/Unplanned Impacts

Leaks from Tanks

The tanks constructed as part of the DLBB Project will be contained within bunded areas of adequate capacity. The tanks have been designed considering the BAT requirements and will be subjected periodic maintenance regime designed to identify leaks. Furthermore, the tanks will be subjected to hydro testing prior to use to allow identification of construction defects and leaks. Hence the potential for leaks resulting in soil/groundwater/ marine pollution is deemed *Unlikely*. The impact resulting from any spill is expected to be *Major* on account of the sensitive nature of the sensitive nature of the surrounding ecology.

Table 7-34: Operation Phase – Leaks from Tanks

Likelihood	Severity	Significance
Unlikely	Major	Medium Impact

Spills of Pet Coke and Sulphur

Handling of Pet Coke and Sulphur could result in spills on the terminal or into the marine environment. Spills on the terminal will be cleaned immediately and recovered product returned to the respective Pet Coke and Sulphur piles and hence will not have any impact on the environment. Spills during the course of loading vessels may result in product falling into the water and sinking to the sea bed, being insoluble in water both Pet Coke and Sulphur will lie at the sea bed. To minimise the spills while loading vessels covered conveyors will be used. All products that falls into the harbour will be lost and removed during maintenance dredging of the port. The use of covered conveyors makes the impact from spills as *Unlikely*. The impact from spills of Pet Coke and Sulphur to the marine environment is considered to be *Minor* as they are insoluble in water and the port area will be dredged during construction.

Table 7-35: Operation Phase – Leaks from Tanks

Likelihood	Severity	Significance
Unlikely	Minor	Medium Impact

Oil Spill

Spill containment strategy for the DLBB Project states that:

- Tier 1 spills - response by DPTC and PDC
- Tier 2 spills – response by PDC
- Tier 3 spills – response by PDC and national agencies

In line with this strategy DPTC is undertaking Oil Spill modelling for Tier 1 spills. At the time of preparing this report the modelling for oil spills was unavailable and hence the assessment could not be completed. The results of the oil spill modelling will be submitted to the regulator when the same has been completed.

7.5 Impact from Associated Development

As discussed in Section 1.2, the DLBB Project lies within the Port of Duqm which in turn lies within SEZD. The SEZD development has a land area of 1,745 km^2 and 80 km of coastline along the Arabian Sea, the SEZD is the largest in the Middle East and North Africa region and ranks among the largest in the world. Hence the environment setting in Duqm is expected to undergo a major change as part of the ongoing development. The DLBB Project is a part of the ongoing development at Duqm; however DPTC itself will not be able to direct the type or scale of development, which in turn will be directed by Government of Oman Policy, SEZAD, and the PDC (port matters and navigation in the Gulf of Masirah). DPTC as a responsible corporate citizen will work to highlight environmental issues to the respective authorities (i.e., SEZAD and PDC). It should be noted that the impacts from associated developments have not been assessed and this section only serves to the highlight potential impacts.

7.5.1 Hydrology

Construction of the SEZD will involve completely changing the hydrology of the SEZAD in addition to reclaiming large areas there will be training and diverting of wadis and construction of Road No. 5 as an embankment. Additionally, to protect SEZD and the port of Duqm a dam will be constructed to hold flood water and gradually release the same. Furthermore the ongoing development will interrupt subsurface groundwater flows. Changes to flooding pattern and interruption to groundwater flow in the study area will impact the *sabkha* and IBA surrounding the port area, leading to the gradual drying of the *sabkha* area.

7.5.2 Land Take

The SEZD development has a land area of 1,745 km^2 and 80 km of coastline (Ref Figure 1-2). The Port of Duqm is a major development within SEZD. The development of the port and SEZD includes the backfilling of the *sabkha* area and hence will result in complete the loss of the IBA. As all the birds visiting Duqm are migratory it is expected that after backfilling of the IBA the bird will fly to other bird sites such as Bar Al Hikman about 100 km to the north and Khawr Ghawi about 120 km further south.

7.5.3 Air Quality

The development of the SEZD will result in establishment of industries and increased road and sea traffic. All these developments will contribute to the air emissions in the area. At present the air quality in the area is representative of rural setting and with the continued development in SEZD it is expected that the air quality will gradually change to be representative of an urban industrial setting.

7.5.4 Movement of Ships

Development of SEZD and Duqm Port will result in increased shipping activity in the area. As per the Royal Haskoning 2013 Master Plan, the traffic visiting the Port of Duqm excluding the LBW is expected to increase gradually, starting with 650 vessels in 2015 and increasing to 2800 by 2040.

It is expected that about 800 vessels will visit the DLBB Project every year. Vessels visiting the DLBB Project will represent a portion of the total vessel in Duqm. The vessels operating will be associated with MARPOL waste and air emissions. MARPOL waste will be managed by PDC as described in Section 3.6.7. Vessels visiting the port will need to comply with MARPOL Annex VI regulations which specify emissions limits for vessels and SEZAD will be responsible to take action against any non-complaint vessels. The movement of large number vessels in the area will also pose a threat to the Cetaceans in the area especially the endemic Arabian Sea Humpback Whale. It is understood that PDC is undertaking studies to gather information on the whales and will develop a management strategy based on the information. This management strategy will also cover the vessels visiting DLBB Project terminal.

7.5.5 Maintenance Dredging

Sedimentation and siltation are natural phenomena and with time sediment will built up in the port. To ensure that the port remains accessible and safe for navigation, periodic maintenance dredging will need to be undertaken. PDC as the port authority will be responsible for maintenance dredging in the Port of Duqm, which includes the area along the DLBB Project. It is expected that PDC will develop the requisite management plans for the necessary maintenance dredging.

8 ENVIRONMENTAL MANAGEMENT PLAN

DPTC is committed to ensure compliance to all its commitments towards Environment, Social, Health and Safety Standards. This Environmental Management Plan (EMP) details a framework of general preventive, mitigation and enhancement measures that are to be put in place by DPTC to manage the likely environmental and social impacts of the construction and operation of the DLBB Project.

The mitigation measures are designed to ensure that negative impacts are reduced to ALARP, and meet relevant Omani national laws and regulations, and internationally acceptable standards. This chapter details the purpose and scope of this EMP, the process adopted and its organisation, the mitigation measures for each phase and the scope of the supporting monitoring and management plans. EPC Contractors are responsible for the preparation of detailed site specific management plans, prior to outset of any activities. All plans shall be approved by DPTC.

8.1 Purpose and Scope

The management of health, safety, security and environmental as well as social issues is an integral part of the overall management of the DLBB Project. Through the implementation of this EMP, DPTC aims to mitigate adverse health, safety, environmental and social impacts. At the same time the intent is to create benefits for the workers, local communities and other project stakeholders

It is expected that all the significant impacts should be minimized to minor and negligible levels as a result of implementation of the Project's EMP. Any minor and negligible residual impacts shall be subject to continuous monitoring and audit. Each phase of the DLBB Project shall also have plans specific to the significant impacts. The EMP includes mitigation, management and monitoring measures during DLBB Project construction, design, commissioning, operation and decommissioning phases. The measures represent the intended means for DPTC to eliminate, offset or reduce negative impacts to ALARP.

In addition to this EMP, site specific management plans shall be prepared to guide the management and monitoring of activities that could potentially result in severe environmental impacts, which are listed below:

- **Dredging Management Plan** – detailed plan describing the dredging along the breakwater, reuse of material and offsite disposal. The plan shall describe the monitoring and management measures related to dredging
- **Chemical Management Plan** – detailed plan to describe the handling and storage of chemicals. EPC Contractors would be required to develop such specific plans to manage the chemicals stored and handled by them.
- **Waste Management Plan** – detailed waste management plan to guide the site specific handling, storage and disposal requirements for waste.
- **Decommissioning and Site Restoration Plan** – to manage the decommissioning of temporary structures during the construction and operation phase of the DLBB Project and the restoration of the land associated with temporary development.

- **Environmental Audit and Monitoring Plan** – this shall define and guide environmental monitoring during the construction and operation phase.
- **Emergency Management Plan** – This shall define actions and responsibilities during emergencies.

DPTC shall be responsible for revision, update and implementation of the EMP through its EPC Contractors. This is necessary for continuous enhancement of DPTC's environmental and social performance.

8.2 Construction Phase

8.2.1 Overview

The construction phase of the DLBB Project shall involve DPTC, Project Management Consultant (PMC) and the EPC Contractors and subcontractors. This section serves to define the framework environmental management plan for activities undertaken at site. It should be noted that DPTC as the DLBB Project proponent is responsible to ensure that all Contractors effectively implement environmental management plans and comply with all permits, regulations and standards.

8.2.2 Organisation and Responsibilities

The overall management and coordination of the DLBB Project shall be managed through DPTC Project Director who shall be supported by the Project Manager and the PMC. The EPC Contractors shall be contractually bound and responsible to establish a site HSE department to ensure effective implementation of the EMP, and to review the environmental management process. The primary reason for making the EMP a contractual requirement is to ensure that the EPC Contractors are fully aware of his environmental responsibilities and to ensure his commitment to achieving the specified standards. The EPC Contractors' Project Managers shall act as the point of contact for all site related HSE matters.

As DLBB Project proponent, DPTC is responsible for the overall Project and shall ensure implementation an effective Health, Safety, and Environmental Management System (HSEMS) for the DLBB Project construction phase. The HSEMS shall comply with the control measures and environmental management requirements outlined in this EMP and any additional conditions provided by the regulator. The EPC Contractor shall be responsible for developing and implementing the HSEMS and ensuring that their subcontractors also abide by. The HSEMS shall work to implement this EMP and the HSEMS Manual shall include:

- Appropriate background information on the construction of the Project with reference to relevant technical reports
- Organisational arrangements, hierarchy and responsibilities with regard to the management of environmental performance during the construction phase. The HSE team, the EPC Contractor(s) team and the DPTC's representatives, included
- A broad construction programme indicating those activities for which specific mitigation is required and providing a schedule for their timely implementation;

- Descriptions of the parameters to be monitored and criteria through which performance shall be assessed including: monitoring frequency and methodology, monitoring locations (typically, the location of sensitive receivers as listed in the EIA), monitoring equipment lists, event contingency plans for exceedances of established criteria and schedule of mitigation and best practice methods for reduced adverse environmental impacts;
- Procedures for undertaking on-site environmental performance audits as a means of ensuring compliance with environmental criteria; and
- Reporting procedures

The HSEMS shall be a live document and shall undergo a series of revisions, as needed, to accommodate the progression of the construction programme.

The HSE Manager of EPC Contractor shall be responsible for day-to-day HSE management onsite. The HSE Manager shall maintain constant interactions with line managers and other staff throughout the construction period. The EPC Contractors shall assist in periodic audits and monitoring to ensure effective implementation of control and mitigation measures and implementation of corrective actions for any deviations. DPTC's corporate HSE team may also interact with the third party auditors on an as needed basis if deemed necessary

8.2.3 Site Security and Safety

The DLBB Project Site shall be fenced on all sides and access to the site shall be through gates, which shall be manned 7 days a week, 24 hours a day. The HSE Manager or persons designated by him shall conduct periodic walkthrough inspections and shall identify any emergency situations, spills, housekeeping and other environmental and safety related issues. Every person at site, including visitors, shall be encouraged to report any unsafe conditions to the HSE manager for corrective action. All personnel shall have access to requisite PPE and the HSE manager shall ensure use of PPE while onsite.

The access to site shall be restricted to employees, authorized sub-contractors and visitors. All workers at the site shall be provided with identity badges, as mark of authorization to work on the site. The DLBB Project in coordination with the ROP and Coast Guard shall carry out regular patrols and inspections to ensure security at the site. The visitors' access to the site shall be controlled through gate passes.

Additionally, a notice shall be placed at the main entrances to DLBB Project site and at select points along the LBW providing the following:

- Name of Project
- Start Date and Expected Date of Completion
- Names of EPC Contractors
- Responsible Personnel
- Emergency Contact Numbers

8.2.4 Permits

DPTC shall ensure that EPC Contractors have the necessary permits before they start work. The EPC Contractors are responsible to obtain the necessary permits. The HSE Manager of the EPC Contractors is responsible for obtaining required approvals and permits, coordinating with the regulatory agencies, and ensuring that all activities are undertaken in line with permit conditions. DPTC shall ensure that all requisite permits are obtained by the EPC Contractor prior to their undertaking the activity. The following list is an indicative list of environmental permits that are to be obtained during the construction phase:

- Preliminary Environmental Permit
- Chemicals Permit
- Permit for Discharge/Reuse of Treated Effluent
- Permit for use of air emissions sources
- Permits for temporary storage of hazardous waste
- Approval for Disposal of Hydrotest Water
- Dredging Permit

It must be noted that during the course of the construction phase some of the above permits may be considered to be not required or permits additional to the above list may be required. The HSE Manager of the EPC Contractor shall understand such requirements through regular communications with the environmental authorities.

8.2.5 Construction Phase Mitigation Measures

The EIA study has concluded that there would be no significant impact from the DLBB Project provided the mitigation measures detailed in the subsequent sections are implemented to manage impacts on the environmental aspects.

Soil Quality

The DLBB Project has been defined to minimise the land take. The land take directly attributed to the DLBB Project is limited to the LBW and root of the LBW. Loss of soil quality as a result of land take though small shall be permanent in nature. Additionally, earthworks shall be associated with the DLBB Project and all material borrowed or disposed shall be as per permits granted from respective authorities. The primary responsibility of addressing the impact lies with the respective EPC Contractors with DPTC overseeing the same.

Table 8-1: Construction Phase Mitigation Measures – Soil Quality

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
LUC1	The land take of the DLBB Project is to be limited and restricted	EPC Contractor	Construction Site all areas

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
LUC2	Material and equipment is to be stored in designated storage areas	EPC Contractor	Construction Site all areas
LUC3	The DLBB Project site and laydown area is to be fenced to prevent creep outside the fenceline	EPC Contractor	Construction Site all areas
LUC4	Temporary land take for construction is to restored after removal of temporary work	EPC Contractor	Construction Site all areas
LUC5	Focus on optimising land required for temporary works	EPC Contractor	Construction Site all areas
LUC6	Ensure EPC Contractors or suppliers have necessary permits and licenses	EPC Contractor	Construction Site all area
LUC7	Ensure borrow of fill material and disposal of excess material is only undertaken in designated areas are permitted by the respective authority	EPC Contractor	Construction Site all area

Hydrology

Hydrology in the study area could be impacted by contaminated storm water runoff, obstruction to wadi flow, and poor waste management practices. Strom water runoff could be contaminated by sediment or by spills at the site or poor waste management practises, while wadis could be obstructed by poor land management practices. Furthermore, Wadi Say and Wadi Jurf flow to the north of the LBW. Table 8-2 presents measures to mitigate impact to hydrology in the study area.

Table 8-2: Construction Phase Mitigation Measures – Hydrology

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
HC1	Spill control and management to be implemented	EPC Contractor	Construction Site all areas
HC2	Staff should be trained to respond to spills and contain the same	EPC Contractor	Construction Site all areas
HC3	Secondary containment as per good engineering practices shall be implemented.	EPC Contractor	Construction Site all areas
HC4	Road Tankers transporting diesel to construction facilities shall use temporary secondary containment equipment when offloading diesel, with standby diesel oil spill response and clean-up capability	EPC Contractor	Construction Site all areas
HC5	The earthwork in the DLBB Project area is to be untaken taking into account the hydrology in the area	EPC Contractor	Construction Site all areas

Air Quality

The dominant emissions during the construction phase are SO_2, NO_X, CO_2, carbon monoxide, PM, and unburnt hydrocarbons. Additionally, fugitive air emissions (VOC) may also result from fuel handling and storage. Dust could arise during earthworks and material handling. The closest receptors to air emissions from the DLBB Project is the fish landing area located 4 km to the north of the LBW and Say Village located approximately 5.5 km to the South-West of the LBW. The regional wind pattern is dominated by the northeast (Nov-Jan) and southwest (April-Oct) monsoons with negligible wind activity from other directions. Table 8-3 specifies the requirements during the construction phase.

Table 8-3: Construction Phase Mitigation Measures – Air Quality

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
AQC1	Good site practices such as regular maintenance and checking of the diesel powered mechanical equipment shall be adopted to avoid any black smoke emissions and to minimize gaseous emissions.	EPC Contractor	Construction Site all areas
AQC2	Malfunctioning and breakdown of the process or air pollution control equipment which would cause exceedance of the emission limits or breaches of other air pollution control requirements should be document and reported to DPTC	EPC Contractor	Construction Site all areas
AQC3	The loading, unloading, handling, transfer or storage of other raw materials which may generate airborne dust emissions such as crushed rock, sand, stone aggregate, shall be carried out in such a manner to prevent or minimize dust emissions. Measures such as water spraying and enclosing (with tarpaulin sheets or permanent structures) are to be adopted to minimise dust	EPC Contractor	Construction Site all areas
AQC4	Cement or other equally dusty materials shall be stored in storage silo fitted with audible high level alarms to warn of over-filling. The high-level alarm indicators shall be interlocked with the material filling line such that in the event of the silo approaching an overfilling condition, an audible alarm shall operate, and after 1 minute or less the material filling line shall be closed.	EPC Contractor	Concrete Batching Plant
AQC5	Vents of all silos shall be fitted with fabric filtering system to meet the emission limit	EPC Contractor	Concrete Batching Plant
AQC6	Vents of all silos shall be fitted with fabric filtering system	EPC Contractor	Concrete Batching Plant
AQC7	Seating of pressure relief valves of all silos shall be checked, and the valves re-seated if necessary, before each delivery	EPC Contractor	Concrete Batching Plant
AQC8	Vehicles shall be periodically washed to reduce dust	EPC Contractor	Construction Site all areas
AQC9	A high standard of housekeeping shall be maintained. All spillages or deposits of materials on ground, support structures or roofs shall be cleaned up promptly by a cleaning method acceptable to the Authority. Any dumping of materials at open area shall be prohibited.	EPC Contractor	Construction Site all areas

Noise

At the construction site there will be variety of noise sources at the site (Refer Table 4-7, pg. 123) among these the most significant source is that attributed to piling at the site. All noise sources at the site are temporary and the noise levels will increase and decrease as activities at the site vary. The nearest receptors to the DLBB Project are the 4 km away followed by Say Village which is approximately 5.5 km away. The baseline noise levels at Say Village along the road was measured to be about 56 dB(A). The noise generated at site will in line with MD 79/94 and MD 80/94. Table 8-4 presents the mitigation measures to manage construction phase noise.

Table 8-4: Construction Phase Mitigation Measures – Noise

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
NC1	Compliance with requirements of MD 79/94 and MD80/94	EPC Contractor/ DPTC	Construction Site all areas
NC2	High noise activity should be scheduled for the day time	EPC Contractor	Construction Site all areas
NC3	Shielding of equipment and use of enclosures to reduce to noise	EPC Contractor	Construction Site all areas
NC4	Regular maintenance of equipment to protect from noise	EPC Contractor	Construction Site all areas
NC5	PPE shall be provided to workers in high noise areas as per MD 80/94	EPC Contractor	Construction Site all areas

Waste

Currently, waste management in the study area is basic; however, the facilities are presently being upgraded and are expected to be operational in Q4-2016, i.e., in the first year of DLBB Project construction. Waste management practices throughout the construction phase will be in line with government regulations and guidelines. Table 8-5 presents mitigation measures for the same.

Table 8-5: Construction Phase Mitigation Measures – Waste

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
WC1	Waste shall be managed in accordance with MD 17/93, MD 18/93, and PDC Port Regulations	EPC Contractor/ DPTC	Construction Site all areas
WC2	Develop and implement a Waste Management Plan which specifies procedures such as a manifest system, to facilitate tracking of loads and protocols for the maintenance of records of the quantities of wastes generated, recycled and disposed.	EPC Contractor	Construction Site all areas
WC3	The EPC Contractor shall apply for and obtain the appropriate permits/licenses for the disposal of waste, storage/disposal of hazardous waste and effluent discharges.	EPC Contractor	Construction Site all areas
WC4	No waste shall be burnt on site. Wastes shall be collected by licensed waste haulier and be disposed of at licence sites.	EPC Contractor	Construction Site all areas
WC5	Excavated material shall be reused to the extent practical.	EPC Contractor	Construction Site all areas
WC6	The site and surroundings shall be kept tidy and litter free. Waste storage area shall be properly cleaned and shall not cause windblown litter and dust nuisance.	EPC Contractor	Construction Site all areas
WC7	Storage of material on site should be kept to a minimum. Construction materials shall be planed and stocked carefully to reduce amount of	EPC Contractor	Construction

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
	waste generated and avoid unnecessary generation of waste.		Site all areas
WC8	Suitable hazardous waste storage areas should be formed at the works site for temporary storage pending collection. Hazardous wastes shall be separated for special handling and shall be disposed at appropriate treatment at the hazardous waste landfill (if available) or stored at site until a suitable disposal facility is available.	EPC Contractor	Construction Site all areas
WC9	A licensed contractor shall be employed to collect waste for delivery to a licensed treatment/disposal facility.	EPC Contractor	Construction Site all areas
WC10	Temporary storage areas for waste should be enclosed or contained to prevent odours, vermin and unauthorised access	EPC Contractor	Construction Site all areas
WC11	Adequate waste containers and storages should be provided at site	EPC Contractor	Construction Site all areas
WC12	Recyclable material should be recovered from waste provided adequate avenues for recycling are available	EPC Contractor	Construction Site all areas
WC13	Waste containers shall be in good condition and fitted with lids or covers to prevent waste from spilling or the ingress of water	EPC Contractor	Construction Site all areas
WC14	Emergency equipment to deal with any spillage or fire shall be kept on site.	EPC Contractor	Construction Site all areas
WC15	Containers used for storage of hazardous waste shall be: • Maintained in good condition and clearly labelled • Suitable for the substance they are holding, resistant to corrosion and securely closed	EPC Contractor	Construction Site all areas
WC16	Storage areas for waste shall be: • Separate areas for storage of Hazardous Waste and Non-hazardous Waste • Clearly labelled and used solely for the storage of waste identified in the labelling • Enclosed on at least 3 sides • Have adequate ventilation • Arranged so that incompatible materials are appropriately separated; • Have impermeable floor and bunding sufficient to fully retain any spillage or - leakages; ventilated; and • Covered to prevent rainfall from entering.	EPC Contractor	Construction Site all areas
WC17	Training shall be provided to site personnel in proper waste management handling procedures, the concepts of site cleanliness and appropriate waste management procedures, including waste reduction, reuse and recycling.	EPC Contractor	Construction Site all areas
WC18	Regular audits of the waste	EPC Contractor /DPTC	Construction Site all areas

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
WC19	Obtain necessary approvals and agreement from be'ah for waste acceptance	EPC Contractor /DPTC	Construction Site all areas

Marine Water Quality

A water quality monitoring programme will provide management actions and supplemental mitigation measures to be employed should impacts arise, thereby ensuring the environmental acceptability of the DLBB Project. Table 8-6 presents mitigation measures for the same.

Table 8-6: Construction Phase Mitigation Measures – Marine Water Quality

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
MQC1	On finalisation of dredging/reclamation/disposal methodology the EPC Contractor shall undertake plume dispersion modelling and provide the same to the regulator	EPC Contractor	Prior to commencing dredging/ reclamation/ disposal
MQC2	Dredging shall comply with the rates modelled and permitted by the regulator. For the various activities assessed a pilot test and monitoring shall be conducted to verify performance prior to commencement of marine construction works. The details of the test shall be reported to the regulators.	EPC Contractor	Marine activity
MQC3	No overflow is permitted from the trailing suction hopper dredger but the Lean Mixture Overboard (LMOB) system should be in operation at the beginning and end of the dredging cycle when the drag head is being lowered and raised.	EPC Contractor	Dredging/ Borrowing
MQC4	Excess dredged material shall be disposed offshore in the area defined in Section 3.5.1 and permitted by the regulator	EPC Contractor	Disposal
MQC5	Offshore borrow of material shall only be permitted in the area defined in Section 3.5.1 and permitted by the regulator	EPC Contractor	Borrowing
MQC6	Disposal vessels shall be fitted with tight bottom seals in order to prevent leakage of material during transport.	EPC Contractor	Material transfer
MQC7	Barges shall be filled to a level, which ensures that material does not spill over during transport to the disposal site and that adequate freeboard is maintained to ensure that the decks are not washed by wave action.	EPC Contractor	Material transfer
MQC8	After dredging, any excess materials shall be cleaned from decks and exposed fittings before the vessel is moved from the dredging area.	EPC Contractor	Post dredging
MQC9	The EPC Contractor(s) shall ensure that the works cause no visible foam, oil, grease, litter or other objectionable matter to be present in the water within and adjacent to the dredging site.	EPC Contractor	Dredging
MQC10	Monitoring and automation systems should be used to improve the crew's information regarding the various parameters to improve accuracy and efficiency.	EPC Contractor	All activities

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
MQC11	Control and monitoring systems shall be used to alert the crew to leaks or any other potential risks such as chemicals and oils.	EPC Contractor	All activities
MQC12	When the dredged material has been unloaded at the disposal areas, any material that has accumulated on the deck or other exposed parts of the vessel shall be removed and placed in the hold or a hopper. Under no circumstances shall decks be washed clean in a way that permits material to be released overboard.	EPC Contractor	Post disposal
MQC13	Dredgers should maintain adequate clearance between vessels and the seabed at all states of the tide and reduce operations speed to ensure that excessive turbidity is not generated by turbulence from vessel movement or propeller wash.	EPC Contractor	Dredging
MQC14	Any pipe leakages shall be repaired quickly. Plant should not be operated with leaking pipes.	EPC Contractor	Dredging/ Reclamation
MQC15	Oil separators shall be provided where necessary and regularly emptied to prevent the release of oil and grease to the environment.	EPC Contractor	All areas
MQC16	Wastewater generated from the washing down of trucks and similar equipment should be recycled wherever practicable. To prevent pollution from wastewater overflow, the pump sump of any wastewater recycling system shall be provided with a standby pump of adequate capacity.	EPC Contractor	All areas
MQC17	Fuel tanks, chemical storage areas, and hazardous waste storage areas should be provided with locks and be sited on sealed areas.	EPC Contractor	All areas
MQC17	Oil leakage or spillage should be contained and cleaned up immediately.	EPC Contractor	All areas
MQC18	Sewage and industrial wastewater shall be collected and managed in line with the requirements of MD 145/93 and MD 159/2005	EPC Contractor	All areas
MQC19	The EPC Contractors shall prepare and implement guidelines and procedures for immediate clean-up actions following any spillages of oil, fuel or chemicals.	EPC Contractor	All areas
MQC20	Surface run-off from bunded areas shall pass through oil/water separators prior to discharge to the environment.	EPC Contractor	All areas
MQC21	Maintain detailed records of material dredged, reclaimed and disposed	EPC Contractor	All areas
MQ22	Discharges to the marine environment shall be through designated permitted outlets and discharges shall meet MD 159/2005 standards and verified through water quality modelling.	EPC Contractor	All areas
MQ23	The EPC Contractor shall prepare an oil spill response plan to address any spills during marine refuelling	EPC Contractor	Marine refuelling

Marine Ecology

The marine ecology in the DLBB Project area is sensitive and a marine mammal exclusion zone will be implemented to mitigate impact to whales and dolphins. Table 8-7 presents mitigation measures to manage the impact to marine ecology.

Table 8-7: Construction Phase Mitigation Measures – Marine Ecology

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
MEC1	A pre-construction marine baseline study (covering physical and chemical analysis of seawater, sediment and marine ecology) shall be undertaken by the EPC Contractor for all the proposed work areas and the findings of the same shall be presented to the regulator	EPC Contractor	Marine Works
MEC2	Vessel operators working on the Project construction shall be given a briefing, alerting them to the possible presence of dolphins, whales and turtles in the area, and guidelines for safe vessel operations in the presence of cetaceans.	EPC Contractor	Marine Works
MEC3	The vessel operators should be required to use predefined and regular routes, as these will become known to dolphins and whales using these waters.	EPC Contractor	Marine Works
MEC4	The vessel operators shall be required to control and manage all effluent from vessels in line with MD 159/2005	EPC Contractor	Marine Works
MEC5	A policy of no dumping of rubbish, food, oil, or chemicals shall be strictly enforced. This shall also be covered in the EPC Contractor briefings.	EPC Contractor	Marine Works
MEC6	To reduce underwater sound levels associated with percussive piling, the following steps should be taken: • Quieter hydraulic hammers should be used instead of the noisier diesel hammers; • Instigate 'ramping-up' of the piling hammer to provide an advance warning system to marine mammals in the vicinity • Acoustic decoupling of noisy equipment on work barges should be undertaken.	EPC Contractor	Marine Works
MEC7	An exclusion zone of 500 m radius shall be scanned around the work area for at least 30 min prior to the start of percussive piling. If dolphins or whales are observed in the exclusion zone, piling shall be delayed until they have left the area.	EPC Contractor	Marine Works
MEC8	Marine mammal exclusion zone within a radius of 250 m from dredging/ borrow/ disposal area shall be implemented during the construction phase. An exclusion zone of 250 m radius shall be scanned around the dredging /borrowing /disposal area for at least 30 minutes prior to the start dredging/borrowing/disposal activity. If dolphins/whales are observed in the exclusion zone for a continuous period of 30 minutes, dredging/ borrowing/ disposal activity shall be delayed until they have left the area. Should dolphins/whales move into the dredging/ borrowing/ disposal area during dredging /borrowing/ disposal activity, it is considered that dolphins/whales shall have acclimatised themselves to the works therefore cessation of dredging is not required. Dolphin and whale sightings shall be reported to PDC and SEZAD.	EPC Contractor	Marine Works
MEC9	Project personnel shall refrain from fishing	EPC Contractor/ DPTC	All phases
MEC10	Contribute to the periodic monitoring of dolphins/whales/turtles visiting the DLBB Project area lead by PDC and SEZAD	DPTC	All phases

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
MEC11	Regulation or management steps put forward by PDC to manage impacts to dolphins / whales / turtles shall be complied with	EPC Contractor/ DPTC	All Phases

Terrestrial Ecology

The DLBB Project area is adjacent to an IBA and the flora and fauna and other natural elements contribute to the sustainability of the IBA. Land take for the DLBB Project, lighting and noise during the construction phase could impact the bird habitat and the birds. Land take will result in a direct loss of habitat for the birds. The fauna in the area will also be susceptible to disturbance from area light. Table 8-8 presents mitigation measures to manage the impact to terrestrial ecology.

Table 8-8: Construction Phase Mitigation Measures – Terrestrial Ecology

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
TEC1	Where possible, structures should utilise appropriate design to complement the surrounding landscape. Materials and finishes should be considered during detailed design. The major lighting sources shall be pointed inward and downwards where practicable to reduce light spill	EPC Contractor/ DPTC	All phases
TEC2	Erect fences along the boundary of the works area before the commencement of works to prevent vehicle movements, and encroachment of personnel, onto adjacent areas	EPC Contractor	Construction Site all areas
TEC3	Regularly check the work site boundaries to ensure that they are not breached and that damage does not occur to surrounding areas.	EPC Contractor	Construction Site all areas
TEC4	Contribute to the periodic monitoring of birds visiting the DLBB Project area lead by PDC and SEZAD	DPTC	Site all areas
TEC5	Hunting or trapping of birds or animals by DLBB Project personnel is prohibited	All site personnel	Construction Site all areas

Archaeological and Cultural Resources

As the DLBB Project will be established on reclaimed land within the existing port it is unlikely the DLBB Project will interact with any archaeological resources. However, in the event of a find the measures presented in Table 8-9 will be adopted.

Table 8-9: Construction Phase Mitigation Measures – Archaeological and Cultural Resources

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
ACC1	Should any archaeological structures be found or suspected in the area the same shall be reported to the Ministry of Heritage and Culture, SEZAD and PDC	EPC Contractor/ DPTC	All phases
ACC2	Should any archaeological or culturally significant features be identified work in the area shall be stopped until the same can be investigated by the respective authorities.	EPC Contractor/ DPTC	All phases

Community and Social

The consultation with stakeholder found that they see the upcoming developments in Duqm as highly positive for overall economic and social development in Duqm. The primary impact during the construction phases, to the socio-economy of the region and is through the influx of expatriate construction workers to the region. It is expected that at the construction phase will extend for a period of 2.5 years and at the peak will involve the employment of approximately 5,000 expatriate labourers. Management of relationship with the local community is crucial for the DLBB Project. Table 8-10 presents measures to manage community relations.

Table 8-10: Construction Phase Mitigation Measures – Community and Social

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
CSC1	Locating the construction camp away from the local community and ensuring self-sufficiency of the camp to minimise interaction between the camp and the local community	EPC Contractor	Construction Camp
CSC2	Movement of workers at the DLBB Project location and labour camps to be properly managed	EPC Contractor	Construction Site all areas
CSC3	Appropriate awareness on local socio-cultural settings and Omani culture and social practices (especially for new employees) to be provided	EPC Contractor	Construction Site all areas
CSC4	Identification of suitable jobs for locals, along with identification of need for training and development	EPC Contractor	Construction Site all areas
CSC5	In line with Government Policy for Omanisation employment of locals shall be encouraged	EPC Contractor/DPTC	Construction Site all areas
CSC6	DPTC and the EPC Contractor shall strive to support local businesses, where possible, by purchasing locally	EPC Contractor/DPTC	Construction Site all areas
CSC7	Interact with all other construction works and industries in coordinate with SEZAD to develop a unified approach to stakeholder management and community consultation	DPTC	SEZD
CSC8	Implement a grievance redressed policy and a community engagement plan	DPTC	Local community
CSC9	Develop and implement a Corporate Social Responsibility (CSR) program in Duqm	DPTC	Local community

Management of Hydrotest/Hydraulic Flushing Water

During the construction phase it is expected that approximately 85,000 m^3 of hydrotest water will be handled at site and a comparable amount of hydraulic flushing water. At any time the amount of water that will be handled will be much less, with the quantity of water depending on the section of pipeline or container being tested / cleaned. Water will be reuse where practicable to reduce the volume of freshwater used.

The may contain chemical additives (corrosion inhibitors, oxygen scavengers, and dyes) which have may be added to the water to prevent internal corrosion or to identify leaks. Hence it is important to ensure discharge of untreated water is avoided. Table 8-11 presents measures to manage hydrotest/hydraulic flushing water.

Table 8-11: Construction Phase Mitigation Measures – Hydrotest/Hydraulic Flushing Water

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
HTC1	Reduce the need for chemicals by optimising the time that the test water remains in the equipment or pipeline	EPC Contractor	Testing/ cleaning
HTC2	If chemical use is necessary, carefully select chemical additives in terms of dose concentration, toxicity, biodegradability, bioavailability, and bioaccumulation potential	EPC Contractor	Testing/ cleaning
HTC3	Hydrostatic test water quality should be monitored before use and discharge and should be treated to meet the discharge limits	EPC Contractor	Testing/ cleaning
HTC4	Reuse water where practicable	EPC Contractor	Testing/ cleaning
HTC5	Use break tanks or energy dissipators (e.g. protective riprap, sheeting, tarpaulins) for the discharge flow	EPC Contractor	Testing/ cleaning
HTC6	Records on the quantity water generated, and disposed should be maintained. Additionally records of the quality of water should be maintained	EPC Contractor	Testing/ cleaning
HTC7	Gradual increase in pressures while hydrotesting	EPC Contractor	Testing

Management of Chemicals and Fuel

The management of the chemicals and fuel should consider the impact as a result of spills onsite and offsite. Table 8-12 presents measures to mitigate impacts from spills of chemical/Fuel.

Table 8-12: Construction Phase Mitigation Measures – Chemicals/Fuel

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
CF1	Transport by licensed contractors	EPC Contractor	Handling/ Storage
CF2	Personnel involved in the transport, handling and storage of Fuel/Chemicals must be trained	EPC Contractor	Handling/ Storage
CF3	Storage must be in accordance with MD 25/2009 and the MSDS	EPC Contractor	Handling/ Storage
CF4	Periodic checking for spills and leaks in the handling area must be done	EPC Contractor	Handling/ Storage
CF5	Records of chemicals/fuel stored at site must be maintained	EPC Contractor	Handling/ Storage
CF6	Adequate secondary containment is to be provided	EPC Contractor	Handling/ Storage
CF7	An emergency management plan is to be prepared which shall define response to spills onsite or offsite	EPC Contractor	Handling/ Storage

8.3 Operation Phase

8.3.1 Organisation and Responsibilities

DPTC shall be responsible for the operation of the DLBB Project. The Operation and Maintenance (O&M) Contractor at site shall be contractually bound to show that necessary HSE personnel are present at site. The primary reason for making the EMP a contractual requirement is to ensure that the O&M Contractor is fully aware of his environmental responsibilities and to ensure his commitment to achieving the specified standards. DPTC's Environmental Manager shall act as the point of contact for all Project related HSE matters.

As DLBB Project proponent, DPTC is responsible for the overall DLBB Project and shall ensure implementation an effective Health, Safety, and Environmental Management System (HSEMS) for the DLBB Project. The HSEMS shall comply with the control measures and environmental management requirements outlined in this EMP and any additional conditions provided by the regulator. The O&M Contractor shall be responsible for developing and implementing the HSEMS and ensuring that their subcontractors also abide by. The HSEMS shall work to implement this EMP and the HSEMS Manual shall include:

- Appropriate background information on the operation of the Project with reference to relevant technical reports
- Organisational arrangements, hierarchy and responsibilities with regard to the management of environmental performance during the operation phase. The HSE team, the O&M Contractor(s) team and the DPTC's representatives, included
- Descriptions of the parameters to be monitored and criteria through which performance shall be assessed including: monitoring frequency and methodology, monitoring locations (typically, the location of sensitive receivers as listed in the EIA), monitoring equipment lists, event contingency plans for exceedances of established criteria and schedule of mitigation and best practice methods for reduced adverse environmental impacts;
- Procedures for undertaking on-site environmental performance audits as a means of ensuring compliance with environmental criteria; and
- Reporting procedures

The HSEMS shall be a live document that shall undergo a series of revisions, as needed, to accommodate changes to DLBB Project operation.

The HSE manager of O&M Contractor shall be responsible for day-to-day HSE management onsite. The HSE Manager shall maintain constant interactions with line managers and other staff throughout the construction period. The O&M Contractor shall assist in periodic audits and monitoring to ensure effective implementation of control and mitigation measures and implementation of corrective actions for any deviations.

8.3.2 Site Security and Safety

Security and safety of the DLBB Project shall be integrated with the Port of Duqm and SEZD safety and security systems. Detailed plans shall be prepared for emergency response and security which shall be integrated with systems at the Port of Duqm and SEZD. The safety and security systems shall include CCTV, lighting, intruder detection systems, access control (personnel and vehicle), maritime systems, guards, and security management system software.

8.3.3 Permits

DPTC shall ensure that all necessary permits and approvals are available prior to the outset of operation. DPTC shall ensure that all requisite permits are obtained prior to the O&M Contractor undertaking any activity. Example environmental permits that are to be obtained are:

- Final Environmental Permit
- Chemicals Permit
- Permit for Discharge/Reuse of Treated Effluent
- Permit for use of air emissions sources
- Permits for temporary storage of hazardous waste

8.3.4 Operation Phase Mitigation Measures

The EIA study has concluded that there would be no significant impact from the project operations provided the mitigation measures detailed in the subsequent sections are implemented to manage impacts on the environmental aspects.

Land Use

During the operation phase the focus will be on limiting land-use and preventing creep beyond the demarcated boundaries.

Table 8-13: Operation Phase Mitigation Measures – Land Use

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
LUO1	The land take of the DLBB Project is to be limited and restricted	DPTC	All areas
LUO2	Material and equipment is to be stored in designated storage areas	DPTC	All areas

Air Quality

Air emissions from the operation of the DLBB Project are expected to be fugitive VOC, fugitive dust and combustion emissions. Fugitive VOC emissions will be from the storage tanks, flanges, pumps etc., while fugitive dust will result from handling and storage of Pet Coke and Sulphur Stockpiles. Combustion emissions will result from periodic operation of DGs/pumps and the emergency flare. Table 8-14 presents mitigation measures to manage air quality during operation phase.

Table 8-14: Operation Phase Mitigation Measures – Air Quality

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
AQO1	Good site practices such as regular maintenance and checking of the diesel powered mechanical equipment shall be adopted to avoid any black smoke emissions and to minimize gaseous emissions.	DPTC	All areas
AQO2	Malfunctioning and breakdown of the process or air pollution control equipment which would cause exceedance of the emission limits or breaches of other air pollution control requirements should be document and reported	DPTC	All areas
AQO3	The loading, unloading, handling, transfer or storage of other raw materials which may generate airborne dust emissions such PET Coke, shall be carried out in such a manner to prevent or minimize dust emissions. Measures such as water spraying are to be adopted to minimise dust	DPTC	Material handling area
AQO4	Vehicles shall be periodically washed to reduce dust	DPTC	All areas
AQO5	A high standard of housekeeping shall be maintained. All spillages or deposits of materials on ground, support structures or roofs shall be cleaned up promptly by a cleaning method acceptable to the Authority. Any dumping of materials at open area shall be prohibited.	DPTC	All areas
AQO6	Leak Detection and Repair program shall be instituted	DPTC	All areas
AQO7	Suitable operation when using belt conveyor by: • Suitable conveyor speed • Avoiding loading of belt to edges	DPTC	Conveyor belt
AQO8	Engage with Duqm Refinery to request frequent cleaning and dust control in the trucks used to transport Pet Coke and Sulphur.	DPTC	Offsite
AQO9	Engage with Duqm Refinery to request the cleaning of dust and debris along road from the refinery to the DLBB Project	DPTC	Offsite
AQO10	Enclosed conveyors shall be used to transfer bulk material from the stockpiles to the ships	DPTC	Conveyor belt
AQO11	The gas flared should be measured and reported	DPTC	Flare
AQO12	Use of suitable burners to ensure high burn efficiency complete combustion of the gas flared, reduced soot and noise	DPTC	Flare
AQO13	Suitable sampling port at a location safely away from any areas of high thermal radiation should be provided for manual sampling of the flare gas followed by laboratory analysis for composition	DPTC	Flare

Noise

Noise will be controlled both for employees within the facilities and for the community outside of the site boundary. The noise level at the DLBB Project fenceline will meet MD 79/94 and in work area noise will be managed in line with MD80/94.

Table 8-15: Operation Phase Mitigation Measures – Noise

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
NO1	Compliance with requirements of MD 79/94 and MD80/94 shall be demonstrated through a noise modelling exercise	DPTC	All areas
NO2	High noise activity shall be scheduled for the day	DPTC	All areas
NO3	Shielding of equipment and use of enclosures to reduce to noise	DPTC	All areas
NO4	Regular maintenance of equipment to protect from noise	DPTC	All areas
NO5	PPE shall be provided to workers in high noise areas as per MD 80/94	DPTC	All areas

Waste

SEZAD and be'ah have proposed an Integrated Waste Treatment, Storage and Disposal Facility in Duqm, which will include a new engineered NHW landfill and HW landfill. The new integrated facility will be located in an area adjoining the existing dumpsite and will be ready in Q4-2016. Hence, all the waste generated by the DLBB Project during the operation phase will be diverted to this facility. Table 8-16 presents waste management practise.

Table 8-16: Operation Phase Mitigation Measures – Waste

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
WO1	Waste shall be managed in accordance with MD 17/93, MD 18/93, and PDC Port Regulations	DPTC	All areas
WO2	Develop and implement a Waste Management Plan which specifies procedures such as a manifest system, to facilitate tracking of loads and protocols for the maintenance of records of the quantities of wastes generated, recycled and disposed.	DPTC	All areas
WO3	Apply for and obtain the appropriate permits/licenses for the disposal of waste, storage/disposal of hazardous waste and effluent discharges.	DPTC	All areas
WO4	No waste shall be burnt on site. Wastes shall be collected by licensed waste haulier and be disposed of at licence sites.	DPTC	All areas
WO5	The site and surroundings shall be kept tidy and litter free. Waste storage area shall be properly cleaned and shall not cause windblown litter and dust nuisance.	DPTC	All areas
WO6	Storage of material on site should be kept to a minimum.	DPTC	All areas
WO7	Suitable hazardous waste storage areas should be formed at the works site for temporary storage pending collection. Hazardous wastes shall be separated for special handling and shall be disposed at appropriate treatment at the hazardous waste landfill (if available) or stored at site until a suitable disposal facility is available.	DPTC	All areas
WO8	A licensed contractor shall be employed to collect waste for delivery to a licensed treatment/disposal facility.	DPTC	All areas

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
WO9	Storage areas for waste should be enclosed or contained to prevent odours, vermin and unauthorised access	DPTC	All areas
WO10	Adequate waste containers and storages should be provided at sit e	DPTC	All areas
WO11	Recyclable material should be recovered from waste provided adequate avenues for recycling are available	DPTC	All areas
WO12	Waste containers shall be in good condition and fitted with lids or covers to prevent waste from spilling or the ingress of water	DPTC	All areas
WO13	Emergency equipment to deal with any spillage or fire shall be kept on site.	DPTC	All areas
WO14	Containers used for storage of hazardous waste shall be: • Maintained in good condition and clearly labelled • Suitable for the substance they are holding, resistant to corrosion and securely closed	DPTC	All areas
WO15	Storage areas for waste shall be: • Separate areas for storage of Hazardous Waste and Non-hazardous Waste • Clearly labelled and used solely for the storage of waste identified in the labelling • Enclosed on at least 3 sides • Have adequate ventilation • Arranged so that incompatible materials are appropriately separated; • Have impermeable floor and bunding sufficient to fully retain any spillage or - leakages; ventilated; and • Covered to prevent rainfall from entering.	DPTC	All areas
WO16	Training shall be provided to site personnel in proper waste management handling procedures, the concepts of site cleanliness and appropriate waste management procedures, including waste reduction, reuse and recycling.	DPTC	All areas
WO17	Regular audits of the waste management practises	DPTC	All areas
WO18	Obtain necessary approval and agreement with be'ah for waste disposal/acceptance	DPTC	Waste management

Marine Water Quality

A water quality monitoring programme will provide management actions and supplemental mitigation measures to be employed should impacts arise, thereby ensuring the environmental acceptability of the DLBB Project. Table 8-17 presents the operation phase mitigation measures.

Table 8-17: Operation Phase Mitigation Measures – Marine Water Quality

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
MQO1	Any pipe leakages shall be repaired quickly. Plant should not be operated with leaking pipes. A comprehensive Leak Detection and Repair (LDRA) program shall be implemented	DPTC	All areas
MQO2	Oil separators shall be provided where necessary and regularly emptied to prevent the release of oil and grease to the environment.	DPTC	All areas
MQO3	Wastewater generated from the washing down of trucks and similar equipment should be recycled wherever practicable. To prevent pollution from wastewater overflow, the pump sump of any wastewater recycling system shall be provided with a standby pump of adequate capacity.	DPTC	All areas
MQO4	Fuel tanks, chemical storage areas, and hazardous waste storage areas should be provided with locks and be sited on sealed areas.	DPTC	All areas
MQO5	Oil leakage or spillage should be contained and cleaned up immediately.	DPTC	All areas
MQO6	Sewage, brine rejects and industrial wastewater shall be collected and managed in line with the requirements of MD 145/93 and MD 159/2005	DPTC	All areas
MQO7	DPTC shall prepare and implement guidelines and procedures for immediate clean-up actions following any spillages of oil, fuel or chemicals. This procedure shall be in line with Port of Duqm's Oil Spill Response Plan.	DPTC	All areas
MQO8	Surface run-off from bunded areas shall pass through oil/water separators prior to discharge to the environment.	DPTC	All areas
MQO9	Collate records on disposal of MARPOL waste from ships visiting the DLBB Project	DPTC	Vessels
MQO10	Collate records of MARPOL waste collected by PDC from ships visiting the DLBB Project	DPTC	Vessels
MQO11	Report any violations by vessels visiting the DLBB Project to the respective authorities (PDC/SEZD)	DPTC	Vessels
MQO12	Separate drainage for contaminated and uncontaminated streams	DPTC	All areas

Marine Ecology

The marine ecology surrounding the Duqm port is sensitive. During the operation phase the interaction of the DLBB Project with the environment will be in the form of discharges to the marine environment and hence the impact to marine ecology is limited. Table 8-18 presents mitigation measures to manage the marine ecology.

Table 8-18: Operation Phase Mitigation Measures – Marine Ecology

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
MEO1	Vessel operators working in the area given a briefing, alerting them to the possible presence of dolphins, whales and turtles in the area, and guidelines for safe vessel operations in the presence of dolphins, whales and turtles.	PDC/Vessel Operators /DPTC	Port / Vessel
MEO2	The vessel operators shall be required to use predefined and regular routes, as these shall become known to dolphins and whales using these waters.	PDC/Vessel Operators	Port / Vessel
MEO3	The vessel operators shall be required to control and manage all effluent from vessels in line with MD 159/2005	PDC/Vessel Operators	Port / Vessel
MEO4	A policy of no dumping of rubbish, food, oil, or chemicals shall be strictly enforced. This shall also be covered in the O&M Contractor briefings.	PDC/Vessel Operators/DPTC	All areas
MEO5	Project personnel shall refrain from fishing	DPTC/PDC/ Vessel Operators	All areas
MEO6	Contribute to the periodic monitoring of dolphins/whales/turtles visiting the DLBB Project area lead by PDC and SEZAD	DPTC	All areas
MEO7	Monitoring of discharges from the DLBB Project to the marine environment	DPTC	All areas
MEO8	Development of long-term dolphins/Whales/turtles management plans	DPTC	All areas

Terrestrial Ecology

The DLBB Project area near an IBA and the flora and fauna and other natural elements contribute to the sustainability of the IBA. Lights and noise from the DLBB Project operation would disturb the birds and animals around the DLBB Project site. It is expected that the light and noise would cause disorientation in among the fauna and result in avoidance behaviour. Table 8-19 presents mitigation measures for the management for terrestrial ecology.

Table 8-19: Operation Phase Mitigation Measures – Terrestrial Ecology

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
TEO1	The major lighting sources shall be pointed inward and downwards where practicable to reduce light spill	DPTC	All phases
TEO2	Erect fences along the boundary of the works area before the commencement of works to prevent vehicle movements, and encroachment of personnel, onto adjacent areas	DPTC	All Areas
TEO3	Regularly check the work site boundaries to ensure that they are not breached and that damage does not occur to surrounding areas.	DPTC	All Areas
TEO4	Contribute to the periodic monitoring of birds visiting the DLBB Project area lead by PDC and SEZAD	DPTC	Site all areas

Community and Social

The consultation with stakeholder found that they see the upcoming developments in Duqm as highly positive for overall economic and social development in Duqm. In order to ensure that this continues measures in Table 8-20 are implemented.

Table 8-20: Operation Phase Mitigation Measures – Community and Social

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
CSO1	Appropriate awareness on local socio-cultural settings and Omani culture and social practices (especially for new employees) to be provided	DPTC	All areas
CSO2	Identification of suitable jobs for locals, along with identification of need for training and development	DPTC	All areas
CSO3	In line with Government Policy for Omanisation employment of locals shall be encouraged	DPTC	All areas
CSO4	DPTC shall strive to support local businesses, where possible, by purchasing locally	DPTC	All areas
CSO5	DPTC shall strive to encourage employment of Omanis from the Duqm region	DPTC	All areas

Hydrology

Impact to hydrology during the operation phase could result from spills and accidents. The following measures are proposed to mitigate the impact.

Table 8-21: Operation Phase Mitigation Measures – Hydrology

EIA Ref	Environmental Protection Measure	Implementation Agent	Location/ Duration /Timing
HO1	Spill control and management and response plan to be implemented	DPTC	All areas
HO2	Staff should be trained to respond to spills and contain the same	DPTC	All areas
HO3	Secondary containment as per good engineering practices shall be implemented.	DPTC	All areas
HO4	Inform relevant stakeholders of any spill	DPTC	All areas
HO5	DPTC should engage with the PDC to understand and prepare for its role and responsibility during spills	DPTC	All areas

8.4 Decommissioning Phase

The DLBB Project is expected to operate for about 50 years after which it may be decommissioned. The activities related to decommissioning will be associated with the generation of large quantities of waste. The decommissioning will be undertaken using the latest methods and techniques available and will be in compliance with relevant legislation and proposed future use of the project area. As a minimum the DLBB Project will need to comply with the environmental management measures specified in this document. As a part of restoration, remediation of contaminated soils will also be undertaken and all recyclable material will be recovered. The following measures will be considered during decommissioning:

- Debris and contaminated soils will be removed;
- The site will be restored by reforming the contours to natural surroundings;
- Natural drainage patterns will be restored;
- Non-native materials will be removed;
- Site recovery will be documented; and
- The DLBB Project site will be restored as close to the original condition as possible

8.5 Management of Other Developments

As highlighted earlier a number of developments within SEZD will be constructed and operated in parallel. In such an industrial area when multiple industries, utilities and infrastructure is being constructed and operated in parallel, environmental violations by any of the developments could create a negative perception about all the industries in the SEZD, including the DLBB Project. Hence it is important that DPTC takes a proactive approach to working with other industries in relation to environmental matters. Some of the steps that DPTC could adopt while working with other developments:

- Establish contact with the Environmental Compliance officers of adjoining developments and other tenants in the SEZD
- Establish a CSR program to interact with local residents and/or participate in CSR programs lead by SEZAD and PDC
- Participate in industry forums to improve visibility
- Share information on environmental monitoring and complaints from local communities

8.6 Monitoring Requirements

Environmental monitoring is necessary to assess environmental performance and to provide guidance to improve environmental practices. Periodic environmental audits help in assessing the effectiveness of implementing the management plans and permit conditions. Appropriate corrective actions will be implemented for any deviations as appropriate.

The proposed monitoring, inspections and auditing plan for the DLBB Project is presented in Table 8-22. Environmental monitoring will be undertaken at regular intervals. The audits are to be scheduled in such a way as to cover significant activities of the DLBB Project that include necessary health, safety, environmental, social and resource issues. The reports of such audits and monitoring are to be documented to demonstrate environmental compliance to regulatory authorities as required. Deviations from the permit conditions will be considered as non-conformities. Nonconformities shall be reviewed to identify suitable corrective measures. The findings of periodic audits, corrective actions and recommendations for improvements will be periodically reviewed by DPTC.

Table 8-22: Framework Environmental Monitoring and Auditing Requirements

#	Aspect	Area	Focus	Frequency
1	General: Compliance Audits	DLBB Project for all phases	• Compliance with the EIA, Permit Conditions, IFC EHS Guidelines, regulations of the Sultanate of Oman • Waste management practices and adequacy of disposal/ recycling methods • Adequacy of permits • Fuel consumed • Emissions to air and water • House Keeping • Management of impacts from activities ongoing activities such as dredging • Close out of deviations identified during inspections and pervious audits (if any)	Quarterly during the construction phase Every 6 months during operation
2	General: Inspection	DLBB Project for all phases	Compliance with the EIA, Permit Conditions, IFC EHS Guidelines, regulations of the Sultanate of Oman	Monthly during construction and operation phase
3	Water Quality	Treated wastewater	• Daily volume of water disposed • Parameters specified in MD 145/93 or MD 159/2005 (depending on receiving environment)	• Monthly during construction and operation phase • Frequency will need to increase in the event of exceedance or expected change in process wastewater character.
		Storm water discharge to environment	Parameters specified in MD 145/93 or MD 159/2005 (depending on receiving environment)	• During selected rain events. • Should exceedances be noted the frequency of the sampling will be increased
		Dredging/ reclaiming /Disposal	Turbidity	Continuous monitoring
			Physicochemical character of water column for parameters monitored during the baseline study	Weekly in the area of dredging, reclaiming and/or disposal and at the water quality control points
4	Air Quality	Ambient air	• Dust at DLBB Project fence line (Operation and construction phase) • Diffusion tubes for NOX, SO2, VOC and O3 around DLBB Project fence line (construction and operation phase)	Quarterly to capture trends in air quality. Frequency of dust monitoring to be increase during high wind conditions.

#	Aspect	Area	Focus	Frequency
		Emissions from vehicles	Verification of road worthiness certificate for all DLBB Project phases	Annual
		Ambient air	Support the continuous ambient air quality monitoring installed by industrial stakeholders (if any)	Operation phase
		VOC emissions	Photoionization detection (PID) or Flame ionisation detection (FID) or Non- dispersive infrared (NDRI) to detect VOCs around fugitive sources (sniffing survey) for all DLBB Project phases	Quarterly during operation
			Thermal Imaging Surveyors for VOC monitoring (operation phase)	During operation
		Flares	• Daily date and time dated photographs of flare when operational • Metering of gas flared, stoichiometric estimation of emission from flare	Compiling and reporting information as part of audits and inspections during operation
5	Ecology	Marine work area	An exclusion zone of 250 m radius will be scanned around the dredging /borrowing /disposal area for at least 30 minutes prior to the start dredging/borrowing/disposal activity.	Prior to outset of activity during construction – Refer Mitigation measures for Marine Ecology
		Marine work area	An exclusion zone of 500 m radius will be scanned around the work area for at least 30 minutes prior to the start of percussive piling	Prior to outset of activity during construction – Refer Mitigation measures for Marine Ecology during construction
		General area	Survey of marine mammals and birds in Duqm, this could be done in conjunction with PDC or SEZAD for all DLBB Project phases	Every 6 months
6	Noise	Project fence line	Monthly monitoring along the DLBB Project fenceline. All DLBB Project phases.	Monthly or when high noise activity is undertaken
7	Resource consumption	All Project phases	Records of the use of the following: • Power • Diesel • Hazardous Chemical • Water • ODS (If any)	Compiling and reporting information as part of audits and inspections
8	Community and Social	All Project phases	• Disclosure of project schedule, mitigation measures & management plans to Wali Sheikh and other stakeholders • Collation of complaints from local community if any	Compiling and reporting information as part of audits and inspections

9 CLIMATE AFFAIRS

9.1 Overview

This chapter discusses the impacts on the climate due to the activities and facilities related to the DLBB Project construction and operation phases. A forecast of the estimated quantities of GHG emissions using the emission factors from the Intergovernmental Panel on Climate Change (IPCC) guideline and data from the DLBB Project design documents is presented in this chapter. It must be noted that the chapter is prepared as per the guidelines from the Directorate General of Climate Affairs (DGCA) at MECA from 23rd November 2010.

9.2 Climate Affairs Contact

The details of the contact within DPTC to discuss matters related to Climate Affairs in the relation to the DLBB Project are as below:

Contact Person:	Ahmed Al Amry, Project Director
Organisation:	Duqm Port Terminal Company LLC
Address:	PO Box 261, Post Code 118, Sultanate of Oman
Telephone Number:	2457 3100

9.3 Ozone Depleting Substances (ODS)

There is no planned use of ODS substances as part of the DLBB Project. ODS use, if any, will mostly be attributed to the use of equipment such as refrigerators, air conditioning units (wall, split), firefighting equipment or rigid foam. Construction activities will be undertaken by EPC Contractors appointed by DPTC and ODS substances if any will be removed by the EPC Contractor during demobilization. Operation phase will be led by DPTC with support from O&M Contractors, but again, the O&M Contractors will be required to take ODS containing equipment offsite for maintenance and repair. DPTC will ensure compliance with MD 243/2005 during the Project and O&M Contractors will be discouraged from the use of ODS containing equipment, as part of the Project.

Estimates of ODS used during the construction and operation phase of the DLBB Project are not available and the same will be monitored as reported to SEZAD during the respective phases.

Table 9-1: ODS Substances

#	Questionnaire	Description
1	Types and quantities of ODS to be used in all stages of the project:	No planned use
2	The number and kinds of equipment that contain ODS in all stages of the project:	No planned use. If any such equipment is used the same will be recorded and reported to the MECA as part of quarterly audit reports.
3	Alternatives for ODS to be used in all stages of the project:	Alternative for ODS will be proposed to Contractors. At present information on potential alternatives is unavailable.
4	Project plan for usage of ODS alternatives and avoidance	Alternative for ODS will be proposed to Contractor.

#	Questionnaire	Description
	of any ODS release to the atmosphere:	Handling of ODS will not be permitted on-site.
5	The procedure to adhere to the requirements of the Regulations for the Control and Management of Ozone Depleting Substances issued by Ministerial Decision No. 243/2005	All activities will be undertaken in compliance with MD 243/2005

9.4 Green House Gas Emissions

GHG may occur naturally or may be generated from combustion of fuel or industrial processes. The primary sources of some prominent GHGs, their atmospheric lifetimes and Global Warming Potential are presented in Table 9-2.

Table 9-2: Source lifetime and Global Warming Potential of some Prominent GHGs

GHG		Atmospheric lifetime (years)	Global Warming Potential (for 100 year time horizon)	Potential use at site
Water vapour		A few days	-	Combustion of fossil fuel
CO_2		Variable	1	Combustion of fossil fuel
CH_4		12	21	Combustion of fossil fuel , fugitive emissions
N_2O		114	310	Combustion of fossil fuel
HFC	R-23 (CHF_3)	250	12,000	Electronics, refrigerants
	R-134a (CF_3CH_2F)	13.8	1,300	Refrigerants
Sulphur hexafluoride (SF_6)		3,200	22,200	Dielectric fluid

Source: Kirby, Alex "CCCC Kick the Habit, A UN Guide to Climate Neutrality", pg. 15 UNEP

9.5 GHG Emissions from Energy Sources – Combustion of Fuel from the Proposed Project

9.5.1 Stationary Combustion Sources

The stationary combustion sources during the construction phase will be the construction equipment and the DGs, which will be moved from location to location depending on the need of the activities involved. The exact number of equipment and DGs that will be used and the period of usage are not known at the present stage of the DLBB Project. The expected frequencies and periods of operation of the DGs are not available at present. Therefore, emissions estimates cannot be made.

During the operation phase power will be purchase from the local grid and the only onsite stationery combustion sources may be in the form of emergency DGs, which will be used infrequently.

In order to provide the regulator with details of GHG emissions as a result of stationery combustion sources, DPTC will collate details of fuel consumed during the construction and operation phases.

Table 9-3: GHG Emissions from Stationery Combustion Sources (2017 to 2042)

Area	CO_2 (tons)	CH_4 (tons)	N_2O(tons)
Data unavailable for the construction and operation phases. Hence not estimated	-	-	-

Table 9-4: GHG Emissions from Stationery Combustion Sources

Year	CO_2 (tons)	CH_4 (tons)	N_2O(tons)
Data unavailable for the construction and operation phases. Hence not estimated	-	-	-

9.5.2 Mobile Combustion Sources

All phases of the DLBB Project will be associated with GHG emissions from mobile sources. A variety of mobile sources will be associated with the DLBB Project including buses, heavy machinery, construction equipment, barges, etc.

Information on the number of vehicles and diesel consumption rate of each vehicle, distances travelled by the vehicles or mileages, and the physical and thermal properties of the diesel that will be used in these vehicles, etc. is required for estimating the amount of GHG emitted from mobile sources. At this stage of the DLBB Project this information is unavailable and hence is not reported.

In order to provide the regulator with the details of the GHG emissions as a result of mobile emission from the DLBB Project, DPTC will collate details of fuel consumed during the construction and operation phases.

Table 9-5: GHG Emissions from Mobile Combustion Sources (2017 to 2042)

Area	CO_2 (tons)	CH_4 (tons)	N_2O(tons)
Data unavailable for the construction and operation phases. Hence not estimated	-	-	-

Table 9-6: GHG Emissions from Mobile Combustion Sources

Year	CO_2 (tons)	CH_4 (tons)	N_2O(tons)
Data unavailable for the construction and operation phases. Hence not estimated	-	-	-

9.5.3 Fugitive Emissions from Oil and Natural Gas System

An emergency flare will be installed as part of the DLBB Project. The flare will be operated under emergency conditions and hence the GHG emissions will depend on the number and duration of emergency situations. In case of any emergency flaring the same will be duly reported to the regulator.

Table 9-7: Fugitive GHG Emissions from Oil and Natural Gas Systems

Area	CO_2 (tons)	CH_4 (tons)	N_2O(tons)
Dependent on the duration and frequency of emergency conditions	-	-	-

Notes:

(a) Emission factor for flaring (during gas production) CO_2 - 1.6E-03, CH_4 – 1.0 E-06 and N_2O - 2.9E-08 Gg per 10E06 cubic meters of gas production 2006 IPCC Guidelines for National Greenhouse Gas Inventories Table 4.2.5 Tier 1 Emission Factors for Fugitive Emissions (including venting and flaring) from oil and gas operations in developing countries and countries with economies in transition

(b) Emission factor for flaring (during oil production) CO_2 - 5.6E-02, CH_4 – 3.4 E-05 and N_2O - 8.8E-07 Gg per 10E3 cubic meters of oil production 2006 IPCC Guidelines for National Greenhouse Gas Inventories Table 4.2.5 Tier 1 Emission Factors for Fugitive Emissions (including venting and flaring) from oil and gas operations in developing countries and countries with economies in transition

Table 9-8: GHG Emissions from Fugitive Emissions from Oil and Natural Gas System

Year	CO_2 (tons)	CH_4 (tons)	N_2O(tons)
2016	-	-	-
2017-2041	-	-	-

9.5.4 Details of GHG Calculations

Table 9-9 presents details of GHG calculations.

Table 9-9: Details of GHG Calculations

Type of Activity	Methodology According to IPCC	Emissions Factor	Quantity	Total Emission (tons) over 25 years
Stationery combustion sources	Tier 1	-	-	-
Mobile combustion sources	Tier 1	-	-	-
Fugitive emissions	Tier 1	-	-	-
Others	Tier 1	-	-	-

9.6 GHG Emissions from Industrial Process of the Proposed Plant/Industry

The facility will operated as storage cum transfer facility, with no processing at site. During the operation phase electric power sourced from the grid will be the major source for energy consumption. As the IPCC does not provide emission factors for electricity consumption this has been excluded from the estimate.

9.7 GHG Emissions from Solvent Use in the Proposed Plant /Industry

A number of solvents will be used in the course of the DLBB Project. At present, the quantity of solvent to be used is unknown. During the construction and operation phases of the DLBB Project the quantity of solvent will be recorded and reported to the regulator.

9.8 GHG Emissions from Solid Waste Generation from Plant/Industry Premises

Non-hazardous waste from the DLBB Project will be disposed as identified in Section 4.2.3 and 4.3.3. The quantities of waste generated, disposed, and recycled will be recorded and reported by DPTC to the respective authority, including the potential greenhouse gas emissions.

9.9 GHG Emission from Wastewater Treatment in Plant/Industry Premises

Domestic waste water from the DLBB Project will be treated and reused as per local regulatory requirements. The quantity of domestic wastewater generated and reused will be recorded and reported by DPTC to the regulator, including the potential greenhouse gas emissions from wastewater treatment plant.

9.10 Assessment of Climate Change Impacts and Vulnerabilities

Oman's economy is dominantly dependent on the oil and gas industry. Investments are being made in economic diversification through the development of non-oil based economic activities through privatization, industrialization and tourism. Oman is working to reduce the oil sector's Gross Domestic Product (GDP) contribution to 9 % by 2020. Arable land is only 0.2 % and agricultural production has been steadily declining since oil was discovered in 1962. In 2000, the agricultural sector's GDP contribution to the national economy accounted for almost 2 %, and it is projected to decline further with the negative impacts of climate change.

Oman imports more than 50 % of its food to meet the needs of its population. Oman has three major land systems: the coastal plain, the mountain ranges, and the internal regions. The topography of rugged mountains and desert plain, coupled with hot, humid and dry weather conditions with strong, southwest summer monsoon winds, renders the country vulnerable to natural hazard risks, including droughts, storms, and sand and dust storms. Climate change is expected to cause dramatic changes in temperature and very strong winds causing sandstorms. Climate variability is likely to increase and negatively impact the country's agricultural sector. Oman's economic development is at risk to the potential impacts of climate change. Groundwater pollution and the increase of water salinity are of growing concern. Soil salinity and desertification are increasing, while beach pollution from oil spills is also very detrimental to the environment. Since 1950 mean annual temperature in Oman has increased by 0.7 ºC, with rainfall in Salalah to the south indicating an increase of 4.59 mm/month per century for the period 1950 to 2000.

Climate change models predict the following changes in Omani Climate (source: http://sdwebx.worldbank.org/climateportalb/home.cfm?page=country_profile&CCode=OMN&ThisTab=ClimateFuture):

- Mean annual temperature may increase by 1 ºC by 2050
- The country is expected to experience more frequent heat waves and more frost days
- Models diverge as to whether the country will become wetter or drier, and on how runoff (precipitation minus evapotranspiration), a measure of water availability, will change. Mean annual precipitation could increase by 2 %

- The maximum amount of rainfall in any 5-day period (a surrogate for an extreme storm event) is projected to increase, while the maximum period between rainy days is expected to decrease

Table 9-10 presents the climate affairs risk matrix which has been prepared considering the above discussion. As per MECA Guideline (2010) the Frequency/degree of vulnerability might be assigned as 1 (low), 2 (medium) or 3 (high). The identified vulnerabilities might be assigned as 1 (low), 2 (medium) or 3 (high). Risk magnitude is calculated multiplying frequency of vulnerabilities and climate impacts.

Table 9-10: Climate Affairs Risk Matrix

Type of Risk	Frequency /Degree of vulnerability	Climate Impacts due to Identified Vulnerability	Risk Magnitude	Remarks if any
Natural Disasters such as cyclone, high waves, landslides, and dust storms	2	2	2	The facility is located on the coast and could be vulnerable to cyclones and high waves.
Sea Level Rise	3	2	3	Potential sea level rise has been factored in the design
Temperature increase	1	1	1	No direct impact on the facility operation
Heavy rains	2	2	2	The facility is located to the south of 2 wadis that are being trained to reduce the flood risk to SEZD, PDC and the DLBB Project. Heavy rain prior to completion of the wadi training during the construction phase could pose a risk to the DLBB Project.
Flash floods	2	2	2	Refer # Heavy rain

9.11 Climate Change Mitigation and Adaptation

9.11.1 Mitigation

DPTC will manage GHG emissions from the DLBB Project by:

- Quantification GHG emissions.
- Identifying options to reduce the emissions.
- Documentation local targets for emission reduction.

In conjunction with the quantification of GHG emissions, an abatement plan will be developed by DPTC to reduce GHG emissions. Measures proposed by DPTC will include

Collecting actual data on the quantity of gas flared and fuel consumed.

- Estimating GHG emission through the data collected on the quantity of gas flared and the fuel consumed.
- Tracking and reporting the GHG emissions all through the DLBB Project.
- Reducing GHG emissions by adopting measures to save energy and fuel, including:
    - Regular equipment maintenance as per manufacturer specification.
    - Planning of men/material/manpower transport in order to minimise movement of vehicles and reduce fuel consumption.
    - Discouraging idling equipment and vehicles.
    - Use of standard equipment without modification.
    - Training drivers operate equipment efficiently in order to minimise fuel consumption.

9.11.2 GHG Sinks

The DLBB Project is being developed on reclaimed land on the LBW making development of a green belt within the DLBB Project premises difficult. As an alternative DPTC will be support afforestation programs led by the government as part of its CSR campaign.

9.11.3 Climate Change Adaptation

Being a coastal project the DLBB Project is in particular vulnerable to sea-level rise and in order to mitigate this, a sea level rise (SLR) of 5 mm/y is applied to the DLBB Project. This equates to an allowance of 0.25 m over a 50 year design life.

10 CONCLUSIONS

The DLBB Project is surrounded by *sabkha* and the nearest inhabited village is the Say village located about 5.5 km south west, with a fish landing area located 4 km north. The predominant wind direction is towards north east away from these population centres. The social baseline survey conducted as part of this EIA study indicated that the local population supports the ongoing developments in Duqm and is looking for an improvement in their quality of life as result of the developments. The terrestrial and coastal environments around the DLBB Project are sensitive on account of the terrestrial area adjoining the DLBB Project being designated an IBA and the presence of the Arabian Sea Humpback Whale which is endemic to the region and endangered. It should be, however, noted that the study area on the whole is undergoing major development as part of the SEZD development and all stakeholders will contribute to environmental impact in the region.

The impacts from the DLBB Project have been rated from slight to medium significance and through the implementation of mitigation measured the impact is considered to be ALARP, supporting the case for the development of the Project.

It should be noted that the following studies/activities were not completed at the time of submission of the EIA and the same will be submitted to the regulator in due course:

- The sediment sampling and analysis that was to be carried out for the EIA study could not be completed because of inclement weather conditions during the *Khareef* period. The same will be undertaken and completed following the end of *Khareef* period.
- The Plume Dispersion Modelling is partially completed. The modelling results were available for the dredging activities within the Port, and this has been presented earlier in this report. However, the modelling studies for the offshore borrow and disposal areas are ongoing.
- The Oil Spill Modelling study to simulate the effect of oil spill on seawater during an operational failure on the terminal / jetty is underway, but has not been completed.
- The letter of waste acceptance has not been received yet from be'ah.

Appendix 1: Diffusion Tubes Laboratory Results

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ilac-MRA UKAS TESTING 2187

LABORATORY ANALYSIS REPORT

REPORT NUMBER	X2874R
CUSTOMER	WORLEY PARSONS OMAN ENGINEERING LLC P.O.BOX 795, PC 133 Dohat Al Abad Street Block 235, Bldg. 350 Al-Khuwair, Muscat Sultanate of Oman
GRADKO LAB REFERENCE	GHSJ0144-0159
DESPATCH NOTE No.	SOR17608
DATE SAMPLES RECEIVED	30.01.15
BOOKING IN REF.	X2874

QUANTITATIVE ANALYSIS OF BTEX
IDENTIFICATION AND ESTIMATION (SEMI-QUANTITATIVE ANALYSIS) OF TOP 10 VOC
ON TENAX DIFFUSION TUBES BY GC/MS
Analysis has been carried out in accordance with in-house method GLM 13

Tube Number	**GRA 08951**
Exposure Time(mins)	**29280**
Sample ID	**DF1A**

BTEX	**ng on tube**	**ppb in air***
Benzene	9.16	0.30
Toluene	<5.00	<0.14
Ethylbenzene	<5.00	<0.11
m/p-Xylene	<5.00	<0.11
o-Xylene	<5.00	<0.11

Top 10 VOC	**ng on tube**	**ppb in air***
Benzoic acid **+**	76.60	1.31
Naphthalene	49.05	0.84
Nonanal** **+**	41.52	0.71
Benzaldehyde**	33.60	0.57
2,2,4-Trimethyl-1,3-pentanediol diisobutyrate	30.67	0.52
Acetophenone**	25.80	0.44
Phenylmaleic anhydride	20.12	0.34
Cyclotetradecane **+**	16.97	0.29
Phenol	16.79	0.29
Acetic Acid	14.12	0.24

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LABORATORY ANALYSIS REPORT

Tube Number	**GRA 09743**
Exposure Time(mins)	**29280**
Sample ID	**DF1B**

BTEX	**ng on tube**	**ppb in air***
Benzene	11.18	0.37
Toluene	<5.00	<0.14
Ethylbenzene	<5.00	<0.11
m/p-Xylene	<5.00	<0.11
o-Xylene	<5.00	<0.11

Top 10 VOC	**ng on tube**	**ppb in air***
Benzoic acid **+**	204.14	3.49
1,2-Benzenedicarboxylic acid, diisooctyl ester **+**	48.04	0.82
Benzaldehyde**	38.26	0.65
Acetophenone**	37.88	0.65
2,5-Cyclohexadiene-1,4-dione, 2,5-diphenyl- **+**	33.78	0.58
Phenylmaleic anhydride	33.20	0.57
Benzoylformic acid **+**	23.13	0.39
Nonanal** **+**	20.06	0.34
Cyclotetradecane **+**	19.28	0.33
2-Naphthyl benzoate **+**	18.95	0.32

Tube Number	**GRA 08934**
Exposure Time(mins)	**27360**
Sample ID	**DF3A**

BTEX	**ng on tube**	**ppb in air***
Benzene	9.34	0.33
Toluene	6.38	0.19
Ethylbenzene	9.52	0.23
m/p-Xylene	8.76	0.21
o-Xylene	<5.00	<0.12

Top 10 VOC	**ng on tube**	**ppb in air***
1,2-Benzenedicarboxylic acid, diisooctyl ester **+**	414.54	7.58
Benzoic acid **+**	254.14	4.64
2,5-Cyclohexadiene-1,4-dione, 2,5-diphenyl- **+**	45.98	0.84
Acetophenone**	41.08	0.75
Phenylmaleic anhydride	40.74	0.74
Diethyl Phthalate **+**	36.78	0.67
Naphthalene	25.24	0.46
Benzoylformic acid **+**	23.47	0.43
2-Naphthyl benzoate **+**	21.67	0.40
Nonanal** **+**	21.47	0.39

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LABORATORY ANALYSIS REPORT

Tube Number	**GRA 07618**
Exposure Time(mins)	**27360**
Sample ID	**DF3B**

BTEX	**ng on tube**	**ppb in air***
Benzene	7.86	0.28
Toluene	<5.00	<0.15
Ethylbenzene	<5.00	<0.12
m/p-Xylene	<5.00	<0.12
o-Xylene	<5.00	<0.12

Top 10 VOC	**ng on tube**	**ppb in air***
Benzoic acid **+**	79.79	1.46
Naphthalene	30.81	0.56
Benzaldehyde**	29.54	0.54
Acetophenone**	28.17	0.51
2,5-Cyclohexadiene-1,4-dione, 2,5-diphenyl- **+**	26.25	0.48
Nonanal** **+**	23.59	0.43
Cyclotetradecane **+**	18.66	0.34
Phenylmaleic anhydride	17.40	0.32
1,2-Benzenedicarboxylic acid, diisooctyl ester **+**	14.10	0.26
Diethyl Phthalate **+**	11.96	0.22

Tube Number	**GRA 08845**
Exposure Time(mins)	**29160**
Sample ID	**DF4A**

BTEX	**ng on tube**	**ppb in air***
Benzene	10.01	0.33
Toluene	15.60	0.44
Ethylbenzene	13.42	0.31
m/p-Xylene	44.09	1.01
o-Xylene	18.87	0.43

Top 10 VOC	**ng on tube**	**ppb in air***
Benzoic acid **+**	181.42	3.11
Heptane, 2,2,4,6,6-pentamethyl- **+**	172.07	2.95
Decane	120.65	2.07
1,2-Benzenedicarboxylic acid, diisooctyl ester **+**	109.25	1.87
Benzaldehyde**	80.89	1.39
2,5-Cyclohexadiene-1,4-dione, 2,5-diphenyl- **+**	48.40	0.83
Acetophenone**	41.20	0.71
2-Ethyl-1-hexanol	41.05	0.70
Phenol	35.63	0.61
Squalene **+**	33.67	0.58

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LABORATORY ANALYSIS REPORT

Tube Number	**GRA 09042**		
Exposure Time(mins)	**29160**		
Sample ID	**DF4B**		
BTEX		**ng on tube**	**ppb in air***
Benzene		11.62	0.39
Toluene		<5.00	<0.14
Ethylbenzene		<5.00	<0.12
m/p-Xylene		<5.00	<0.12
o-Xylene		<5.00	<0.12
Top 10 VOC		**ng on tube**	**ppb in air***
Benzoic acid **+**		151.51	2.60
1,2-Benzenedicarboxylic acid, diisooctyl ester **+**		47.28	0.81
2,5-Cyclohexadiene-1,4-dione, 2,5-diphenyl- **+**		40.65	0.70
Benzaldehyde**		35.01	0.60
Naphthalene		32.61	0.56
Acetophenone**		29.92	0.51
Phenylmaleic anhydride		23.01	0.39
Nonanal** **+**		22.79	0.39
Benzoylformic acid **+**		18.08	0.31
Cyclohexadecane **+**		16.95	0.29

Tube Number	**GRA 10518**		
Exposure Time(mins)	**30060**		
Sample ID	**DF5A**		
BTEX		**ng on tube**	**ppb in air***
Benzene		8.17	0.26
Toluene		<5.00	<0.14
Ethylbenzene		<5.00	<0.11
m/p-Xylene		<5.00	<0.11
o-Xylene		<5.00	<0.11
Top 10 VOC		**ng on tube**	**ppb in air***
Benzoic acid **+**		142.86	2.38
1,2-Benzenedicarboxylic acid, diisooctyl ester **+**		61.50	1.02
Naphthalene		39.98	0.67
Nonanal** **+**		34.48	0.57
Acetophenone**		30.83	0.51
Benzaldehyde**		27.19	0.45
Benzoylformic acid **+**		16.81	0.28
Cyclotetradecane **+**		15.64	0.26
Phenol		13.23	0.22
2-Naphthyl benzoate **+**		10.40	0.17

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LABORATORY ANALYSIS REPORT

Tube Number	**GRA 04017**
Exposure Time(mins)	**30060**
Sample ID	**DF5B**

BTEX	**ng on tube**	**ppb in air***
Benzene	7.16	0.23
Toluene	<5.00	<0.14
Ethylbenzene	<5.00	<0.11
m/p-Xylene	<5.00	<0.11
o-Xylene	<5.00	<0.11

Top 10 VOC	**ng on tube**	**ppb in air***
Benzoic acid **+**	137.20	2.28
Phenylmaleic anhydride	32.17	0.54
Benzaldehyde**	31.44	0.52
Acetophenone**	28.74	0.48
Naphthalene	24.70	0.41
Benzoylformic acid **+**	18.56	0.31
Phenol	12.04	0.20
Acetic Acid	12.01	0.20
Cyclotetradecane **+**	11.42	0.19
Benzoyl isothiocyanate **+**	6.67	0.11

Tube Number	**GRA 09669**
Exposure Time(mins)	**27360**
Sample ID	**DF6A**

BTEX	**ng on tube**	**ppb in air***
Benzene	18.32	0.65
Toluene	<5.00	<0.15
Ethylbenzene	<5.00	<0.12
m/p-Xylene	<5.00	<0.12
o-Xylene	<5.00	<0.12
Top 10 VOC	**ng on tube**	**ppb in air***
Benzoic acid **+**	815.06	14.90
2,5-Cyclohexadiene-1,4-dione, 2,5-diphenyl- **+**	156.23	2.86
Phenylmaleic anhydride	124.33	2.27
Acetophenone**	97.14	1.78
Benzaldehyde**	90.36	1.65
2-Naphthyl benzoate **+**	72.10	1.32
Benzoylformic acid **+**	69.72	1.27
Phenol	29.47	0.54
Benzoyl isothiocyanate **+**	24.07	0.44
1,2-Benzenedicarboxylic acid, diisooctyl ester **+**	18.64	0.34

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L. Gates, Laboratory Manager

(A division of Gradko International Ltd.)
St. Martins House, 77 Wales Street Winchester, Hampshire SO23 0RH
tel.: 01962 860331 fax: 01962 841339 e-mail:diffusion@gradko.co.uk

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LABORATORY ANALYSIS REPORT

Tube Number	**GRA 11921**
Exposure Time(mins)	**27360**
Sample ID	**DF6B**

BTEX	ng on tube	ppb in air*
Benzene	9.15	0.32
Toluene	<5.00	<0.15
Ethylbenzene	<5.00	<0.12
m/p-Xylene	<5.00	<0.12
o-Xylene	<5.00	<0.12

Top 10 VOC	ng on tube	ppb in air*
Benzoic acid **+**	201.63	3.68
2,5-Cyclohexadiene-1,4-dione, 2,5-diphenyl- **+**	44.92	0.82
Naphthalene	41.90	0.77
Phenylmaleic anhydride	35.44	0.65
Benzaldehyde**	34.02	0.62
Acetophenone**	33.87	0.62
Benzoylformic acid **+**	23.20	0.42
2-Naphthyl benzoate **+**	21.49	0.39
Phenol	17.26	0.32
2-Ethyl-1-hexanol	13.28	0.24

Tube Number	**GRA 11954**
Exposure Time(mins)	**29100**
Sample ID	**DF7A**

BTEX	ng on tube	ppb in air*
Benzene	16.34	0.55
Toluene	<5.00	<0.14
Ethylbenzene	<5.00	<0.12
m/p-Xylene	<5.00	<0.12
o-Xylene	<5.00	<0.12

Top 10 VOC	ng on tube	ppb in air*
Benzoic acid **+**	180.64	3.10
2,5-Cyclohexadiene-1,4-dione, 2,5-diphenyl- **+**	40.24	0.69
Benzaldehyde**	34.84	0.60
Acetophenone**	32.82	0.56
Diethyl Phthalate **+**	32.66	0.56
Naphthalene	32.17	0.55
Nonanal** **+**	19.48	0.33
Benzoylformic acid **+**	17.21	0.30
2-Propenoic acid, 3-(4-methoxyphenyl)-, 2-ethylhexyl ester **+**	17.20	0.30
Phenol	15.88	0.27

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LABORATORY ANALYSIS REPORT

Tube Number	**GRA 09662**
Exposure Time(mins)	**29100**
Sample ID	**DF7B**

BTEX	ng on tube	ppb in air*
Benzene	9.40	0.31
Toluene	<5.00	<0.14
Ethylbenzene	<5.00	<0.12
m/p-Xylene	<5.00	<0.12
o-Xylene	<5.00	<0.12

Top 10 VOC	ng on tube	ppb in air*
Benzoic acid **+**	238.68	4.10
2,5-Cyclohexadiene-1,4-dione, 2,5-diphenyl- **+**	85.91	1.48
1,2-Benzenedicarboxylic acid, diisooctyl ester **+**	41.93	0.72
Benzaldehyde**	39.38	0.68
Acetophenone**	36.40	0.63
Phenylmaleic anhydride	35.49	0.61
1,2-Benzenedicarboxylic acid, mono(2-ethylhexyl) ester **+**	26.02	0.45
Benzoylformic acid **+**	24.79	0.43
Cyclohexadecane **+**	20.51	0.35
Diethyl Phthalate **+**	19.62	0.34

Tube Number	**GRA 07619**
Exposure Time(mins)	**29820**
Sample ID	**DF8A**

BTEX	ng on tube	ppb in air*
Benzene	6.31	0.21
Toluene	<5.00	<0.14
Ethylbenzene	<5.00	<0.11
m/p-Xylene	<5.00	<0.11
o-Xylene	<5.00	<0.11

Top 10 VOC	ng on tube	ppb in air*
Naphthalene	51.73	0.87
Benzaldehyde**	29.04	0.49
Acetophenone**	27.91	0.47
1,2-Benzenedicarboxylic acid, diisooctyl ester **+**	25.67	0.43
Nonanal** **+**	23.65	0.40
Cyclohexadecane **+**	22.85	0.38
Benzoic acid, tetradecyl ester **+**	18.33	0.31
Benzoic acid, tridecyl ester **+**	16.85	0.28
2,5-Cyclohexadiene-1,4-dione, 2,5-diphenyl- **+**	16.43	0.28
Benzoic acid, eicosyl ester **+**	12.14	0.20

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LABORATORY ANALYSIS REPORT

Tube Number	**GRA 08443**
Exposure Time(mins)	**29820**
Sample ID	**DF8B**

BTEX	ng on tube	ppb in air*
Benzene	6.33	0.21
Toluene	<5.00	<0.14
Ethylbenzene	<5.00	<0.11
m/p-Xylene	<5.00	<0.11
o-Xylene	<5.00	<0.11

Top 10 VOC	ng on tube	ppb in air*
Naphthalene	96.86	1.62
1,2-Benzenedicarboxylic acid, diisooctyl ester **+**	56.46	0.95
Cyclohexadecane **+**	26.03	0.44
Benzaldehyde**	18.95	0.32
Octadecanal **+**	17.61	0.30
Acetophenone**	14.45	0.24
2-Ethyl-1-hexanol	12.43	0.21
Dodecane	10.72	0.18
Tridecane	10.18	0.17
1,4-Methanoazulene, decahydro-4,8,8-trimethyl-9-methylene-, [1S-(1.alpha.,3a.beta.,4.alpha.,8a.beta.)]- **+**	8.98	0.15

Tube Number	**GRA 02464**
Exposure Time(mins)	**29760**
Sample ID	**DF9A**

BTEX	ng on tube	ppb in air*
Benzene	6.01	0.20
Toluene	9.35	0.26
Ethylbenzene	13.72	0.31
m/p-Xylene	32.64	0.74
o-Xylene	10.85	0.24

Top 10 VOC	ng on tube	ppb in air*
Naphthalene	47.04	0.79
Benzoic acid **+**	35.03	0.59
1,2-Benzenedicarboxylic acid, diisooctyl ester **+**	33.16	0.56
Acetophenone**	25.57	0.43
Benzaldehyde**	25.50	0.43
Cyclohexadecane **+**	24.80	0.42
Squalene **+**	22.99	0.39
Dodecane	16.76	0.28
Phenol	13.19	0.22
Heptane, 2,2,4,6,6-pentamethyl- **+**	12.92	0.22

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LABORATORY ANALYSIS REPORT

Tube Number	**GRA 09685**
Exposure Time(mins)	**29760**
Sample ID	**DF9B**

BTEX	**ng on tube**	**ppb in air***
Benzene	6.00	0.20
Toluene	<5.00	<0.14
Ethylbenzene	<5.00	<0.11
m/p-Xylene	<5.00	<0.11
o-Xylene	<5.00	<0.11

Top 10 VOC	**ng on tube**	**ppb in air***
Benzoic acid **+**	161.35	2.71
Naphthalene	63.59	1.07
Nonanal** **+**	35.58	0.60
2,5-Cyclohexadiene-1,4-dione, 2,5-diphenyl- **+**	34.87	0.59
Benzaldehyde**	27.31	0.46
Acetophenone**	25.33	0.43
Phenylmaleic anhydride **+**	19.35	0.33
Benzoylformic acid **+**	17.81	0.30
2-Ethyl-1-hexanol	15.98	0.27
Cyclohexadecane **+**	12.39	0.21

Uptake Rates:
Benzene 1.03 ng.ppm^{-1}.min^{-1}.
Toluene 1.22 ng.ppm^{-1}.min^{-1}.
Ethylbenzene 1.49 ng.ppm^{-1}.min^{-1}.
m/p Xylene 1.49 ng.ppm^{-1}.min^{-1}.
o-Xylene 1.49 ng.ppm^{-1}.min^{-1}.
All other compounds: 2.00 ng.ppm^{-1}.min^{-1}.

Results reported as <5ng on tube are below the reporting limit.
Reporting Limits:
Toluene 5ng
Ethylbenzene 5ng
m/p-Xylene 5ng
o-Xylene 5ng

****Compounds may be an artifact due to reaction of ozone with the Tenax sorbent.**
$^{+}$These compounds are not covered by our UKAS accredited flexible scope.
Acetic Acid may be an artifact due to the breakdown of Tenax sorbent.
Identification and estimation results for ng on tube are calculated by reference to toluene and toluene-d8 Internal standard.

The Diffusion Tubes have been tested within the scope of Gradko International Ltd. Laboratory Quality Procedures calculations and assessments involving the exposure procedures and periods provided by the client are not within the scope of our UKAS accreditation. Those results obtained using exposure data shall be indicated by an asterisk. Any queries concerning the data in this report should be directed to the Laboratory Manager Gradko International Ltd. This report is not to be reproduced, except in full, without the written permission of Gradko International Ltd.

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LABORATORY ANALYSIS REPORT

Overall MU 13.6% for quantitative analysis of BTEX.

		Date of Analysis	**04.02.2015**
Analysts Name	**Mariella Angelova**	**Date of Report**	**12.02.2015**

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LABORATORY ANALYSIS REPORT

NITROGEN DIOXIDE IN DIFFUSION TUBES BY U.V.SPECTROPHOTOMETRY

REPORT NUMBER X2875R

BOOKING REFERENCE No X2875

DESPATCH NOTE No SOR017608

CUSTOMER Worley Parsons Oman Engineereing LLC
Dohat Al Adab Street, Block 235, Bldg. 350, P.O. Box: 795, Al-Khuwair
Muscat, Sultanate of Oman

DATE SAMPLES RECEIVED 30-Jan

			Exposure Data			NO_2	NO_X	NO	NO_2	NO_X	NO	TOTAL	TOTAL
NO_2	Tube Number	NO_x	Date On	Date Off	Time (hr.)	ppb *	ppb *	ppb * +	µg/m^3	µg/m^3	µg/m^3 +	µG NO_2	µG NOx
465689	DF1A	465709	06/01/2015	26/01/2015	487.83	1.07	4.24	3.16	2.06	8.12	6.06	0.07	0.29
465690	DF1B	465710	06/01/2015	26/01/2015	487.83	1.28	4.64	3.36	2.45	8.88	6.43	0.09	0.32
465691	DF3A	465711	07/01/2015	26/01/2015	455.75	2.02	5.56	3.55	3.86	10.66	6.79	0.13	0.35
465692	DF3B	465712	07/01/2015	26/01/2015	455.75	1.31	5.75	4.44	2.51	11.02	8.51	0.08	0.37
465693	DF4A	465713	06/01/2015	26/01/2015	485.78	1.49	6.84	5.35	2.86	13.11	10.25	0.10	0.46
465694	DF4B	465714	06/01/2015	26/01/2015	485.78	1.71	5.50	3.78	3.29	10.54	7.25	0.12	0.37
465695	DF5A	465715	06/01/2015	27/01/2015	500.77	1.51	5.84	4.33	2.88	11.18	8.30	0.11	0.41
465696	DF5B	465716	06/01/2015	27/01/2015	500.77	1.53	6.01	4.47	2.94	11.51	8.57	0.11	0.42
465697	DF6A	465717	07/01/2015	26/01/2015	455.68	1.58	6.34	4.76	3.02	12.14	9.12	0.10	0.40

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LABORATORY ANALYSIS REPORT

465698	DF6B	465718	07/01/2015	26/01/2015	455.68	1.34	3.64	2.30	2.57	6.97	4.41	0.09	0.23
465699	DF7A	465719	06/01/2015	26/01/2015	484.78	2.33	7.35	5.02	4.46	14.08	9.62	0.16	0.50
465700	DF7B	465720	06/01/2015	26/01/2015	484.78	1.66	5.95	4.30	3.18	11.41	8.23	0.11	0.40
465701	DF8A	465721	06/01/2015	27/01/2015	497.48	2.05	6.67	4.62	3.93	12.78	8.85	0.14	0.46
465702	DF8B	465722	06/01/2015	27/01/2015	497.48	2.30	4.60	2.31	4.40	8.82	4.43	0.16	0.32
465703	DF9A	465723	06/01/2015	27/01/2015	496.20	2.40	5.75	3.34	4.60	11.01	6.41	0.17	0.40
465704	DF9A	465724	06/01/2015	27/01/2015	496.20	1.42	7.15	5.73	2.72	13.70	10.98	0.10	0.49
	Lab Blanks				500.77	0.06	0.22	0.16	0.11	0.41	0.30	0.004	0.015

Comment: Results are not blank subtracted

+NO results are derived by subtracting NO2 from NOx.
Results have been corrected to a temperature of 293K (20C)
Overall M.O.U. 7.3% +/- **Limit of Detection** 0.071ug NOx, 0.017ug NO2 on tube
Tube Preparation: 20%TEA/Water Analysed on UVS04 Camspec M550

Analyst Name C. Gemmell

Date of Analysis 04/02/2015 **Date of Report** 11/02/2015

Analysis carried out in accordance with documented in-house Laboratory Method GLM7

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LABORATORY ANALYSIS REPORT

DETERMINATION OF OZONE IN DIFFUSION TUBES BY ION CHROMATOGRAPHY

REPORT NUMBER	J00561R
BOOKING IN REFERENCE No	J00561
DESPATCH NOTE No	SOR017608
CUSTOMER	Worley Parsons Oman Attn: Radhakrishnan C. Bldg 1135, Way 4509 Block 245, Po Box 795 Postal Code 133, Al Khuw Sultanate Of Oman
DATE SAMPLES RECEIVED	30/01/2015

Location	Sample Number	Date Exposed	Date Finished	Exposure Hours	µg on Tube Total	µg - Blank	O_3 µg/m^3*	O_3 ppb*
DF1A	465749	06/01/2015	26/01/2015	487.83	1.15	1.13	133.58	66.79
DF1B	465750	06/01/2015	26/01/2015	487.83	1.27	1.25	148.39	74.19
DF3A	465751	07/01/2015	26/01/2015	455.75	1.03	1.00	127.26	63.63
DF3B	465752	07/01/2015	26/01/2015	455.75	0.95	0.92	117.17	58.58
DF4A	465753	06/01/2015	26/01/2015	485.78	1.03	1.01	119.94	59.97
DF4B	465754	06/01/2015	26/01/2015	485.78	1.24	1.22	145.25	72.63
DF5A	465755	06/01/2015	27/01/2015	500.77	1.34	1.32	152.23	76.12
DF5B	465756	06/01/2015	27/01/2015	500.77	1.42	1.39	160.95	80.47
DF6A	465757	07/01/2015	26/01/2015	455.68	0.99	0.97	122.57	61.28
DF6B	465758	07/01/2015	26/01/2015	455.68	1.45	1.42	180.77	90.38
DF7A	465760	06/01/2015	26/01/2015	484.78	1.11	1.09	130.02	65.01
DF7B	465761	06/01/2015	26/01/2015	484.78	1.09	1.07	127.53	63.76
DF8A	465762	06/01/2015	27/01/2015	497.48	1.13	1.10	128.09	64.04
DF8B	465763	06/01/2015	27/01/2015	497.48	0.96	0.94	109.30	54.65
DF9A	465764	06/01/2015	27/01/2015	496.20	1.02	0.99	115.69	57.85
DF9B	465765	06/01/2015	27/01/2015	496.20	1.42	1.40	163.00	81.50
Laboratory Blank					0.02			

Comment: Results are blank subtracted

Tubes were dirty when received. Results may be compromised.

Overall M.U.	±10.0%	**Reporting Limit**	0.096µg O_3
Analysed on Dionex ICS3000 ICU5		**Analyst Name**	Katya Paldamova
Date of Analysis	10/02/2015	**Date of Report**	11/02/2015

Analysis has been carried out in accordance with in-house method GLM 2

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LABORATORY ANALYSIS REPORT

DETERMINATION OF SULPHUR DIOXIDE IN DIFFUSION TUBES BY ION CHROMATOGRAPHY

REPORT NUMBER J00557R
BOOKING IN REFERENCE No J00557
DESPATCH NOTE No SOR017608
CUSTOMER Worley Parsons Oman Attn: Radhakrishnan C.
Bldg 1135, Way 4509
Block 245, Po Box 795
Postal Code 133, Al Khuw
Sultanate Of Oman

DATE SAMPLES RECEIVED 30/01/2015

Location	Sample Number	Date Exposed	Date Finished	Exposure Hours	µg S Total	µg S - Blank	SO_2 µg/m^3*	SO_2 ppb*
DF1A	465729	06/01/2015	26/01/2015	487.83	0.03	0.02	1.75	0.66
DF1B	465730	06/01/2015	26/01/2015	487.83	<0.03	<0.02	<1.57	<0.59
DF3A	465731	07/01/2015	26/01/2015	455.75	0.17	0.17	13.37	5.01
DF3B	465732	07/01/2015	26/01/2015	455.75	0.04	0.03	2.73	1.02
DF4A	465733	06/01/2015	26/01/2015	485.78	0.04	0.03	2.29	0.86
DF4B	465734	06/01/2015	26/01/2015	485.78	0.03	0.03	1.91	0.72
DF5A	465735	06/01/2015	27/01/2015	500.77	<0.03	<0.02	<1.53	<0.57
DF5B	465736	06/01/2015	27/01/2015	500.77	<0.03	<0.02	<1.53	<0.57
DF6A	465737	07/01/2015	26/01/2015	455.68	<0.03	<0.02	<1.68	<0.63
DF6B	465738	07/01/2015	26/01/2015	455.68	<0.03	<0.02	<1.68	<0.63
DF7A	465739	06/01/2015	26/01/2015	484.78	0.03	0.02	1.76	0.66
DF7B	465741	06/01/2015	26/01/2015	484.78	<0.03	<0.02	<1.58	<0.59
DF8A	465740	06/01/2015	27/01/2015	497.48	0.04	0.03	2.22	0.83
DF8B	465742	06/01/2015	27/01/2015	497.48	<0.03	<0.02	<1.54	<0.58
DF9A	465743	06/01/2015	27/01/2015	496.20	<0.03	<0.02	<1.55	<0.58
DF9B	465744	06/01/2015	27/01/2015	496.20	0.04	0.03	2.38	0.89
Laboratory Blank					0.01			

Comment: Results are blank subtracted
Results reported as <0.03µg S are below the reporting limit.

Tubes were dirty when received. Results may be compromised.

Overall M.U. ±6.0%

Reporting Limit 0.03µg S

Analysed on Dionex ICS3000 ICU5

Analyst Name Katya Paldamova

Date of Analysis 12/02/2015

Date of Report 13/02/2015

Analysis has been carried out in accordance with in-house method GLM1

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Appendix 2: Marine Baseline Study Report

WorleyParsons
resources & energy

الدقم للمستودعات البترولية
DUQMTERMINAL

DUQM LIQUID BULK BERTHS PROJECT

Report

Marine Environmental Baseline Survey

SEZAD-DPTC-00-WP-EV-REP-2004-B2

22-Sep-2015

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DUQMTERMINAL

DUQM LIQUID BULK BERTHS PROJECT
REPORT MARINE ENVIRONMENTAL BASELINE SURVEY

SYNOPSIS

This document presents the Report on the Marine Environmental Baseline Survey for DUQM LIQUID BULK BERTHS PROJECT.

PROJECT # 303060-00098 - REPORT - MARINE ENVIRONMENTAL BASELINE SURVEY

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
A1	Issued for IDC	M Brosa	A Concesso	N/A	01-June-2015	N/A	
A2	Issued for Client Review	M Brosa	A Concesso	J Akhtar	10-June-2015		
B1	Approved for Use	M Brosa	A Concesso	J Akhtar	11-Aug-2015		
B2	Approved for Use	S Poonacha	A Concesso	J Akhtar	22-Sep-2015	22-9-2015	22/9/2015

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REVISION DESCRIPTION LIST

Rev.	Para.	Revision Description
A1		Issued for Inter-Disciplinary Check
A2		Issued for Client Review (Incorporated IDC Comments)
B1		Approved for Use (Incorporated ICR Comments) – document has HOLDs as described below. When the relevant data is available this document will be updated accordingly and issued for client review
B2		Approved for Use with HOLDs as explained above (Incorporated Client comments on Rev-B1)

Hold No.	Para.	Description of Hold
1	**4.2**	Physical and chemical sediment sampling is due to be undertaken after Khareef in 2015. Consequently, results of the sediment quality analyses are on hold.
2	4.2	Physical Sediment Quality - As above
3	4.2.2	Chemical Sediment Quality - As above
4	5.3	Physical and chemical sediment sampling is due to be undertaken after Khareef in 2015. Consequently, discussion of physical sediment quality is on hold.
5	5.4	Physical and chemical sediment sampling is due to be undertaken after Khareef in 2015. Consequently, discussion of chemical sediment quality is on hold.

1 INTRODUCTION

1.1 Overview

Duqm Petroleum Terminal Company (DPTC), a joint venture company between Oman Oil Company (OOC) and the Port of Duqm (PDC), has been established to develop and operate the Liquid Bulk Berths Terminal, in the Duqm Port. WorleyParsons has been retained by DPTC for the Consultancy Services for Project Definition, FEED and supervision of the New Liquid Bulk Berths in the Port of Duqm.

As part of the contract, WorleyParsons was commissioned by DPTC to prepare an Environmental Impact Assessment (EIA) to describe the likely environmental and social impacts associated with the proposed development. As part of this EIA, WorleyParsons is required to undertake an assessment of the existing marine environmental conditions of the area surrounding the site. The aim is to determine environmental impacts associated with the construction and operation of the Liquid Bulk Berths Terminal.

1.2 Location

The study area is situated on the eastern coast of Oman, approximately 450 km southwest of Muscat and faces the Arabian Sea. The study area comprises the developing Port of Duqm, the adjacent coastline to the north and south of the lee breakwater and the proposed liquid bulk berths erminal on the lee breakwater (Figure 1-1). Existing infrastructure of the Port includes a main breakwater, lee breakwater, dry dock yard, cargo storage areas and Government Quay.

In addition, an offshore dredge spoil disposal area and a material reclamation borrow areas were also surveyed. These areas are situated east of the Port, the disposal area is 18 km offshore and the borrow area is 40 km offshore.

Figure 1-1 Project Location

1.3 Project Description

The Liquid Bulk Berths Terminal Project involves the development of liquid bulk berths and tank facilities for the export of finished products, from the Duqm Refinery. Phase 1 of the Duqm Refinery, with a capacity of 230,000 BPD, is currently being planned. The finished products handled are Naphtha, Jet A1, Diesel, High Sulphur Fuel Oil (HSFO), Pressurized Liquefied Petroleum Gas (PLPG), Pet Coke and Sulphur.

1.4 Survey Brief and Scope

This report details the findings of the marine environmental baseline assessment undertaken within the study area. It will provide information to assist with the identification of likely impacts of the proposed terminal on the existing marine environment and will inform the EIA. The key objectives of the assessment were to:

- Conduct a desktop review of existing literature and available data to provide context and understanding to the current assessment of environmental conditions.
- Describe ambient water quality, including both physicochemical and chemical properties within the study area;
- Characterise surface sediments within the study area; and
- Describe the condition and extent of subtidal and intertidal marine benthic habitats in the study area.

1.5 Structure of the Report

This report of the Marine Environmental Baseline Survey is structured in the following way:

1	**Introduction**	Overview of the proposed Project and objectives of the marine environmental baseline survey.
2	**Literature Review**	Compilation of available and relevant information from the literature.
3	**Field Methods**	Description of equipment, sampling design and coordinates.
4	**Results**	Presentation of analysed data and comparison against available guideline values.
5	**Discussion**	Description of trends and comparison between locations and with collected as part of previous surveys.
6	**Conclusions**	Overview of key findings from the collected survey data.

1.6 Abbreviations

ASHW	Arabian Sea Humpback Whales
BTEX	Benzene, Toluene, Ethyl benzene, and Xylenes
DPTC	Duqm Petroleum Terminal Company
DO	Dissolved Oxygen
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
ESO	Environment Society of Oman
FNU	Formazin Nephelometric Unit
GPS	Global Positioning System
HSFO	High Sulphur Fuel Oil
IBA	Important Bird Area
MECA	Ministry of Environment and Climate Affairs
NOAA	National Oceanic and Atmospheric Administration
OBRC	Oman Bird Records Committee
OOC	Oman Oil Company
PAH	Poly Aromatic Hydrocarbons
PDC	Port of Duqm
PLPG	Pressurized Liquefied Petroleum Gas
PSU	Practical Salinity Unit
SEZ	Special Economic Zone
TPH	Total Petroleum Hydrocarbon
TSS	Total Suspended Solids

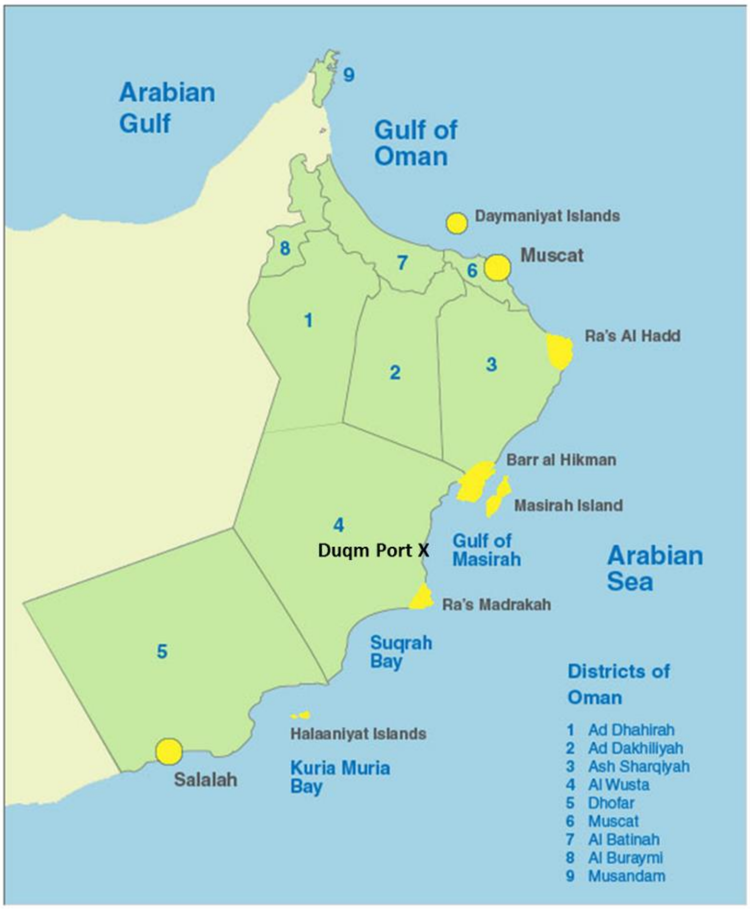
2 LITERATURE REVIEW

2.1 Protected Areas

2.1.1 Marine Reserves

A number of Marine Nature Reserves were declared in the 1990s by the then Ministry of Regional Municipalities, Environment & Water Resource to protect vulnerable marine areas (Figure 2-1). All are located outside the Gulf of Masirah and a significant distance from Duqm Port. These include:

- Ra's Al-Hadd Nature Reserve (Turtle nesting), approximately 350 km to the northeast of Duqm;
- Daymaniyat Islands Nature Reserve (Turtle nesting), approximately 450 km north of Duqm; and
- The Khawars (Lagoons) of the Salalah Coast Reserve, approximately 480 km to the southwest of Duqm.



Source: Environment Society of Oman

Figure 2-1 Protected areas and other regions of conservation interest Oman

2.1.2 Areas of Conservation

A number of internationally recognised conservation areas exist in the region of the Port, but do not have full protected status within Oman. All are located outside the Gulf of Masirah and a significant distance from Duqm Port. Conservation areas closest to the Port include the following.

2.1.2.1 Masirah Island

Although globally recognised as an area of conservation significance, Masirah Island, located approximately 100 km to the northeast of Duqm is not currently declared a formal protected area under Oman legislation. However it has been proposed as a candidate Marine Protected Area (MPA) (Holt 2012). Fishing is also banned within the eastern nearshore area of the island (NATO 2013).

2.1.2.2 Barr al Hikman

To the northern end of the Gulf of Masirah, Barr al Hikman, located approximately 90 km to the northeast of Duqm, is one of the largest coastal wetlands in the Middle East, providing 148 Km^2 of inter-tidal mudflats. In winter the area attracts up to half a million predominantly shorebirds (waders), gulls, terns, and herons.

Barr al Hikman also supports approximately 30 km^2 of Coral Reef, uniquely consisting of a single coral species, the Oman cabbage coral (*Montipora foliosa*).

2.1.2.3 The Halaaniyat Islands

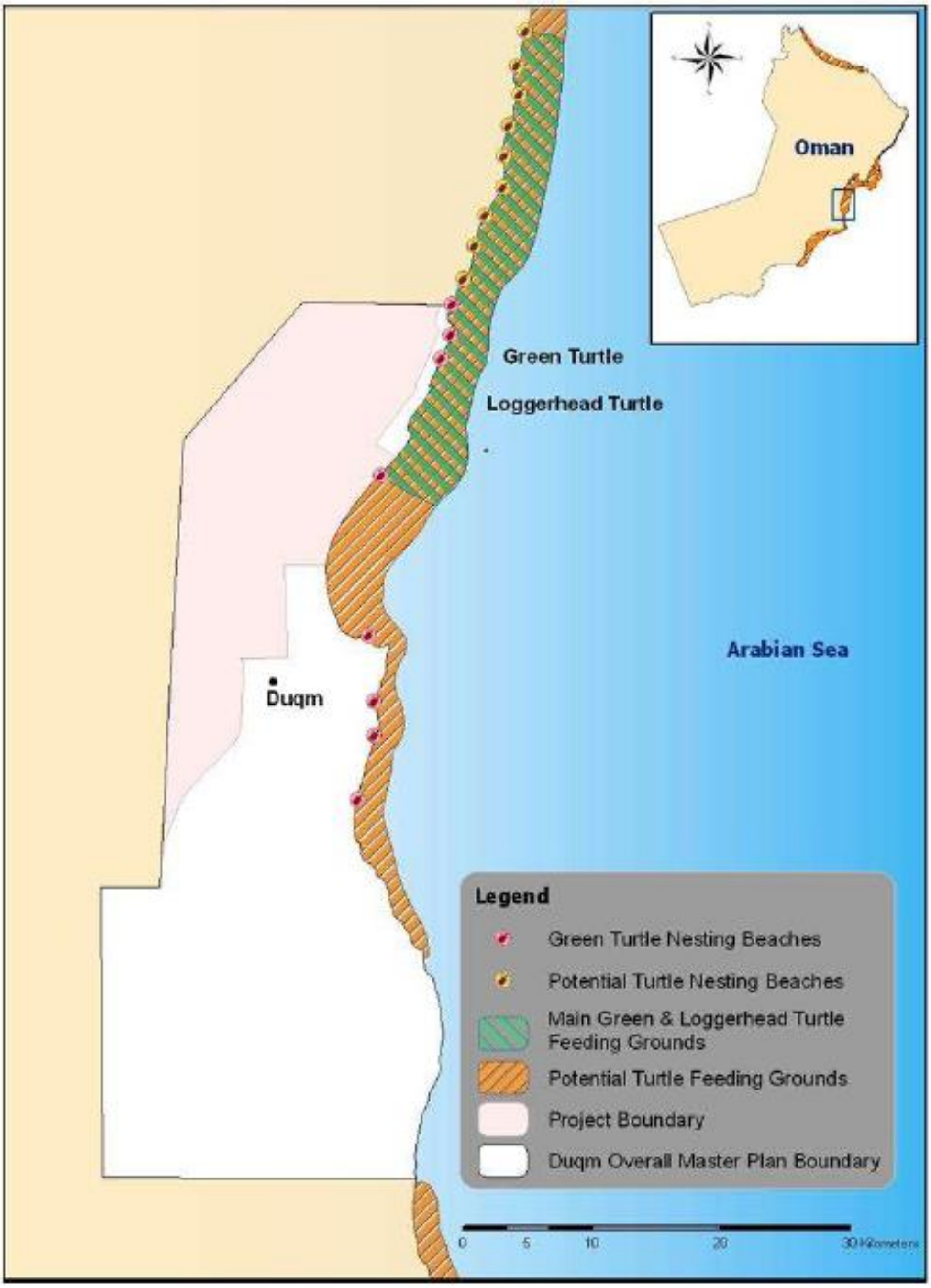
The Halaaniyat Islands, approximately 300 km to the south of Duqm, are a significant seabird nesting site for masked boobies (*Sula dactylatra*), red-billed tropic birds (*Phaethon aethereus)*, jouanin's petrel (*Bulweria fallax)*, roseate terns (*Terna dougallii)* and others. The islands are also noted for supporting pods of sperm whales (*Physeter Macrocephalus*). Long-Beaked Common Dolphins (*Delphinis capensis tropicalis)* are also recorded schooling in the thousands.

2.1.2.4 Ras Madrakah

The Ras Madrakah region of beaches, approximately 70 km from Duqm, on the southern end of the Gulf of Masirah is known for high incidents of turtle nesting (ESO 2009).

2.2 Turtles

There is evidence that turtles feed and nest on beaches along the coast immediately surrounding the Duqm area, such as green and loggerhead turtles (Ross, 1979, Salm, 1991, Siddeek and Baldwin 1996) (Figure 2-2). Although their abundance is relatively low compared to other nearby areas such as Masirah Island, the area around Duqm is considered a critical feeding and breeding habitat for certain turtle species, as well as being on a migratory pathway.



Source: Duqm Port IDZ EIA Report 2011, based on Salm 1991

Figure 2-2 Main nesting beaches and feeding grounds for turtles

The main area of conservation concern for turtles in proximity to Duqm Port is Masirah Island, approximately 100 km away. Masirah Island is a key turtle nesting location of global significance. Four species of marine turtle nest on Masirah's beaches: the loggerhead turtle *(Caretta caretta)*, green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*) and olive ridley turtle (*Lepidochelys olivacea*) (Table 2-1). Masirah Island is internationally known for its loggerhead nesting population, considered one of the largest in the world, with tens of thousands of loggerheads estimated to nest annually (Ross 1998).

Each species nests on specific beaches at varying times throughout the year. Hawksbill and olive ridley turtles nest in the winter and spring months whereas the loggerhead and green turtles nest in the summer and autumn (Ross and Barwani 1982).

Table 2-1 Summary of Masirah Island's marine turtle species

Species	Nesting season	IUCN Red List status 01/2015
Loggerhead *(Caretta caretta)*	July to September	Endangered – needs updating
Green Turtle (*Chelonia mydas*)	July to September	Endangered - population trend decreasing
Hawksbill Turtle (*Eretmochelys imbricata*)	February to April	Critically endangered - population trend decreasing
Olive Ridley (*Dermochelys coriacea*)	February to April	Vulnerable - population trend decreasing

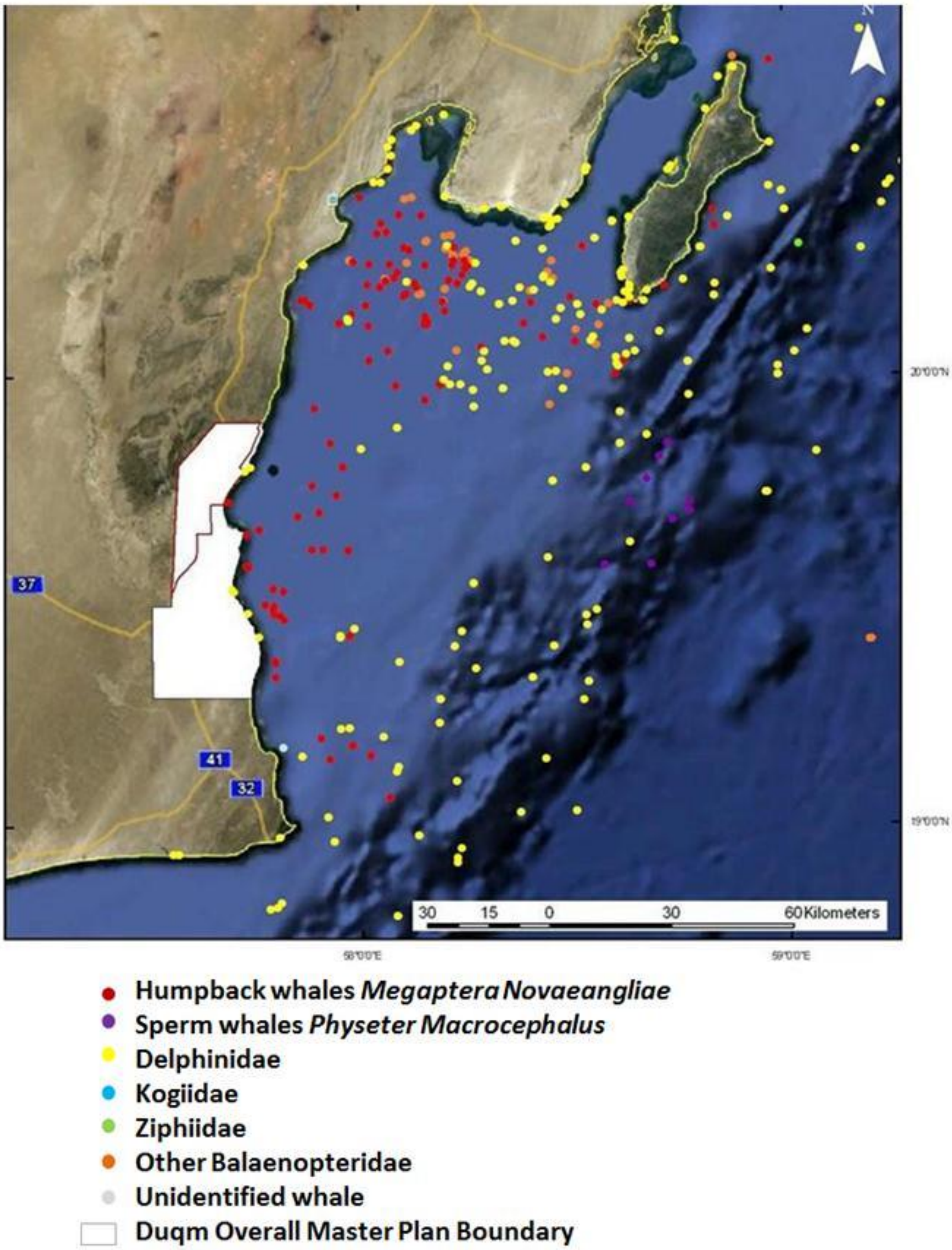
In 2011 a tracking study undertaken by the Ministry of Environment and Climate Affairs (MECA) and Environment Society of Oman (ESO) showed that post nesting movements of loggerhead turtles from Masirah Island, included southwards through the Gulf of Masirah and nearshore areas around Duqm Port (MECA and ESO 2011). Olive ridley turtles have also been shown to migrate through coastal areas around Duqm (MTRG 2008).

ESO has signed two memoranda of understanding with the Oman Oil Company (OOC) and the Port of Duqm to support marine turtle conservation on Masirah Island. All turtle species are protected by both Omani national legislation and international agreements to which Oman is a signatory, such as the Convention on the Conservation of Migratory Species of Wild Animals (CMS Convention).

2.3 Cetaceans

There are 21 species of cetaceans recorded in Oman (Hoyt 2012). The following is a focussed summary of information on key species recorded specifically around the Gulf of Masirah and Duqm Port.

Figure 2-3 presents sightings data for cetacean in the Gulf of Masirah over the last 20 years (ESO 2010). This data should only be viewed as indicative to cetacean presence, as it does not show density over time. The most commonly recorded nearshore species in the Duqm area are humpback whales and various species of the *Delphinidae* family, for example dolphins, pilot whales and killer whales.



Source: Environmental Society of Oman, 2010

Figure 2-3 Live sightings and strandings in proximity to Duqm Port

2.3.1 Arabian Sea Humpback Whale (*Megaptera novaeangliae)*

Arabian Sea Humpback Whales (ASHW) are the only known non-migratory population of humpback whales, with the current population estimated to number less than 100 individuals (Corkeron *et.al* 2011). ASHW were designated as an endangered subpopulation in the 2008 revision of the IUCN Red List for cetacean species and are listed as Endangered. Data from photo-identified individuals (Minton *et al.* 2010) and genetics (Pomila *et al.* 2014) demonstrate this population is genetically isolated from the nearest neighbouring Indian Ocean populations. ASHW are geographically and demographically rare, with a unique year-round residency in sub-tropical waters of the Arabian Sea. This group are therefore of significant conservation interest.

An almost continuous survey between 2007-2008 of the Oman Marine Science and Fisheries Centre recorded multiple humpback whales around Duqm Port (Gheilani 2008). Survey sightings occurred mainly between August to November (60%) and February to April (40%). No humpback whales were recorded between May to July.

A 2012 vessel survey in the Gulf of Masirah also recorded three sightings of ASHW (Willson *et al.* 2013). Two humpbacks were recorded within 5 km of Duqm Port. When the Port becomes active, vessel traffic passing to the east of Masirah Island may be diverted inshore across potential Humpback Whale habitat. Minton *et al.* (2010) concluded the nearshore areas of the Gulf of Masirah to be a critical habitat for humpback whales.

2.3.2 Bryde's Whale (*Balaenoptera edeni*)

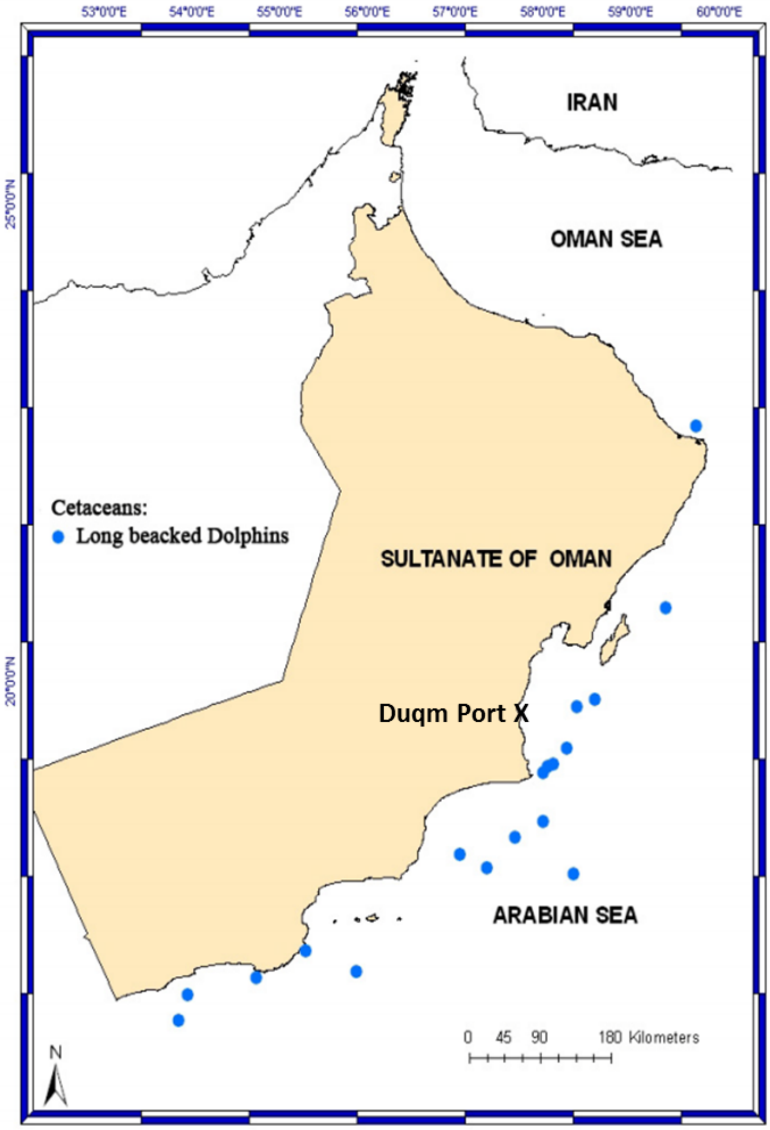
The Bryde's whale is also known to be found in the Gulf of Masirah (ESO 2009), attracted by the high productivity and fish abundance in the area. The area acts as an important calving habitat for the Bryde's and humpback whales.

Additional whale species, including the sperm whale (*Physeter macrocephalus*) and rarer blue whale (*Balaenoptera musculus*) have been recorded in the Gulf of Masirah, but seasonality to the sighting data suggests a migratory route through the area (Baldwin 2003).

2.3.3 Long-beaked Common Dolphin (*Delphinis capensis tropicalis*)

Willson *et al.* (2013) recorded the long-beaked common dolphin as present in the Gulf of Masirah. It is recognised as the second most common cetacean species in Oman.

The 2007-2008 Ghelaini survey recorded a number of sightings in and around the Gulf of Masirah (Figure 2-4). Sightings occurred in March, May and November, 60% were found between Masirah and Demaniat Island. *Delphinis capensis tropicalis* is not currently listed under the IUCN Red List.



Source: Gheilani 2007-2008

Figure 2-4 Long beaked common dolphin sightings around Duqm Port

2.3.4 Indo-Pacific Humpback Dolphins (*Sousa chinensis*)

The range of *Sousa chinensis* appears to be continuous along the coast of Oman (Baldwin and Salm 1994). A study conducted between 2000 and 2003 demonstrated that the nearshore areas of the Gulf of Masirah are a concentration zone for the Arabian Sea's population of *Sousa chinensis* (Minton *et al.* 2010). The IUCN Red List currently lists the status of *Sousa chinensis* as 'Near Threatened' with a decreasing population trend.

2.3.5 Bottlenose Dolphin (*Tursiops sp*)

Willson *et al.* (2013) recorded two sightings of bottlenose dolphin species in the Gulf of Masirah. Specifically the Indo-Pacific bottlenose dolphin is found in Omani waters. A 2012 study suggests they feed primarily in shallow, inshore waters along the Gulf of Masirah and over the continental shelf (Ponnampalam *et al.* 2012). The IUCN red list provides its current status as data deficient, with population trend unknown.

2.3.6 Spinner Dolphin (*Stenella longirostris*)

Spinner dolphins are commonly recorded along the coastal waters of Oman coast including the Gulf of Masirah (Gallagher 1991). It is concluded that Omani spinner dolphins should be treated as a discrete population, morphologically distinct from all known spinner dolphin subspecies (Warebeek *et al.* 1999). The IUCN red list provides its current status as data deficient.

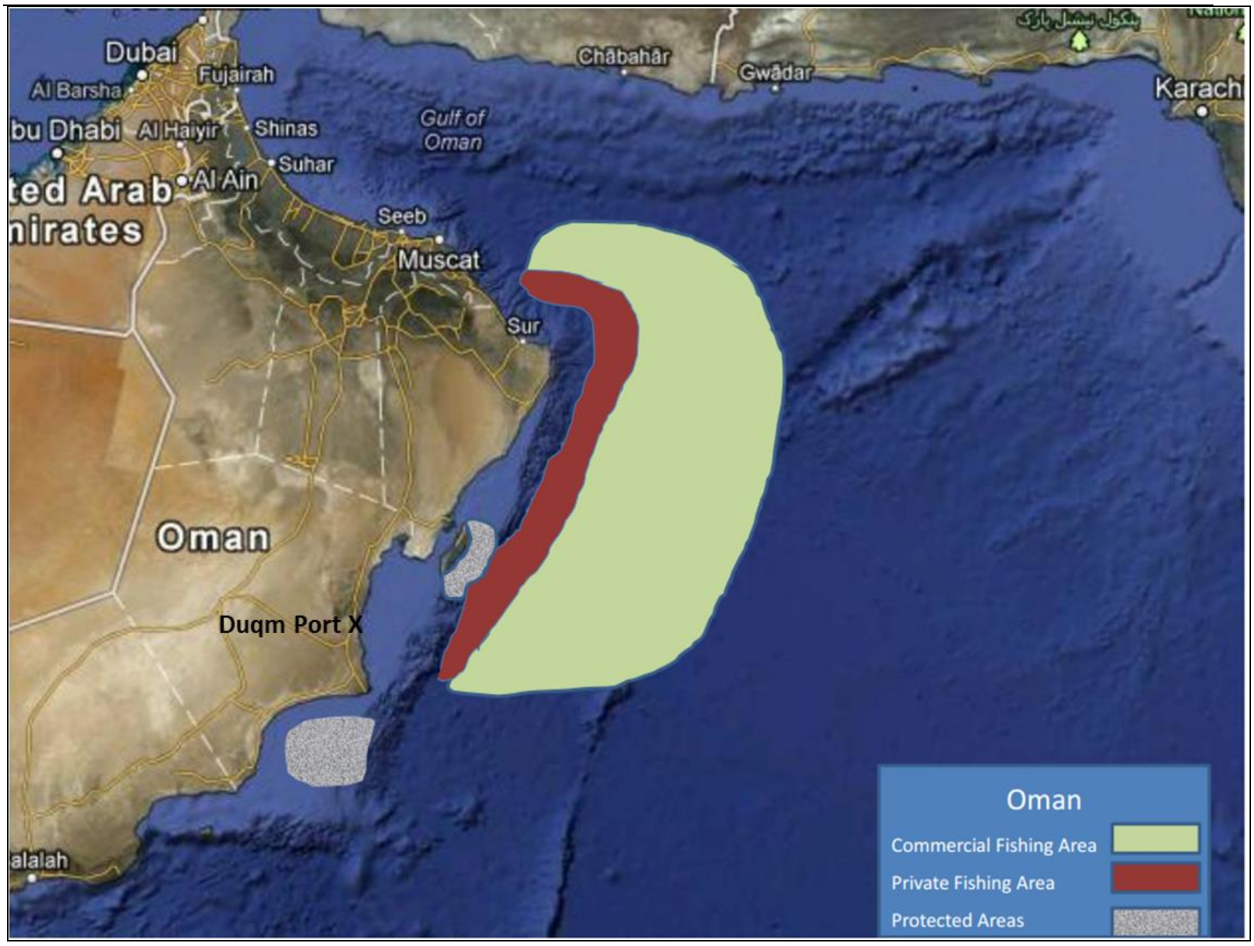
2.4 Birds

The Oman Bird Records Committee (OBRC) has recorded 120 bird species within the Duqm area. Sixty-two percent of these species are marine\shoreline species, 54% are considered migratory. The predominant species are gulls and terns and herons, attracted by the high productivity, fish abundance, fishing activity and generated waste. Thousands of birds congregate along the beaches that front the Duqm Master Plan area such as near the fish factories, while from early autumn to late spring the mudflats are important habitat for high numbers of waders and herons (Sargeant *et al*, 2008).

The Port area does have some significance as an Important Bird Area (IBA) principally due to the sandy bay of the Ghubbat Quwayrat (includes the area of the Port and adjacent coastline), which includes a few small coastal khawrs (lagoons) and intertidal mudflats. Development of the port has already impacted the southern end of the IBA. Further expansion of the Port has the potential to impact the IBA further.

2.5 Fisheries

Abundant fisheries and marine resources are found throughout Omani waters of the Arabian Sea, including the Al Wusta Governorate surrounding Duqm Port. Duqm is therefore an ideal location for fish-processing, aquaculture, and other fisheries related activities (Figure 2-5).



Source: NATO Shipping Centre 2013

Figure 2-5 Key fishing areas at Duqm

2.6 Commercial Fishing

2.6.1 Operations

Oman's fishery is largely for personal consumption or export to countries such as Jordan and landlocked African countries. Seasonal variations in fishing effort are affected by the South West Monsoon between May and September. Predominant fishing methods include purse seines, beach seines, hand lines, gill nets, trolls, long line and traps (NATO 2013).

Small fiberglass boats operate up to 6 Nautical Miles (NM), artisanal boats fish beyond 6 NM, the coastal fleet operates beyond 8 NM. Demersal industrial trawlers are allowed to operate deeper than 50 m or at least 10 nautical miles from shore, whichever is further. They are restricted to sea areas between latitude 20° 00 N and longitude 55° 45 E (FAO 2001).

2.6.2 Target Species

Key commercial target species included tuna, sardine, large jacks, mackerel, sailfish, barracuda, snappers, groupers, sea breams, sharks, rays, shrimp, lobster, cuttlefish, and abalone (NATO 2013). Among crustaceans, two species of shrimp, *Penaeus indicus* and *Penaeus semisulcatus*, contribute over 99% of the shrimp landings in Gulf of Masirah, Oman (FAO 2001).

The four small pelagic species mainly found in the Omani Exclusive Economic Zone (EEZ) were Indian oil sardine (*Sardinella longiceps),* Indian scad (*Decapterus russelli*), horse mackerel (*Trachurus indicus*) and bigeye scad (*Selar crumenophtalmus*) (FAO 2001).

2.7 Artisanal Fishing

Demersal and pelagic artisanal fishing occurs throughout the Gulf of Masirah, typically up to 50 m (FAO 2012). Methods include Skiff and Dhow vessel handlines and trolling lines, nets and trap fisheries. Beach seining is also common. Artisanal fishing takes place all year round.

Typical target species include emperors (*Lethrinidae)*, tiger perches (*Terapontidae)*, long tail tuna (*Thunnus tonggol)*, yellow fin tuna (*Thunnus albacares)*, barracudas (*Sphyraenidae),* hammerhead sharks (*Sphyrnidae)* and multiple grouper species e.g. brownspotted grouper (*Epinephelus chlorostigma)* (FAO 2012).

Plate 2-1 Examples of Skiff and Dhow fishing vessels that operate within the study area.

Plate 2-2 Commercially caught species, photographed at a market north of the Port.

2.8 Duqm Port Special Economic Zone

In response to this abundance of resources, one of Oman's largest fishery harbours is to be constructed at Duqm Port. The project will support the development of a major fishery hub, planned as part of an ambitious Special Economic Zone (SEZ) at Duqm.
This will encompass:

- A fishing harbour at -6m depth with all facilities required to accommodate small and medium size fishing boats;
- Retail, wholesale and export markets;
- Land area to house fish processing, canning, fish oil and animal feed industries.
- Fish & shrimp farming;
- A training centre and extension services;
- A marine research centre; and
- An international standards quality assurance centre for fresh and processed fish exports.

3 FIELD METHODS

In response to the EIA Scoping report (WorleyParsons, 2014) approved by MECA, the following methodology was developed to survey the marine environmental conditions of the study area.

3.1 Sampling Locations

The study area was subdivided into five areas:

- The intertidal area of the adjacent shoreline;
- The proposed location of the liquid berths within the Port;
- The nearshore area outside of the Port, northwest of the Lee Breakwater and east of the Main Breakwater;
- The Borrow area, located 40 km offshore; and
- The Disposal area, located 18 km offshore.

Water quality and benthic habitat data were collected over a thirteen-day period from 31st March to 12th April 2015. Ghost fishing nets abandoned along the outside of the lee breakwater caused damage to the camera equipment, towfish frame and winch during the survey. As a consequence, a second survey was required from 12th to 16th May to complete habitat mapping data collection.

Nearshore conditions consisted of generally calm weather with very high turbidity. Offshore conditions also consisted of generally calm weather. Two days were met with a regional dust storm, strong winds, 1-2 m swell and reduced visibility. The average day time air temperature was 40 ^{0}C with no precipitation.

Physicochemical water quality profiles and water quality samples were collected from a total of 27 sites, six sites inside of the Port and eleven sites outside of the Port (Figure 3-1), five sites at the disposal area (Figure 3-2) and five sites at the borrow area (Figure 3-3)

A subtidal benthic habitat assessment was completed using video footage from underwater towed video transects. A total of 33 transects were completed, covering approximately 80 km of seabed at locations inside and outside of the Port (Figure 3-1), and at disposal and borrow areas (Figure 3-2 and Figure 3-3 respectively).

GPS coordinates of sampling sites and start and finish points for transects are presented below in Table 3-1 and Table 3-2.

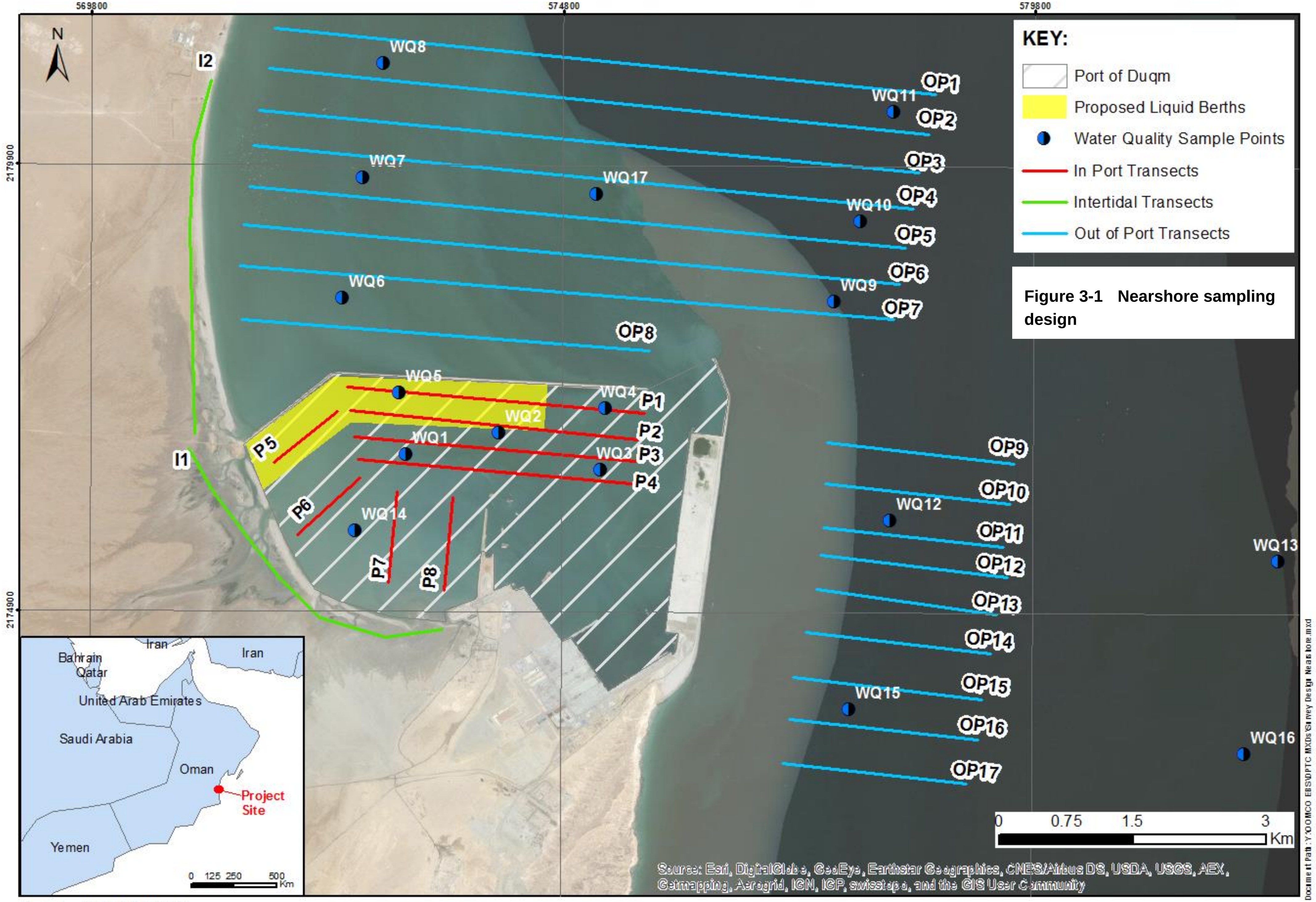


Figure 3-1 Nearshore sampling design

Projection: UTM40N WGS84

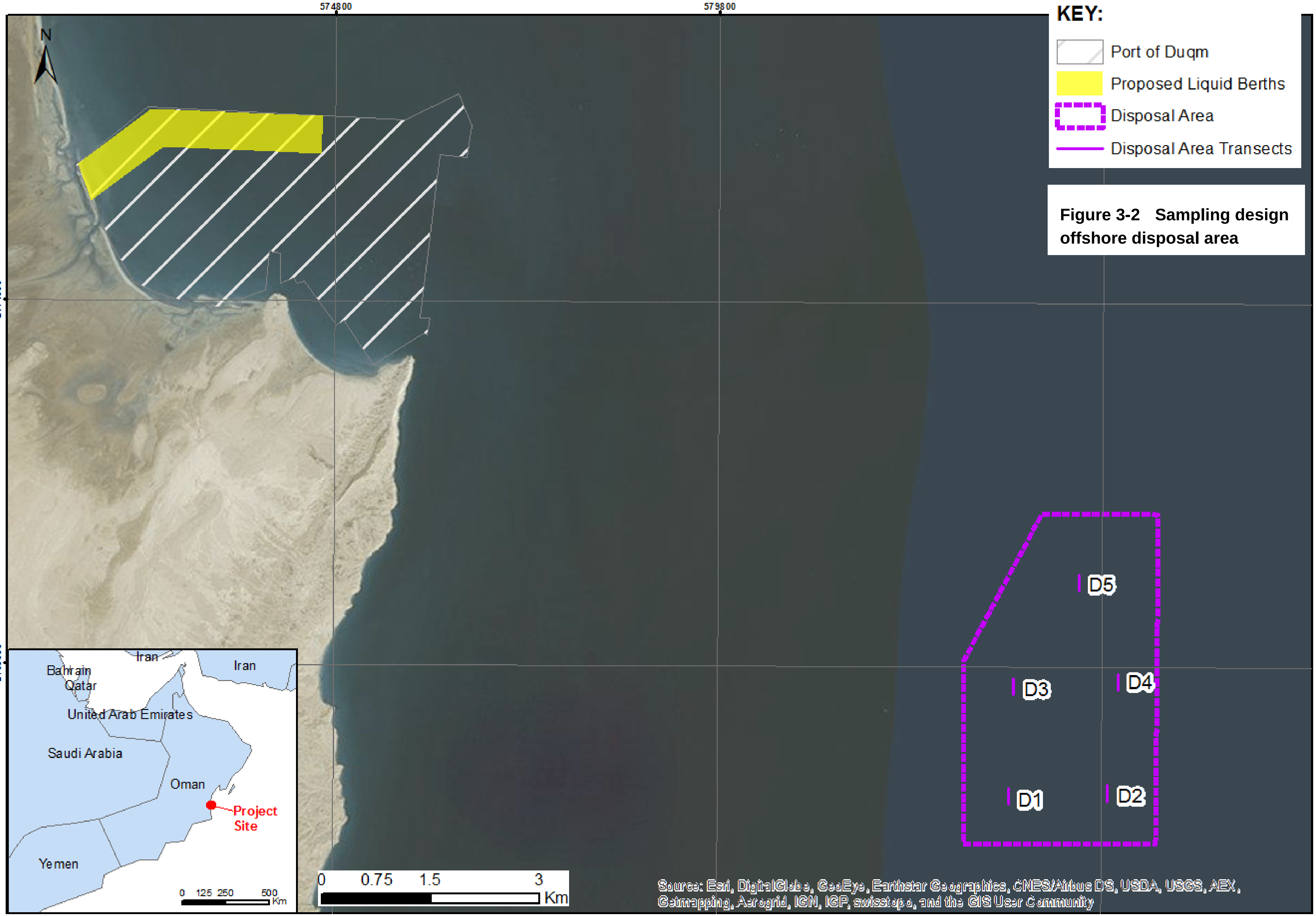


Figure 3-2 Sampling design offshore disposal area

Projection: UTM40N WGS84

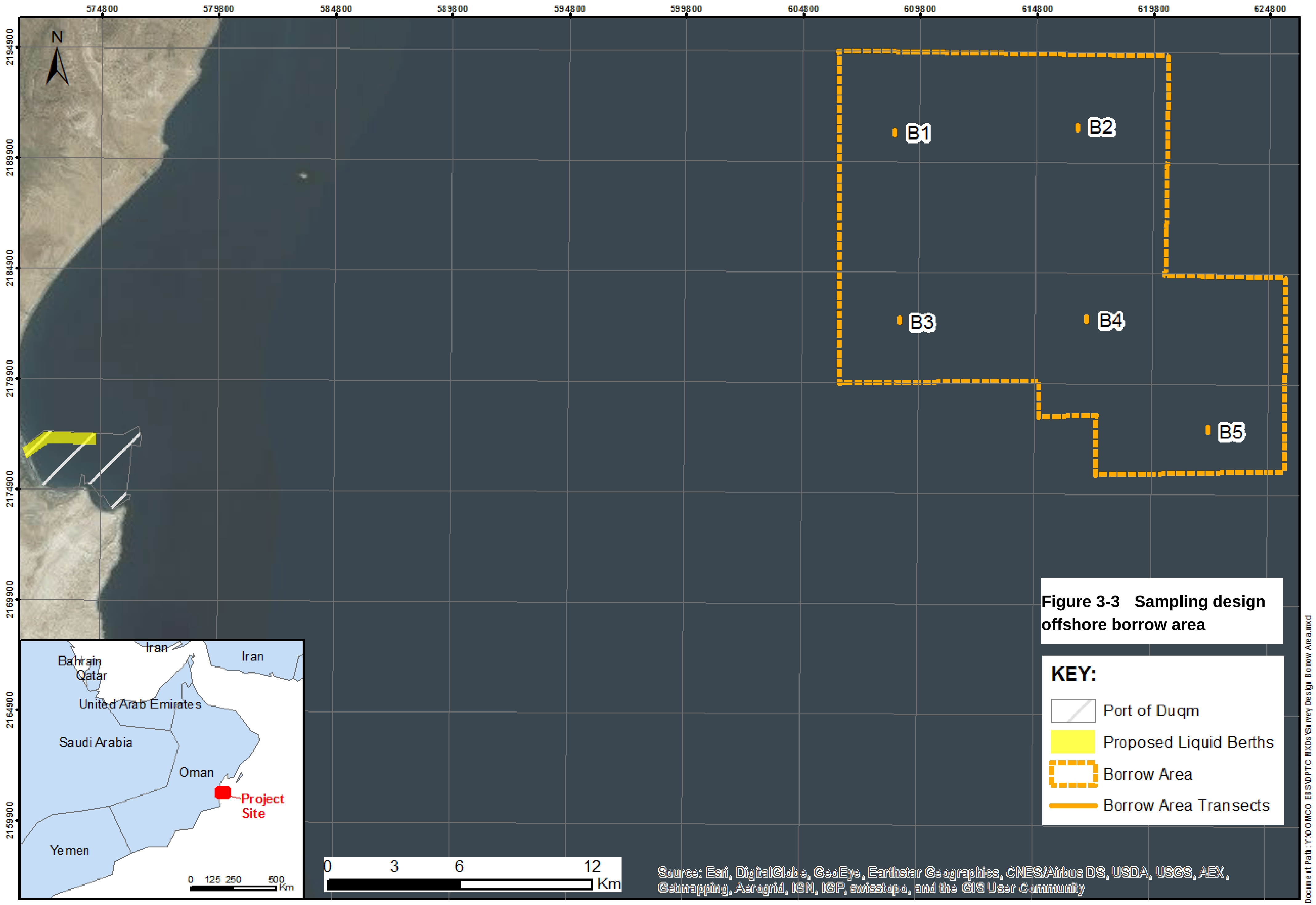


Figure 3-3 Sampling design offshore borrow area

Projection: UTM40N WGS84

Table 3-1 GPS coordinates of water quality sampling sites (WGS 84)

Study Area	Sampling Site	Latitude	Longitude
Inside the Port	WQ01	19.68392	57.69785
	WQ02	19.68613	57.70725
	WQ03	19.68235	57.71752
	WQ04	19.68855	57.71807
	WQ05	19.69022	57.69713
	WQ14	19.67626	57.69269
Nearshore Area Outside the Port	WQ06	19.69981	57.69145
	WQ07	19.71199	57.69353
	WQ08	19.72358	57.69559
	WQ09	19.69944	57.74126
	WQ10	19.70752	57.74391
	WQ11	19.71857	57.74727
	WQ12	19.67721	57.74692
	WQ13	19.67302	57.78622
	WQ15	19.65811	57.74272
	WQ16	19.65351	57.78273
	WQ17	19.71029	57.71716
Disposal Area	D01	19.60646	57.79718
	D02	19.60673	57.80943
	D03	19.62004	57.79776
	D04	19.62055	57.81083
	D05	19.6329	57.80597
Borrow Area	B01	19.81399	58.03855
	B02	19.816	58.11322
	B03	19.73719	58.04026
	B04	19.73773	58.11668
	B05	19.69246	58.16657

Table 3-2 GPS coordinates of subtidal benthic habitat transects (WGS 84)

Study Area	Transect	Start		End	
		Latitude	Longitude	Latitude	Longitude
Inside the Port	**P01**	19.6908	57.69188	19.68808	57.72198
	P02	19.68835	57.69219	19.68538	57.72143
	P03	19.68576	57.69263	19.68327	57.72114
	P04	19.68346	57.69297	19.68102	57.72076
	P05	19.68306	57.68445	19.68822	57.69087
	P06	19.67573	57.68693	19.68153	57.69322
	P07	19.67092	57.6961	19.6801	57.69698
	P08	19.67015	57.7017	19.6796	57.70261
Nearshore Area Outside the Port	**OP01**	19.72713	57.68455	19.72037	57.75155
	OP02	19.72305	57.6842	19.71633	57.7508
	OP03	19.71878	57.683	19.71241	57.74986
	OP04	19.71526	57.68257	19.70883	57.74924
	OP05	19.71099	57.68177	19.70488	57.74842
	OP06	19.70728	57.68153	19.70118	57.74798
	OP07	19.70305	57.68102	19.69756	57.74732
	OP08	19.69762	57.68131	19.69435	57.72233
	OP09	19.68516	57.74062	19.68295	57.75947
	OP10	19.68079	57.74056	19.67889	57.75901
	OP11	19.67637	57.74012	19.67451	57.75842
	OP12	19.67346	57.73983	19.67137	57.75863
	OP13	19.67026	57.73939	19.66773	57.75772
	OP14	19.66592	57.73837	19.66375	57.75706
	OP15	19.66134	57.73706	19.65917	57.75621
	OP16	19.65699	57.73679	19.65497	57.75576
	OP17	19.65259	57.73599	19.65059	57.7546
Disposal Area	**D01**	19.60657	57.79706	19.6077	57.79672
	D02	19.60692	57.80925	19.60712	57.8071
	D03	19.6202	57.79763	19.62351	57.7969
	D04	19.62062	57.81057	19.6223	57.80959
	D05	19.63313	57.80556	19.6331	57.80365
Borrow Area	**B01**	19.81394	58.03849	19.81472	58.03526
	B02	19.81602	58.11331	19.818	58.11259
	B03	19.73723	58.04026	19.73887	58.03844
	B04	19.73756	58.11696	19.73852	58.11482
	B05	19.69269	58.16686	19.69389	58.16509

3.2 Water Quality

3.2.1 Physicochemical Profiling

A calibrated multi-parameter water quality logger (YSI 6600) (Plate 3-1), was used to measure physicochemical water quality within the survey area. At each site a physicochemical water quality profile was obtained by lowering the instrument from the surface to the seabed recording measurements at 1 m intervals. The water quality logger was lowered and raised at a speed of approximately one meter per five seconds.

The following parameters were measured:

- Temperature (°C);
- Salinity (practical salinity unit (psu));
- pH;
- Dissolved Oxygen (DO: % Saturation); and
- Turbidity (Formazin Nephelometric Unit (FNU))

Plate 3-1 Multi parameter water quality logger – YSI 6600

3.2.2 Chemical Sampling

At each sampling site, a water sample was collected from the mid-point in the water column using a 2.5 L Niskin sampler (Plate 3-2). Samples were retrieved to the surface and decanted into appropriate containers and stored at 4 ^{0}C before being couriered to Exova Laboratory in Muscat. Water samples were analysed for the following parameters:

- Total Petroleum Hydrocarbons

- Poly-Aromatic Hydrocarbons
- Metals (arsenic, zinc, vanadium, cadmium, chromium, copper, lead, nickel, mercury)
- Benzene, Toluene, Ethyl benzene, and Xylenes (BTEX)
- Total Nitrogen
- Total Phosphorous
- Total Suspended Solids (TSS)
- Nitrate
- Nitrite

Plate 3-2 Niskin sampler

3.2.3 Water Quality Criteria

Water contaminant concentrations obtained from each sample were compared against a series of ambient water quality guidelines. As no water quality guidelines currently exist for Oman, the following guidelines were adopted:

- Saudi Arabian National Environmental Standard Ambient Water Quality Objectives for the Red Sea (Marine) (Presidency of Meteorology and Environment, 2012);
- Dubai Government, Department of Planning and Development, Ports, Customs and Free Zone Corporation, Water Environment Regulations (EN/002) – Harbour Water Quality Objectives (Government of Dubai, 2010); and

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality Guidelines for slightly to moderately disturbed systems. All toxicants were compared to the 95% species protection trigger levels (ANZECC 2000).

3.2.4 Data Analysis

Physicochemical data were analysed and presented as a graphical profile, mean and standard deviation were calculated for each parameter and any spatial trends identified. Chemical data were tabulated and compared to adopted guideline values.

3.3 Subtidal Benthic Habitat

3.3.1 Sample Collection

Subtidal benthic habitats were surveyed using a Delta Vision high definition underwater video camera (Plate 3-3). The video camera was towed behind the vessel, travelling at a speed of less than 1 knot. Video footage was taken approximately 50 cm above the substratum and recorded to a hard drive. Co-ordinates of the video transects were tracked and incorporated as a data stamp on the collected video footage.

Plate 3-3 Delta Vision HD camera and towfish frame

3.3.2 Data Analysis

The video footage was analysed by marine scientists experienced in classifying benthic habitats. Each transect was viewed in its entirety and the habitat classified for the whole transect. Habitats were defined based on a change of 20% either in substrate or biota type.

Subtidal benthic habitat types were classified using an adapted form of the National Oceanic and Atmospheric Administration's (NOAA) system (Zitello *et al*., 2009). NOAA habitat classification is determined according to geomorphological structure and colonising epifauna.

Geomorphological structure was classified using the following groups

- **Reef and Hard Bottom:**
  - Rock Outcrop;
  - Boulder;
  - Aggregate Reef;
  - Individual Patch Reef;
  - Aggregated Patch Reefs;
  - Spur and Groove;
  - Pavement;
  - Pavement with Sand Channels;
  - Reef Rubble; Rhodoliths; and
  - Unknown.
- **Unconsolidated Sediment:**
  - Sand;
  - Mud;
  - Sand with Scattered rock; and
  - Unknown.
- **Other:**
  - Land;
  - Artificial; and
  - Unknown

Biological structure was classified using the following biota groups:

- Turfing Algae;

- Live Coral;
- Coralline Algae;
- Mangrove;
- Seagrass;
- No Cover;
- Unknown;

A qualitative classification method was also applied to define the cover (density) of specific biota groups as dense (90 –100 %), moderate (50 – 90 %), patchy (10 – 50 %), and sparse (<10%). Substrate type was defined using the Wentworth grade scale of particulate sizes (Wentworth, 1922).

A map displaying the distribution of habitats, including specification of substrate and biota group type was then derived from the results of this analysis.

It should be noted that due to the presence of abandoned “ghost” fishing nets along the outside of the lee breakwater it was not possible to collect benthic video footage from Transect OP08. Whilst surveying along Transect OP07 the towfish frame became entangled and the camera was damaged. The survey team were aware of the problem of ghost nets from this point on and avoided surveying any closer to the outside of the lee breakwater on recommendation from the Port Authority Captain , local fishermen and the survey vessel operator.

3.4 Intertidal Benthic Habitats

Intertidal habitats were surveyed on foot, in areas adjacent to the proposed liquid berths. Qualitative data were collected to describe the intertidal habitat.

4 RESULTS

4.1 Water Quality

A summary of physicochemical water quality data collected at each sampling site is provided below. Laboratory data for chemical water quality, including hydrocarbons and metals were also analysed, a summary of results is presented in Section 4.1.2. Trends in the data set have been identified and interpreted where possible.

4.1.1 Physicochemical Water Quality

Physicochemical water quality measurements were recorded *In situ* at 27 sites, six sites inside of the Port, eleven sites outside of the Port opposite the adjacent coastline and five sites each at the offshore disposal area and offshore borrow area. Water quality sites 13 and 16 were treated as control sites. Physicochemical water quality mean values and standard deviations are presented in this section, together with vertical profiles at each site. Physicochemical water quality conditions are described below in terms of conditions inside the Port, conditions outside the Port and offshore conditions at the borrow area and disposal area.

4.1.1.1 INSIDE THE PORT

Maximum depths at sites sampled inside the port ranged from 2 m to 19 m. Depth was greatest in the shipping channel that runs through the centre of the Port and shallowest nearshore. Depth decreased rapidly outside of the shipping channel and then gradually towards shore (Figure 4-1, overleaf).

Temperature varied between sites and over depth, ranging from 24.5 ^{0}C to 25.6 ^{0}C. Surface temperatures were generally warmer at shallower sites and decreased with distance from the breakwater. Temperature decreased with depth at all sites. This was most noticeable at the deepest site in the shipping channel. In the shipping channel, clear stratification was observed between 4 m and 6 m forming a thermocline (Figure 4-1 A).

Mean turbidity ranged from 2.3 to 9.1 Formazin Nephelometric Units (FNU) (Table 4-1, pg. 35). Turbidity was lowest in the deeper water of the shipping channel and increased nearshore with decreasing depth. Turbidity was highest towards the seabed at all sites (Figure 4-1 B).

Salinity values were similar between sites and over depth, ranging from mean values of 36.4 to 37.3 Practical Salinity Units (psu) (Table 4-1). A slight halocline can be observed in the profile of WQ 03 in the shipping channel at 4 – 6 m depth. Salinity is also higher at WQ 01 than at other stations (Figure 4-1 C).

Dissolved Oxygen (DO) values range from mean values of 97.9 % to 59.3 % (Table 4-1). DO levels reduced with depth at all sites. An oxycline can be seen at WQ03 in the shipping channel, DO levels drop at between 4 and 6 m (Figure 4-1 D).

Values for pH range between mean values of 7.7 and 7.8 (Table 4-1). pH generally reduced with depth at all sites (Figure 4-1 E).

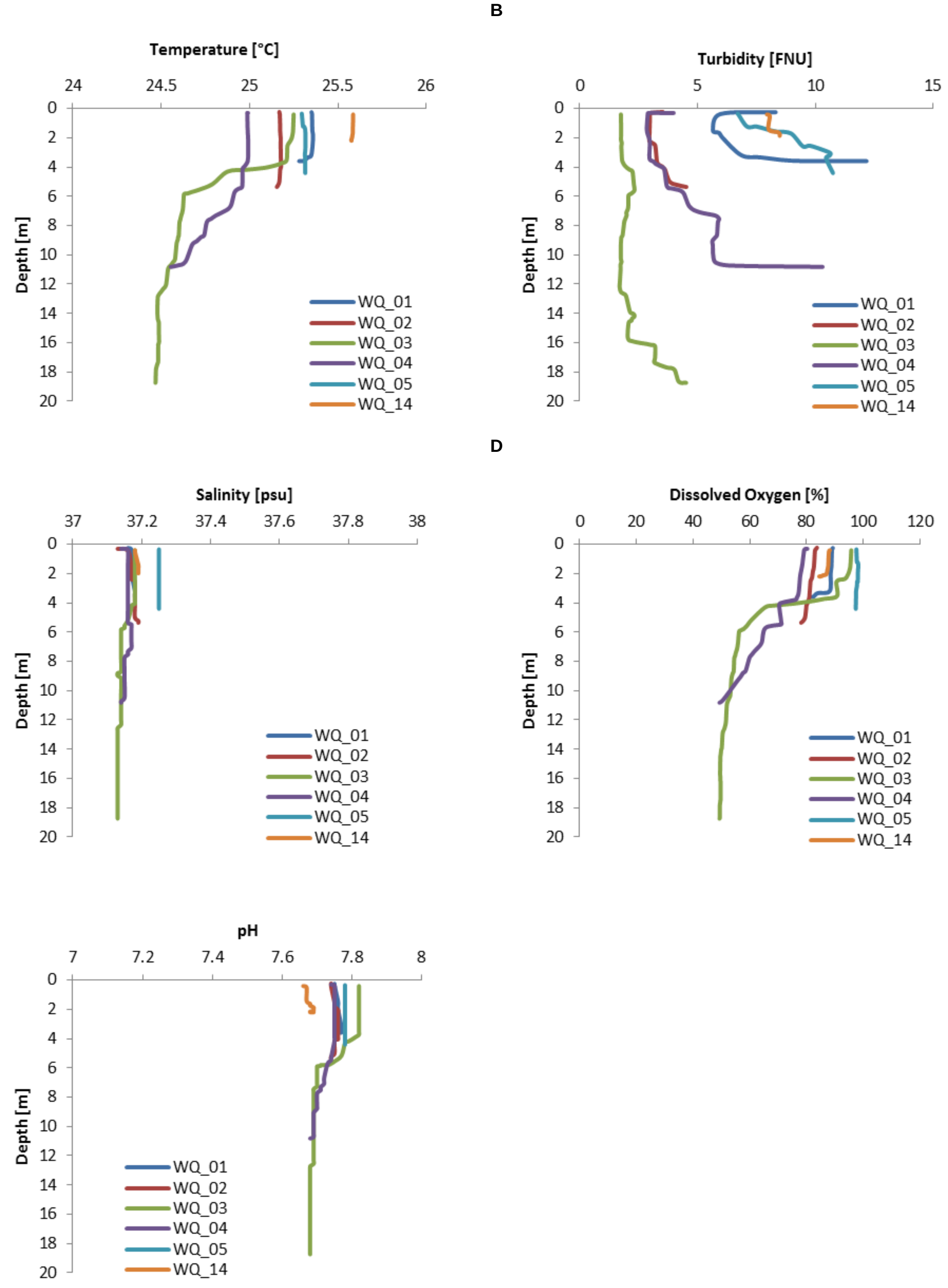


Figure 4-1 Profile plots of physicochemical water quality data inside the Port

Table 4-1 Summary of water quality profile data inside the Port

Site	Depth (m)	Temperature (^{0}C)		Turbidity (FNU)		DO (%)		pH		Salinity (psu)	
		Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
WQ 01	3.6	25.3	0.0	7.5	2.1	86.7	3.1	7.8	0.0	37.2	0.0
WQ 02	5.4	25.2	0.0	3.4	0.5	81.2	1.6	7.8	0.0	37.2	0.0
WQ 03	18.7	24.7	0.3	2.3	0.7	59.3	14.7	7.7	0.1	37.1	0.0
WQ 04	10.8	24.9	0.1	4.5	1.7	67.4	10.2	7.7	0.0	37.2	0.0
WQ 05	4.4	25.3	0.0	9.1	1.5	97.9	0.3	7.8	0.0	37.3	0.0
WQ 14	2.2	25.6	0.0	8.2	0.3	86.3	1.2	7.7	0.0	36.4	0.8

4.1.1.2 NEARSHORE AREA OUTSIDE OF THE PORT

Depth outside the Port in the nearshore area ranged from 3.6 m at WQ 07 closest to shore to 22.6 m at WQ 16 located furthest offshore of the outer Port sites. Depths at all sites followed this trend, with shallow sites located nearshore and deeper sites offshore (Figure 4-2, overleaf).

Mean temperature values were largely comparable at all sites, ranging from 24 ^{0}C to 24.8 ^{0}C (Table 4-2, pg. 37). Temperature decreased with depth at all sites and there is evidence of a thermocline between 1.5 m and 4.5 m depth (Figure 4-2 A).

Mean turbidity levels ranged from 1.3 to 3.1 FNU (Table 4-2). Turbidity increased with depth at all sites and increased at depths near to the seabed. Sites closest to shore had higher surface and water column turbidity values than deeper offshore sites (Figure 4-2 B).

Salinity values of 37 psu were recorded across all sites and depths (Table 4-2 and Figure 4-2 C).

Mean DO levels ranged from 66.2 % to 85.3 %. DO levels were lowest at sites opposite the mouth of the Port and highest at nearshore shallow sites to the north of the lee breakwater (Table 4-2). DO levels decreased with depth at all sites (Figure 4-2 D).

Values of pH were comparable at all sites and depths at around pH 7.7 (Table 4-2 and Figure 4-2 E).

No unexpected differences were observed between control sites (WQ 13 and WQ 16) and other sites.

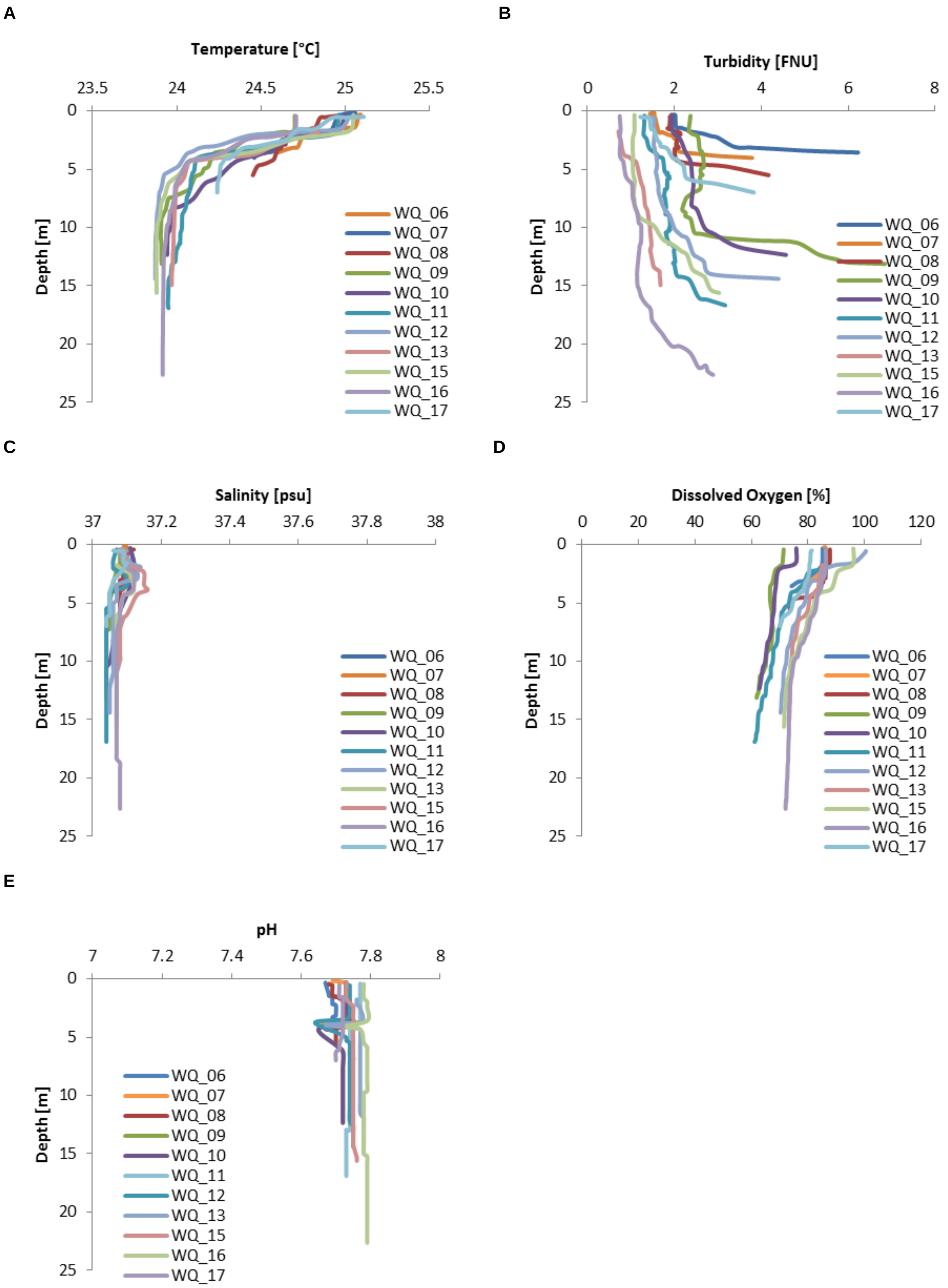


Figure 4-2 Profile plots of physicochemical water quality data nearshore outside of the Port

Table 4-2 Summary of water quality profile data nearshore outside of the Port

Site	Depth (m)	Temperature (^{0}C)		Turbidity (FNU)		DO (%)		pH		Salinity (psu)	
		Mean	Std. Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
WQ 06	3.6	24.8	0.2	3.1	1.3	81.8	4.3	7.7	0.0	37.1	0.0
WQ 07	4.0	24.8	0.2	2.0	0.6	83.6	3.9	7.7	0.0	37.1	0.0
WQ 08	5.5	24.7	0.1	2.1	0.4	85.3	3.6	7.7	0.0	37.1	0.0
WQ 09	13.1	24.1	0.2	3.1	1.3	66.2	2.5	7.7	0.0	37.0	0.0
WQ 10	12.3	24.3	0.4	2.6	0.7	67.8	3.9	7.7	0.0	37.1	0.0
WQ 11	16.9	24.1	0.3	2.0	0.9	70.1	6.3	7.7	0.0	37.0	0.0
WQ 12	14.4	24.1	0.4	1.9	0.6	78.8	8.8	7.7	0.0	37.1	0.0
WQ 13	14.9	24.1	0.3	1.3	0.3	77.2	4.2	7.8	0.0	37.1	0.0
WQ 15	15.6	24.1	0.4	1.6	0.7	79.5	8.1	7.7	0.0	37.1	0.0
WQ 16	22.6	24.0	0.2	1.3	0.6	76.9	5.0	7.8	0.0	37.1	0.0
WQ 17	7.0	24.5	0.3	2.0	0.7	77.5	3.9	7.7	0.0	37.1	0.0

4.1.1.3 OFFSHORE DISPOSAL AREA

Depths at the offshore disposal area were largely comparable, ranging from 25.3 m to 26.7 m.

Mean temperature values were similar at all sites at around 23.8 ^{0}C. Temperature decreased with depth at all sites.

Mean turbidity values ranged from 0.6 to 2.2 FNU. Throughout the water column turbidity values were comparable at below 1 FNU increasing from around 10 m depth to the sea bed.

Salinity was comparable between stations and at all depths at around 37.4 psu.

Mean DO values ranged from 72.2 % to 85.9 %. DO levels decreased with depth and were comparable between sites in the bottom waters.

Values of pH were comparable between sites and over depth, with mean values of around pH 7.8.

Table 4-3 Summary of water quality profile data at the offshore disposal area

Site	Depth (m)	Temperature (^{0}C)		Turbidity (FNU)		DO (%)		pH		Salinity (psu)	
		Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
DA 01	26.2	23.8	0.4	0.6	0.4	85.9	15.9	7.8	0.1	37.4	0.0
DA 02	26.7	23.8	0.4	1.1	1.2	80.6	12.0	7.7	0.0	37.4	0.0
DA 03	25.8	23.8	0.2	1.5	1.3	77.2	11.9	7.8	0.0	37.4	0.0
DA 04	25.6	23.7	0.1	0.9	0.9	76.2	6.4	7.8	0.0	37.4	0.0
DA 05	25.3	23.8	0.0	2.2	1.4	72.3	3.2	7.8	0.0	37.3	0.0

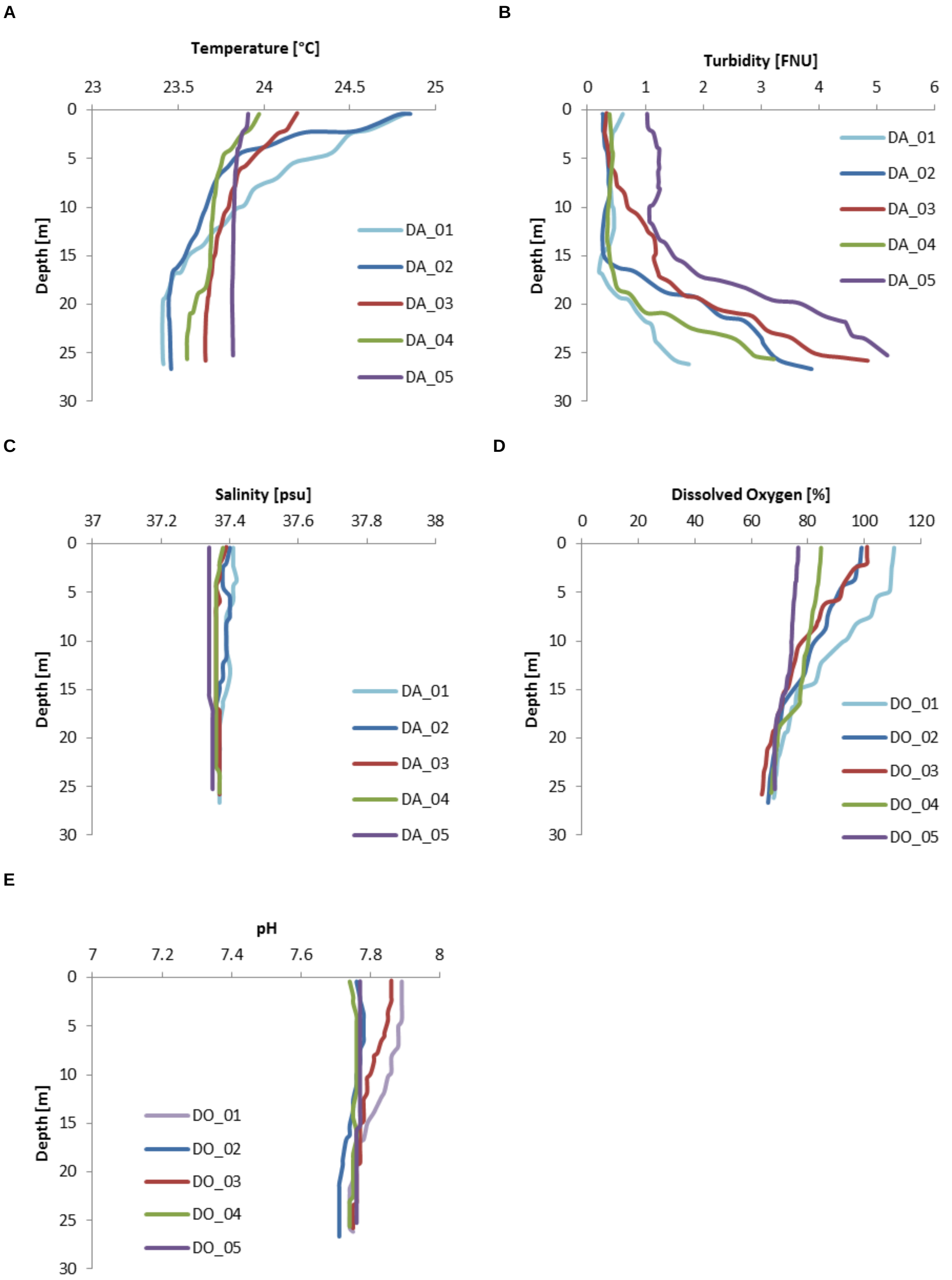


Figure 4-3 Profile plots of physicochemical water quality data offshore disposal area

4.1.1.4 OFFSHORE BORROW AREA

Depth at the offshore borrow area was largely consistent, ranging from between 29 m and 33.2 m.

Mean temperature values were similar at all sites at approximately 25 ^{0}C. Temperature decreased with depth at all sites. A thermocline was identified between a depth of 22 m and 28 m.

Mean turbidity values were similar at all sites ranging from 0.1 to 0.3 FNU. Throughout the water column turbidity values were comparable at below 1 FNU increasing slightly from 15 m depth to the sea bed.

Salinity was largely comparable between stations and at all depths at around 37.3 psu.

DO values showed good levels with some minor variation between sites in the surface waters. DO levels decreased with depth and were comparable between sites in the bottom waters. An oxycline was identified between a depth of 22 m and 28 m.

Values of pH were largely comparable between sites and over depth, with mean values of around pH 7.8.

Table 4-4 Summary of water quality profile data at the offshore borrow area

Site	Depth (m)	Temperature (^{0}C)		Turbidity (FNU)		DO (%)		pH		Salinity (psu)	
		Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
BA 01	29.3	24.9	0.8	0.3	0.4	76.7	23.0	7.8	0.1	37.3	0.0
BA 02	33.2	25.1	0.9	0.2	0.2	84.9	20.6	7.8	0.1	37.3	0.0
BA 03	29.0	25.1	0.4	0.3	0.3	87.5	9.9	7.8	0.0	37.3	0.0
BA 04	31.4	24.8	0.7	0.1	0.1	83.5	19.2	7.8	0.1	37.3	0.0
BA 05	32.2	24.8	0.4	0.1	0.0	90.4	12.9	7.9	0.0	37.2	0.0

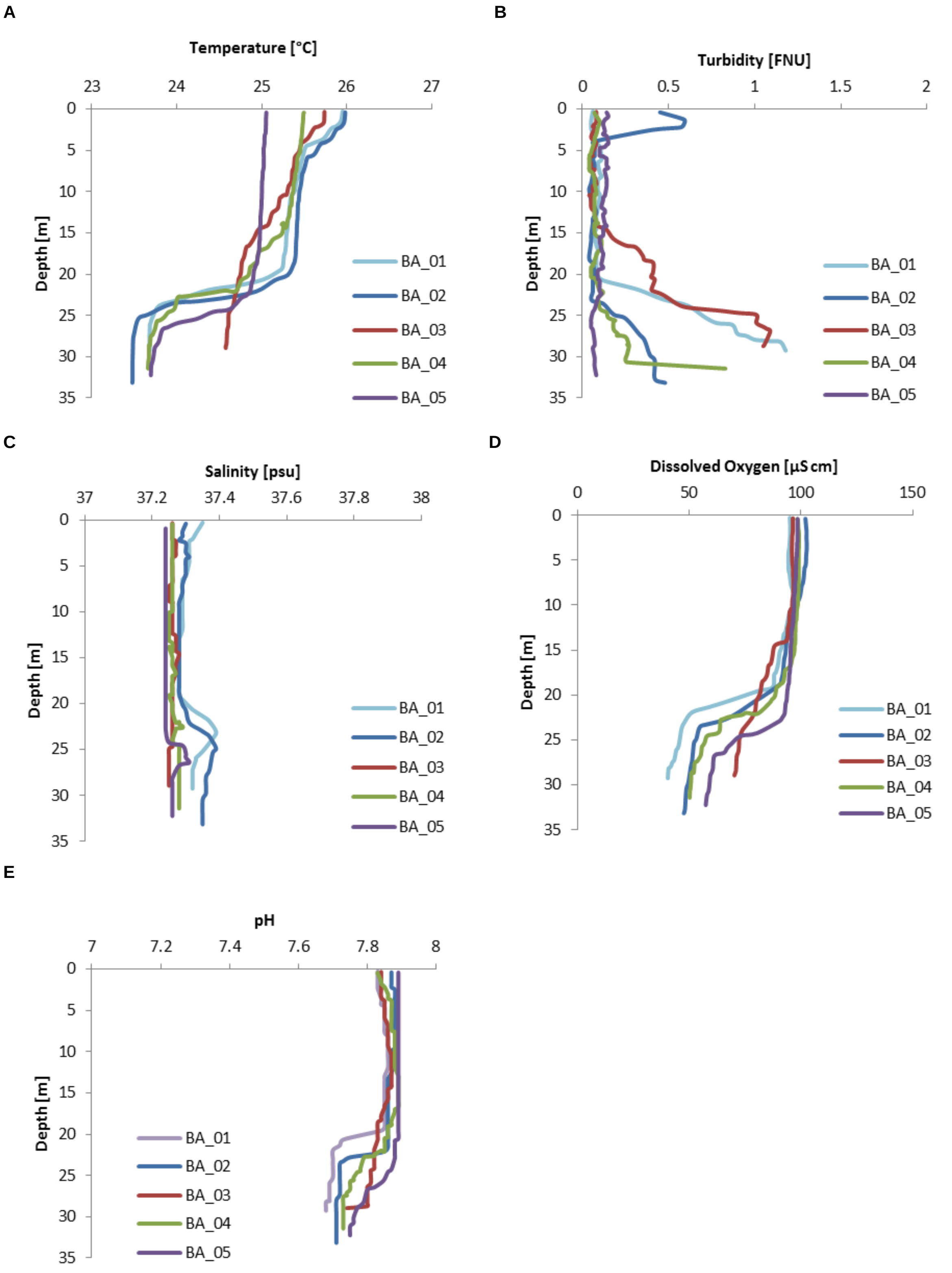


Figure 4-4 Profile plots of physicochemical water quality data offshore borrow area

4.1.2 Chemical Water Quality

A summary of results describing chemical water quality parameters are presented throughout this section. Laboratory certificates are provided in Appendix 1. Chemical water quality samples were collected from 27 sites, six sites inside of the Port, 11 sites outside of the Port, five sites at the disposal ground and five sites at the borrow ground.

4.1.2.1 Inside the Port

A summary of chemical water quality results inside the port is presented in Table 4-5.

4.1.2.1.1 Metals

All metals concentrations were below laboratory detection limits and adopted guideline values at all sites.

4.1.2.1.2 BTEX

All BTEX (benzene, toluene, ethylbenzene, and xylenes) were below laboratory detection limits at all sites and therefore below adopted guideline values.

4.1.2.1.3 Hydrocarbons

Hydrocarbons values were below laboratory detection limits at all sites. Total Petroleum Hydrocarbon (TPH) values were not identified from adopted guideline values.

4.1.2.1.4 Poly Aromatic Hydrocarbons

All Poly Aromatic Hydrocarbons (PAHs) concentrations were below laboratory detection limits at all sites. Concentrations of all PAHs were below adopted guidelines.

4.1.2.1.5 Nutrients

Phosphorous concentrations were above laboratory detection limits at all sites, ranging from 0.07 to 0.09 mg/L and far below the most stringent guideline value of 0.5 mg/L. Nitrate concentrations were above laboratory detection limits at all sites, ranging from 0.18 to 0.22 mg/L, which is below the most stringent guideline value of 10 mg/L. Nitrite concentrations were above laboratory detection limits at all sites, at 0.03 mg/L and far below the most stringent guideline value of 1 mg/L. Total Nitrogen values were below detection limits at all sites. Concentrations of all nutrients were therefore below adopted guidelines.

4.1.2.1.6 Physical

Total Suspended Solids (TSS) concentrations were at or below laboratory detection limits at all sites. TSS values were below adopted guidelines

Table 4-5 Chemical water quality concentrations inside the Port

Results Group	Parameter	Unit	Guideline			Detection Limit	WQ1	WQ2	WQ3	WQ4	WQ5	WQ14
			Dubai Harbour	KSA Red Sea	ANZECC							
Metals	Arsenic	mg/L	0.05	0.05	0.05	0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Cadmium	mg/L	0.05	0.005	0.0055	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Chromium	mg/L	0.2	0.05	0.0044	0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
	Copper	mg/L	0.5	0.05	0.0013	0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
	Lead	mg/L	0.1	0.05	0.0044	0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Nickel	mg/L	0.1	0.05	0.07	0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
	Vanadium	mg/L			0.1	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Zinc	mg/L	0.5	0.8	0.015	0.03	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
	Mercury	µg/L	1		0.4	0.3	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300
BTEX	Benzene	µg/L		10	700	10	<10	<10	<10	<10	<10	<10
	Toluene	µg/L		2		10	<10	<10	<10	<10	<10	<10
	Ethyl benzene	µg/L				10	<10	<10	<10	<10	<10	<10
	m&p-Xylene	µg/L				20	<20	<20	<20	<20	<20	<20
	o-Xylene	µg/L				10	<10	<10	<10	<10	<10	<10
Hydrocarbons	VPH C5-C10	µg/L				10	<10	<10	<10	<10	<10	<10
	EPH C10-C40	µg/L				50	<50	<50	<50	<50	<50	<50
PAH	Acenaphthene	µg/L			20	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Acenaphthylene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Anthracene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25

Results Group	Parameter	Unit	Guideline			Detection Limit	WQ1	WQ2	WQ3	WQ4	WQ5	WQ14
			Dubai Harbour	KSA Red Sea	ANZECC							
	Benzo(a)anthracene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Benzo(a)pyrene	µg/L			10	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Benzo(b)fluoranthene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Benzo(g,h,i)perylene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Benzo(k)fluoranthene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Chrysene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Dibenzo(a,h)anthracene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Fluoranthene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Fluorene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Indeno(1,2,3-c,d)pyrene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Naphthalene	µg/L			70	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Phenanthrene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Pyrene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Nutrients	Phosphorus	mg/L	2	0.5		0.03	0.08	0.08	0.07	0.07	0.08	0.09
	Nitrate as NO3	mg/L	40		10	0.1	0.18	0.22	0.18	0.18	0.18	0.18
	Nitrite as NO2	mg/L			1	0.01	0.03	0.03	0.03	0.03	0.03	0.03
	Total Nitrogen	mg/L	2	1.5	1	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Physical	Total Suspended Solids	mg/L	50	5	10	1	1	<1	<1	<1	<1	1

4.1.2.2 NEARSHORE AREA OUTSIDE OF THE PORT

A summary of chemical water quality results outside of the port in the nearshore area is presented in Table 4-6.

4.1.2.2.1 METALS

All metals concentrations were below laboratory detection limits except for copper at site WQ11 (0.009 mg/L) and zinc at site WQ10 (0.039 mg/L). Metals concentrations were below adopted guideline values at all sites, except for copper and zinc at these stations. Copper concentrations recorded at site WQ11 and zinc concentrations recorded at site WQ10, exceeded the adopted ANZECC water quality guideline values but remained below other adopted guideline values.

4.1.2.2.2 BTEX

All BTEX (benzene, toluene, ethylbenzene, and xylenes) were below laboratory detection limits at all sites and therefore below adopted guideline values

4.1.2.2.3 HYDROCARBONS

Hydrocarbons values were below laboratory detection limits at all sites. Total Petroleum Hydrocarbon (TPH) values were not available from adopted guideline values.

4.1.2.2.4 POLY AROMATIC HYDROCARBONS

All Poly Aromatic Hydrocarbons (PAHs) concentrations were below laboratory detection limits at all sites and were therefore below adopted guideline values.

4.1.2.2.5 NUTRIENTS

Phosphorous concentrations were above laboratory detection limits at all sites, ranging from 0.05 to 0.08 mg/L and far below the most stringent guideline value of 0.5 mg/L. Nitrate concentrations were above laboratory detection limits at all sites, ranging from 0.18 to 0.27 mg/L, which is below the most stringent guideline value of 10 mg/L. Nitrite concentrations were above laboratory detection limits at all sites, ranging from 0.02 and 0.04 mg/L and far below the most stringent guideline value of 1 mg/L. Total Nitrogen values were below detection limits at all sites. Concentrations of all nutrients were therefore below adopted guidelines.

4.1.2.2.6 PHYSICAL

Total Suspended Solids (TSS) concentrations were at or below laboratory detection limits at all sites and therefore below adopted guideline values.

No unexpected differences were observed between control sites (WQ 13 and WQ 16) and other sites.

Table 4-6 Chemical water quality concentrations in the nearshore area outside of the Port

Results Group	Parameter	Unit	Guideline			Detection Limit	WQ6	WQ7	WQ8	WQ9	WQ10	WQ11	WQ12	WQ13	WQ15	WQ16	WQ17
			Dubai Harbour	KSA Red Sea	ANZECC												
Metals	Arsenic	mg/L	0.05	0.05	0.05	0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Cadmium	mg/L	0.05	0.005	0.0055	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Chromium	mg/L	0.2	0.05	0.0044	0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
	Copper	mg/L	0.5	0.05	0.0013	0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.009	<0.003	<0.003	<0.003	<0.003	<0.003
	Lead	mg/L	0.1	0.05	0.0044	0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Nickel	mg/L	0.1	0.05	0.07	0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
	Vanadium	mg/L			0.1	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Zinc	mg/L	0.5	0.8	0.015	0.03	<0.030	<0.030	<0.030	<0.030	0.039	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
	Mercury	µg/L	1		0.4	0.3	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300
BTEX	Benzene	µg/L		10	700	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	Toluene	µg/L		2		10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	Ethyl benzene	µg/L				10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	m&p-Xylene	µg/L				20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	o-Xylene	µg/L				10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Hydrocarbons	VPH C5-C10	µg/L				10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	EPH C10-C40	µg/L				50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
PAH	Acenaphthene	µg/L			20	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Acenaphthylene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Anthracene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25

Results Group	Parameter	Unit	Guideline			Detection Limit	WQ6	WQ7	WQ8	WQ9	WQ10	WQ11	WQ12	WQ13	WQ15	WQ16	WQ17
			Dubai Harbour	KSA Red Sea	ANZECC												
	Benzo(a)anthracene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Benzo(a)pyrene	µg/L			10	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Benzo(b)fluoranthene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Benzo(g,h,i)perylene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Benzo(k)fluoranthene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Chrysene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Dibenzo(a,h)anthracene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Fluoranthene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Fluorene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Indeno(1,2,3-c,d)pyrene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Naphthalene	µg/L			70	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Phenanthrene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Pyrene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Nutrients	Phosphorus	mg/L	2	0.5		0.03	0.08	0.08	0.08	0.06	0.06	0.07	0.06	0.05	0.05	0.05	0.07
	Nitrate as NO3	mg/L	40		10	0.1	0.22	0.27	0.18	0.18	0.18	0.22	0.22	0.22	0.22	0.18	0.18
	Nitrite as NO2	mg/L			1	0.01	0.03	0.04	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.02	0.03
	Total Nitrogen	mg/L	2	1.5	1	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Physical	Total Suspended Solids	mg/L	50	5	10	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1

4.1.2.3 Offshore Disposal Area

A summary of chemical water quality results at the offshore disposal area is presented in Table 4-7.

4.1.2.3.1 Metals

All metals concentrations were below laboratory detection limits and adopted guideline values at all sites.

4.1.2.3.2 BTEX

All BTEX (benzene, toluene, ethylbenzene, and xylenes) were below laboratory detection limits at all sites and therefore below adopted guideline values.

4.1.2.3.3 Hydrocarbons

Hydrocarbons values were below laboratory detection limits at all sites. Total Petroleum Hydrocarbon (TPH) values were not identified from adopted guideline values.

4.1.2.3.4 Poly Aromatic Hydrocarbons

All Poly Aromatic Hydrocarbons (PAHs) concentrations were below laboratory detection limits at all sites. Concentrations of all PAHs were below adopted guidelines.

4.1.2.3.5 Nutrients

Phosphorous concentrations were above laboratory detection limits at all sites, ranging from 0.069 to 0.123 mg/L and below the most stringent guideline value of 0.5 mg/L. Nitrate concentrations were above laboratory detection limits at all sites, ranging from 0.18 to 0.27 mg/L, which is below the most stringent guideline value of 10 mg/L. Nitrite concentrations were above laboratory detection limits at all sites, ranging from 0.02 to 0.04 mg/L and far below the most stringent guideline value of 1 mg/L. Total Nitrogen values were below detection limits at all sites. Concentrations of all nutrients were therefore below adopted guidelines.

4.1.2.3.6 Physical

Total Suspended Solids (TSS) concentrations were at or below laboratory detection limits at all sites. TSS values were below adopted guidelines.

Table 4-7 Chemical water quality concentrations at the offshore disposal area

Results Group	Parameter	Unit	Guideline			Detection Limit	DO5 Top	DO5 Bottom	DO4 Top	DO4 Bottom	DO3 Top	DO3 Bottom	DO2 Top	DO2 Bottom	DO1 Top	DO1 Bottom
			Dubai Harbour	KSA Red Sea	ANZECC											
Metals	Arsenic	mg/L	0.05	0.05	0.05	0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Cadmium	mg/L	0.05	0.005	0.0055	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Chromium	mg/L	0.2	0.05	0.0044	0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
	Copper	mg/L	0.5	0.05	0.0013	0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
	Lead	mg/L	0.1	0.05	0.0044	0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Nickel	mg/L	0.1	0.05	0.07	0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
	Vanadium	mg/L			0.1	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Zinc	mg/L	0.5	0.8	0.015	0.03	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
	Mercury	µg/L	1		0.4	0.3	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300
BTEX	Benzene	µg/L		10	700	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	Toluene	µg/L		2		10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	Ethyl benzene	µg/L				10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	m&p-Xylene	µg/L				20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	o-Xylene	µg/L				10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Hydrocarbons	VPH C5-C10	µg/L				10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	EPH C10-C40	µg/L				50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
PAH	Acenaphthene	µg/L			20	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Acenaphthylene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Anthracene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25

Results Group	Parameter	Unit	Guideline			Detection Limit	DO5 Top	DO5 Bottom	DO4 Top	DO4 Bottom	DO3 Top	DO3 Bottom	DO2 Top	DO2 Bottom	DO1 Top	DO1 Bottom
			Dubai Harbour	KSA Red Sea	ANZECC											
	Benzo(a)anthracene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Benzo(a)pyrene	µg/L			10	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Benzo(b)fluoranthene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Benzo(g,h,i)perylene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Benzo(k)fluoranthene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Chrysene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Dibenzo(a,h)anthracene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Fluoranthene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Fluorene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Indeno(1,2,3-c,d)pyrene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Naphthalene	µg/L			70	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Phenanthrene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Pyrene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Nutrients	Phosphorus	mg/L	2	0.5		0.03	0.094	0.121	0.086	0.12	0.08	0.069	0.091	0.1	0.123	0.086
	Nitrate as NO3	mg/L	40		10	0.1	0.18	0.22	0.22	0.27	0.22	0.18	0.18	0.18	0.18	0.22
	Nitrite as NO2	mg/L			1	0.01	0.02	0.03	0.03	0.03	0.03	0.04	0.03	0.03	0.03	0.04
	Total Nitrogen	mg/L	2	1.5	1	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Physical	Total Suspended Solids	mg/L	50	5	10	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

4.1.2.4 Offshore Borrow Area

A summary of chemical water quality results at the offshore borrow area is presented in Table 4-8.

4.1.2.4.1 Metals

All metals concentrations were below laboratory detection limits except from copper at site B03 top with a value of 0.045 mg/L. This value exceeded the ANZECC guideline value for copper concentrations. No other guideline values for metals concentrations in water were exceeded.

4.1.2.4.2 BTEX

All BTEX (benzene, toluene, ethylbenzene, and xylenes) were below laboratory detection limits at all sites and therefore below adopted guideline values.

4.1.2.4.3 Hydrocarbons

Hydrocarbons values were below laboratory detection limits at all sites. Total Petroleum Hydrocarbon (TPH) values were not identified from adopted guideline values.

4.1.2.4.4 Poly Aromatic Hydrocarbons

All Poly Aromatic Hydrocarbons (PAH) concentrations were below laboratory detection limits at all sites. Concentrations of all PAHs were below adopted guidelines.

4.1.2.4.5 Nutrients

Phosphorous concentrations were above laboratory detection limits at all sites, ranging from 0.069 to 0.123 mg/L and below the most stringent guideline value of 0.5 mg/L. Nitrate concentrations were above laboratory detection limits at all sites, ranging from 0.18 to 0.28 mg/L, which is below the most stringent guideline value of 10 mg/L. Nitrite concentrations were above laboratory detection limits at all sites, ranging from 0.02 to 0.04 mg/L and far below the most stringent guideline value of 1 mg/L. Total Nitrogen values were below detection limits at all sites. Concentrations of all nutrients were therefore below adopted guidelines.

4.1.2.4.6 Physical

Total Suspended Solids (TSS) concentrations were at or below laboratory detection limits at all sites. TSS values were below adopted guidelines.

Table 4-8 Chemical water quality concentrations at the offshore borrow area

Results Group	Parameter	Unit	Guideline			Detection Limit	BO5 Top	BO5 Bottom	BO4 Top	BO4 Bottom	BO3 Top	BO3 Bottom	BO2 Top	BO2 Bottom	BO1 Top	BO1 Bottom
			Dubai Harbour	KSA Red Sea	ANZECC											
Metals	Arsenic	mg/L	0.05	0.05	0.05	0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Metals	Cadmium	mg/L	0.05	0.005	0.0055	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Metals	Chromium	mg/L	0.2	0.05	0.0044	0.003	<0.003	<0.003	0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Metals	Copper	mg/L	0.5	0.05	0.0013	0.003	<0.003	<0.003	<0.003	<0.003	0.045	<0.003	<0.003	<0.003	<0.003	<0.003
Metals	Lead	mg/L	0.1	0.05	0.0044	0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Metals	Nickel	mg/L	0.1	0.05	0.07	0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Metals	Phosphorus	mg/L	2	0.5		0.03	0.051	0.129	0.107	0.061	0.082	0.144	0.07	0.14	0.046	0.043
Metals	Vanadium	mg/L			0.1	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Metals	Zinc	mg/L	0.5	0.8	0.015	0.03	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Metals	Mercury	µg/L	1		0.4	0.3	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300
BTEX	Benzene	µg/L		10	700	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
BTEX	Toluene	µg/L		2		10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
BTEX	Ethyl benzene	µg/L				10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
BTEX	m&p-Xylene	µg/L				20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
BTEX	o-Xylene	µg/L				10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Hydrocarbons	VPH C5-C10	µg/L				10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Hydrocarbons	EPH C10-C40	µg/L				50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
PAH	Acenaphthene	µg/L			20	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH	Acenaphthylene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25

Results Group	Parameter	Unit	Guideline			Detection Limit	BO5 Top	BO5 Bottom	BO4 Top	BO4 Bottom	BO3 Top	BO3 Bottom	BO2 Top	BO2 Bottom	BO1 Top	BO1 Bottom
			Dubai Harbour	KSA Red Sea	ANZECC											
PAH	Anthracene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH	Benzo(a)anthracene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH	Benzo(a)pyrene	µg/L			10	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH	Benzo(b)fluoranthene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH	Benzo(g,h,i)perylene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH	Benzo(k)fluoranthene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH	Chrysene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH	Dibenzo(a,h)anthracene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH	Fluoranthene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH	Fluorene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH	Indeno(1,2,3-c,d)pyrene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH	Naphthalene	µg/L			70	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH	Phenanthrene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH	Pyrene	µg/L				0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Inorganic	Nitrate as NO3	mg/L	40		10	0.1	0.22	0.22	0.18	0.18	0.18	0.22	0.22	0.28	0.22	0.22
Inorganic	Nitrite as NO2	mg/L			1	0.01	0.04	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Inorganic	Total Nitrogen	mg/L	2	1.5	1	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Physical	Total Suspended Solids	mg/L	50	5	10	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

4.2 Sediment Quality- HOLD-1

Sediment quality samples will be collected in June 2015 and included in this report following laboratory analyses and provision of data.

4.2.1 Physical Sediment Properties- HOLD-2

4.2.2 Chemical Sediment Quality- HOLD-3

4.3 Subtidal Benthic Habitat

An overview of the baseline habitat types encountered throughout the survey area is presented here. The benthic habitat of the study area has been divided into four distinct geographical areas, the area Inside the Port, the Nearshore Area Outside of the Port, the Offshore Disposal Area and the Offshore Borrow Area. A summary of the results is presented in table format at the beginning of each section. Benthic habitat maps have been constructed from the analysed video footage results and are presented in their respective section. Representative still images are presented throughout as a visual aid to the written description of habitat types. Raw video transect footage is available in DVD format in Appendix 2.

4.3.1 Inside the Port

Table 4-9 Summary of surveyed benthic habitat type inside the Port

Transect	P1	P2	P3	P4	P5	P6	P7	P8
Geomorphological Structure								
Reef and Hard Bottom								
Rock Outcrop	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-
Aggregate Reef	-	-	-	-	-	-	-	-
Individual Patch Reef	-	-	-	-	-	-	-	-
Aggregated Patch Reefs	-	-	-	-	-	-	-	-
Spur and Groove	-	-	-	-	-	-	-	-
Pavement	-	-	-	-	-	-	-	-
Pavement with Sand Channels	-	-	-	-	-	-	-	-
Reef Rubble	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-
Unconsolidated Sediment								
Sand	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mud	-	-	-	-	-	-	-	-
Sand with Scattered rock	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-
Other								

Transect	P1	P2	P3	P4	P5	P6	P7	P8
Land	-	-	-	-	-	-	-	-
Artificial	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-
Biological Structure								
Turfing Algae	-	-	-	-	-	-	-	-
Live Coral	-	-	-	-	-	-	-	-
Coralline Algae	-	-	-	-	-	-	-	-
Mangrove	-	-	-	-	-	-	-	-
Seagrass	-	-	-	-	-	-	-	-
No Cover	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-

4.3.1.1 GEOMORPHOLOGICAL STRUCTURE

The surface of the seabed surveyed inside the Port was comprised entirely of unconsolidated sediments (Figure 4-5). Sediments located on transects throughout the Port were composed of silty sand (Plate 4-1 to Plate 4-8).

4.3.1.2 BIOLOGICAL COVER

Biological cover was extremely sparse inside the Port area, with no biological cover observed in association with unconsolidated sediments (Figure 4-5). In terms of observable infauna, all transects included extensive sections of infauna holes made by burrowing crustacea (Plate 4-1 to Plate 4-8). These crustacea are likely to have comprised a single or various species of shrimp, but may also have included some crab species – no direct observations were made. Infauna holes were most numerous with increasing distance from the shoreline.

Plate 4-1 Unconsolidated sediment, silty sand, with infauna holes, Transect P1

Plate 4-2 Unconsolidated sediment, silty sand, Transect P2

Plate 4-3 Unconsolidated sediment, silty sand, Transect P4

Plate 4-4 Unconsolidated sediment, silty sand, with infauna holes Transect P4

Plate 4-5 Unconsolidated sediment, silty sand, with infauna holes Transect P4

Plate 4-6 Unconsolidated sediment, silty sand, with infauna holes, Transect P8

Plate 4-7 Unconsolidated sediment, silty sand, with infauna holes, Transect P5

Plate 4-8 Unconsolidated sediment, silty sand, Transect P5

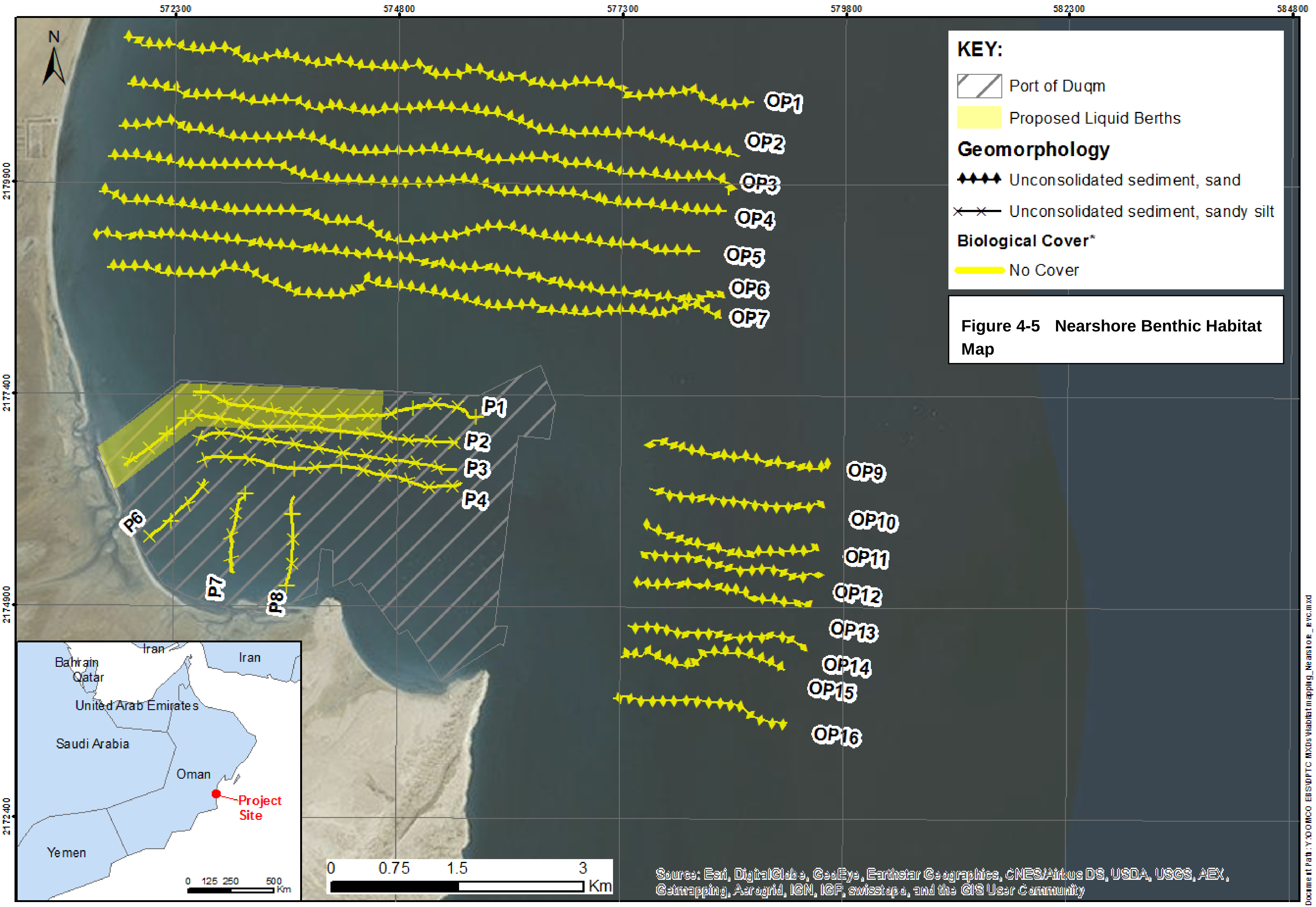


Figure 4-5 Nearshore Benthic Habitat Map

Projection: UTM40N WGS84

4.3.2 Nearshore Area Outside of the Port

Table 4-10 Summary of surveyed benthic habitat type nearshore area outside of the Port

Transect	OP1	OP2	OP3	OP4	OP6	OP7	OP8	OP9	OP10	OP12	OP13	OP14	OP15	OP16	OP17	OP18
Geomorphological Structure																
Reef and Hard Bottom																
Rock Outcrop	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aggregate Reef	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Individual Patch Reef	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aggregated Patch	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spur and Groove	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pavement	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pavement with Sand Channels	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reef Rubble	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unconsolidated Sediment																
Sand	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mud	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sand with Scattered rock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other																

Transect	OP1	OP2	OP3	OP4	OP6	OP7	OP8	OP9	OP10	OP12	OP13	OP14	OP15	OP16	OP17	OP18
Land	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Artificial	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological Structure																
Turfing Algae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Live Coral	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coralline Algae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mangrove	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
No Cover	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

4.3.2.1 Geomorphological Structure

The surface of the seabed surveyed in the nearshore area outside of the Port was comprised entirely of unconsolidated sediments (Figure 4-5). Fine sand was the dominant sediment type throughout the survey area (Plate 4-9 to Plate 4-14).

4.3.2.2 Biological Cover

Biological cover was extremely sparse in the nearshore area, no biological cover was observed in association with unconsolidated sediments (Figure 4-5). All transects included extensive sections of infauna holes made by burrowing crustacea. These crustacea are likely to have comprised a single or various species of shrimp, but may also have included some crab species – no direct observations were made. Infauna holes were most numerous with increasing distance from the shoreline.

Plate 4-9 Unconsolidated sediment, sand, Transect OP3

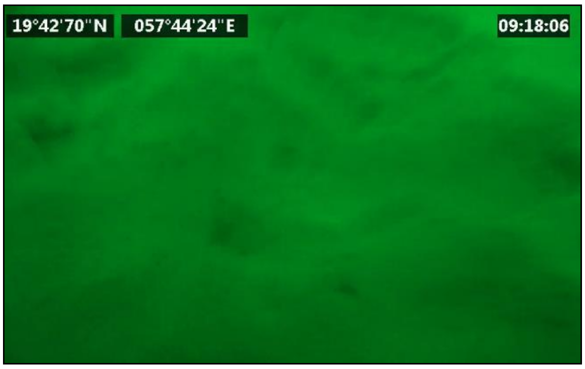


Plate 4-10 Unconsolidated sediment, sand, Transect OP3

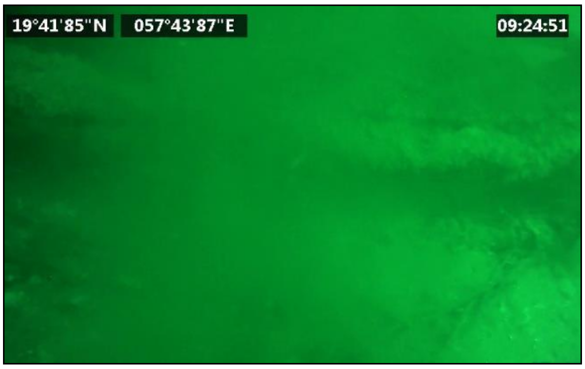


Plate 4-11 Abandoned net, Transect OP7

Plate 4-12 Unconsolidated sediment, sand, Transect OP7

Plate 4-13 Unconsolidated sediment, sand, Transect OP6

Plate 4-14 Unconsolidated sediment, sand, Transect OP9

4.3.3 Offshore Disposal Area

Table 4-11 Summary of surveyed benthic habitat type at the offshore disposal area

Transect	D1	D2	D3	D4	D5
Geomorphological Structure					
Reef and Hard Bottom					
Rock Outcrop	-	-	-	-	-
Boulder	-	-	-	-	-
Aggregate Reef	-	-	-	-	-
Individual Patch Reef	-	-	-	-	-
Aggregated Patch Reefs	-	-	-	-	-
Spur and Groove	-	-	-	-	-
Pavement	-	-	-	-	-
Pavement with Sand Channels	-	-	-	-	-
Reef Rubble	-	-	-	-	-
Unknown	-	-	-	-	-
Unconsolidated Sediment					
Sand	Yes	Yes	Yes	Yes	Yes
Mud	-	-	-	-	-
Sand with Scattered rock	Yes	Yes	Yes	Yes	Yes
Unknown	-	-	-	-	-
Other					
Land	-	-	-	-	-
Artificial	-	-	-	-	-
Unknown	-	-	-	-	-
Biological Structure					

Transect	D1	D2	D3	D4	D5
Turfing Algae	-	-	-	-	-
Live Coral	-	-	-	-	-
Coralline Algae	-	-	-	-	-
Mangrove	-	-	-	-	-
Seagrass	-	-	-	-	-
No Cover	-	-	-	-	-
Unknown	-	-	-	-	-

4.3.3.1 Geomorphological Structure

The surface of the seabed surveyed at the offshore disposal area was comprised entirely of unconsolidated sediments (Figure 4-6). The dominant sediment type was sand with scattered rock (Plate 4-15, Plate 4-16 and Plate 4-18), though some variation was observed with short sections of sand only (Plate 4-17).

4.3.3.2 Biological Cover

Biological cover was extremely sparse throughout the disposal area, with no biological observed in association with unconsolidated sediments (Figure 4-6). All transects included shell fragments on the surface. Shell fragments were found predominantly in sections with rock rubble (Plate 4-15). All transects included short sections of Infauna holes. Infauna holes were found in association with sections of sand only (Plate 4-17). These crustacea are likely to have comprised a single or various species of shrimp, but may also have included some crab species–no direct observations were made.

Plate 4-15 Unconsolidated sediment, sand with rock rubble, shell fragments are also visible, Transect D01

Plate 4-16 Unconsolidated sediment, sand with rock rubble, Transect D01

Plate 4-17 Unconsolidated sediment, sand, Infauna holes are visible, Transect D02

Plate 4-18 Unconsolidated sediment, sand with rock rubble, Transect D02

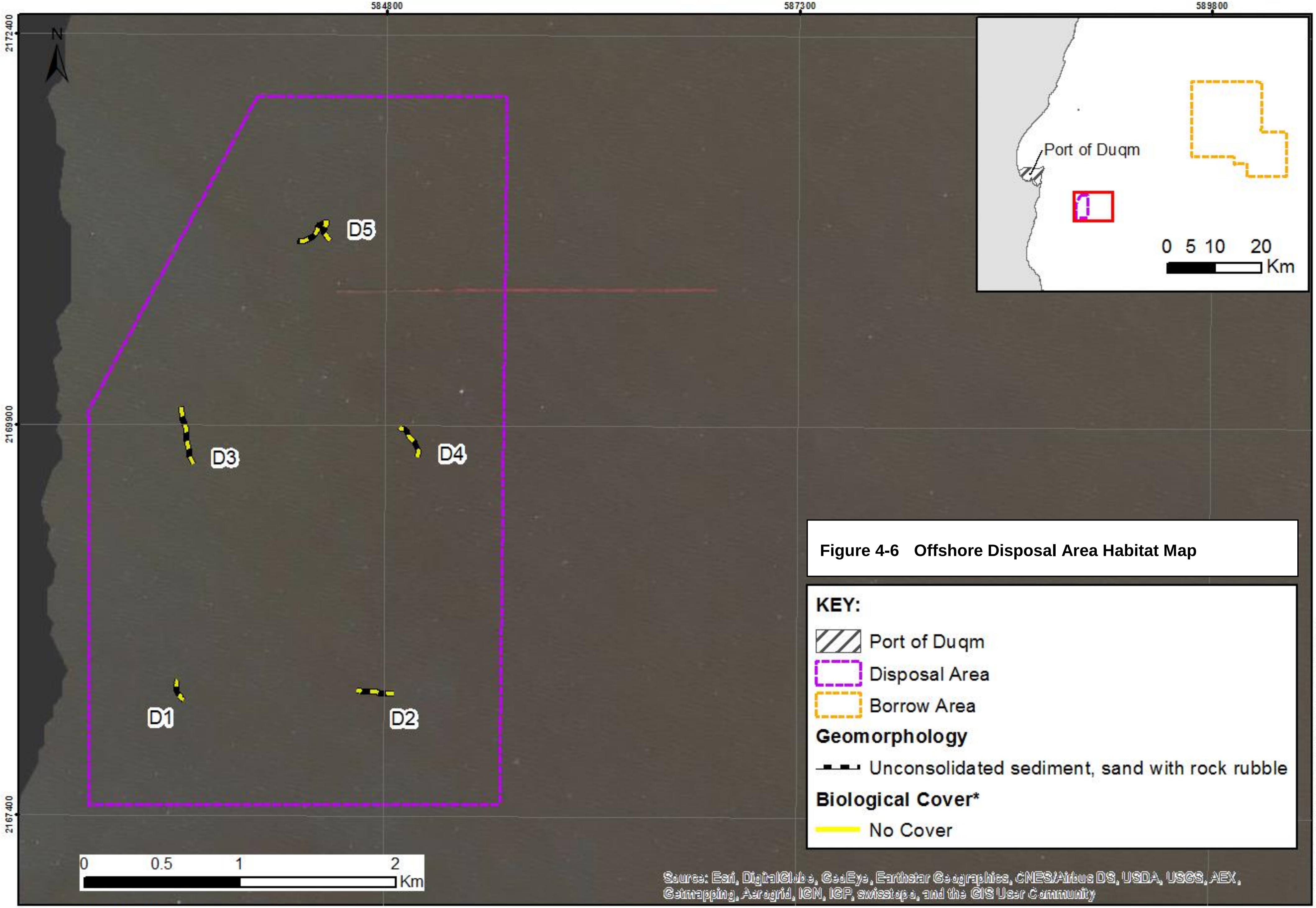


Figure 4-6 Offshore Disposal Area Habitat Map

Projection: UTM40N WGS84

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4.3.4 Offshore Borrow Area

Table 4-12 Summary of surveyed benthic habitat type at the offshore borrow area

Transect	B1	B2	B3	B4	B5
Geomorphological Structure					
Reef and Hard Bottom					
Rock Outcrop	-	-	-	-	-
Boulder	-	-	-	-	-
Aggregate Reef	-	-	-	-	-
Individual Patch Reef	-	-	-	-	-
Aggregated Patch Reefs	-	-	-	-	-
Spur and Groove	-	-	-	-	-
Pavement	-	-	-	-	-
Pavement with Sand Channels	-	-	-	-	-
Reef Rubble	-	-	-	-	-
Unknown	-	-	-	-	-
Unconsolidated Sediment					
Sand	Yes	Yes	Yes	Yes	Yes
Mud	-	-	-	-	-
Sand with Scattered rock	-	-	-	-	-
Unknown	-	-	-	-	-
Other					
Land	-	-	-	-	-
Artificial	-	-	-	-	-
Unknown	-	-	-	-	-
Biological Structure					
Turfing Algae	-	-	-	-	-
Live Coral	-	-	-	-	-
Coralline Algae	-	-	-	-	-
Mangrove	-	-	-	-	-
Seagrass	-	-	-	-	-
No Cover	-	-	-	-	-
Unknown	-	-	-	-	-

4.3.4.1 Geomorphological Structure

The surface of the seabed surveyed within the offshore borrow area was comprised entirely of unconsolidated sediments (Figure 4-7). The only sediment type observed at this location was sand (Plate 4-19 and Plate 4-20).

4.3.4.2 Biological Cover

Biological cover was extremely sparse throughout the borrow area, with no biological cover observed in association with unconsolidated sediments (Figure 4-7). Some shell fragments were present on the surface of the sediment in low concentration (Plate 4-20).

Plate 4-19 Unconsolidated sediment, sand, Transect B05

Plate 4-20 Unconsolidated sediment, sand, Transect B01

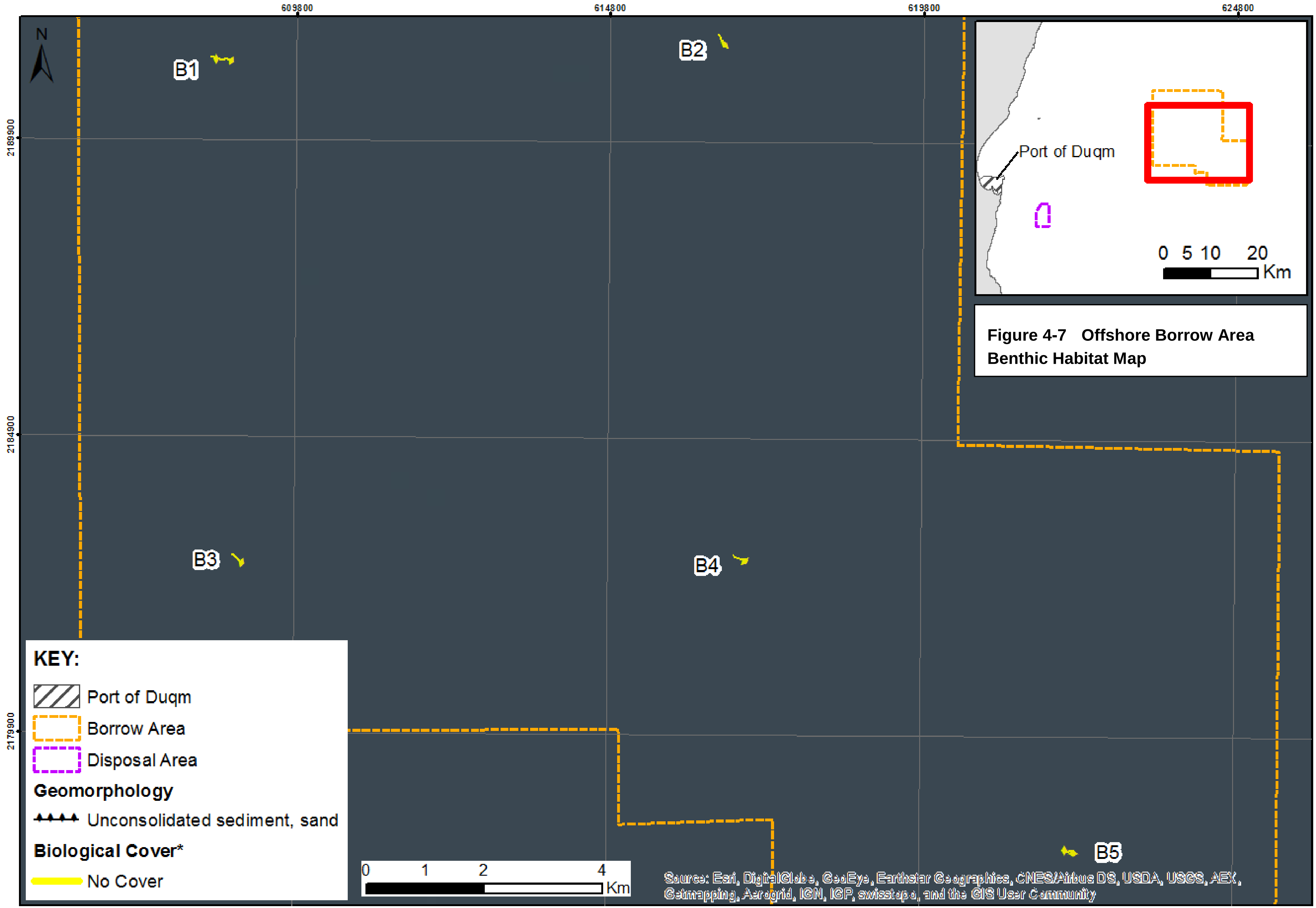

Figure 4-7 Offshore Borrow Area Benthic Habitat Map

Projection: UTM40N WGS84

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4.4 Intertidal Habitat

The intertidal habitat of the adjacent coastline was surveyed on foot from the center of the port to the lee breakwater and from the lee breakwater to 4 km along the adjacent coastline to the north. Surveys were completed over a two day period from 3rd to 4th April 2015. In total 12.6 km of coastline were surveyed.

The primary focus of the survey was to identify signs of cetacean strandings and turtle nesting. In addition the survey noted the location of wetland habitats, seabird presence and geomorphology relevant to local ecology.

4.4.1 Inside the Port

Transect I1 from the Government Quay to the lee breakwater was 7.4 km in length and encompassed concrete infrastructure of the Port, disturbed and undisturbed intertidal habitats.

4.4.1.1 GEOMORPHOLOGY

The dominant substrate type of the intertidal was sandy mud with sandy silt at the mouths of the wadi outlets. Hard bottom substrate was also encountered in the form of Port infrastructure, comprised of the Government Quay and the lee breakwater (Plate 4-1).

Immediately inland of the intertidal zone the soft bottom sandy mud formed a hard crust. Occasional sink holes were noted within this inland section. The majority of these sink holes had water at the bottom. The depth to water varied in correlation with distance from shore, with deeper sink holes appearing further from shore (Plate 4-2). Occasional rocky outcrops were visible, standing 1-2 m above the surrounding flat landscape.

Inland and a few hundred meters north of the Government Quay, a wastewater outfall formed a small settling pond with no notable ecology (Plate 4-2). Very shallow surface water was encountered in the form of wadis and their outlets. Although shallow at the time of the survey, it is expected that during the Khareef these water courses will be more prominent, swelling with freshwater from the surrounding catchment area.

Several sandbanks were exposed at low water close to shore. One large bank close to the Government Quay was exposed throughout the tidal range (Plate 4-3).

Plate 4-1 Soft sediment intertidal sandy mud and rock sides of the Port infrastructure

Plate 4-2 Inland sink hole and wastewater outfall close to the Government Quay

4.4.1.2 Ecology

4.4.1.2.1 Cetaceans and Turtles

No observations of turtles or cetaceans were made during this transect. In the view of the survey team and author, only the exposed sandbank close to the Government Quay may be suitable for turtle nesting within the port (Plate 4-3). It is considered unlikely that the sandbank is used by nesting turtles however, although a single green or olive ridley turtle was seen inside the port from the boat.

4.4.1.2.2 Benthic Macrofauna

Benthic macrofauna was generally sparse. The hard concrete and rock substrate of the Port's walls and breakwaters had been colonized to an extent with epifauna, including limpets, barnacles, rock oysters and muscles present on most intertidal hard surfaces. It is surmised that colonization is not yet mature as the coverage of these benthic invertebrates was only around 20% at maximum.

Infauna also appeared to be sparsely distributed throughout the intertidal zone, with less than a handful of worm casts spotted within a typical 1 m^2 area. The intertidal area was vast however and clearly supported large numbers of vertebrates (birds and fish).

4.4.1.2.3 BIRDS

At the time of the survey (3rd to 4th April 2015), small sea birds such as terns were seen in large numbers, concentrated on the exposed sandbanks. The greatest concentration of birds was observed on the sandbank close to the Government Quay (Plate 4-3).

Footprints of larger birds were seen throughout the intertidal area (Plate 4-3). It is suggested that this is indicative of foraging activity over the entire soft sediment intertidal. Larger birds were seen to roost on the edge of the walls and breakwaters throughout the Port. During periods of inclement weather, the walls and breakwaters of the Port were lined with seabirds, mostly gulls, sheltering form strong winds.

Plate 4-3 Terns on exposed sand bank and seabird footprints in the intertidal sediment

4.4.2 Outside the Port

Transect I2 from the lee breakwater to water desalination plant north of the Port, was 5.2 km in length and encompassed concrete infrastructure of the Port, disturbed and undisturbed intertidal habitats.

4.4.2.1 GEOMORPHOLOGY

The dominant substrate type of the intertidal was fine sand. Sandy mud and sandy silt were also encountered close to the breakwater and at the mouths of the wadi outlets. Hard bottom substrate was also encountered in the form of the lee breakwater.

Very few sandbanks were exposed at low water close to shore. The shoreline was mostly continuous, but did include one large sand spit toward the center of the transect.

Very shallow surface water was encountered in the form of wadis and their outlets. Although shallow at the time of the survey, it is expected that during the Khareef these water courses will be more prominent, swelling with freshwater from the surrounding catchment area.

At the location of the spit toward the center of the transect, a 2-3 m wide inlet separated the spit from the mainland. This inlet increased and decreased in size throughout the tidal range. At low tide it was possible to cross the dry inlet at most locations.

4.4.2.2 Ecology

4.4.2.2.1 Cetaceans and Turtles

No observations of turtles or cetaceans were made during this transect. In the view of the survey team and author, the fine sand substrate of over the majority of the coastline may be suitable for turtle nesting. The sand spit was composed of the most consistent fine sand substrate and is therefore the most likely location for any possible turtle nesting.

Plate 4-4 View to sand spit across inlet and fine sand sediment on the spit

4.4.2.2.2 Benthic Macrofauna

Benthic macrofauna was generally sparse. The hard concrete and rock substrate of the Port's walls and breakwaters had been colonized to an extent with epifauna, including limpets, barnacles, rock oysters and muscles present on most intertidal hard surfaces. It is surmised that colonization is not yet mature however as the coverage of these benthic invertebrates was only around 20% at maximum.

Infauna also appeared to be sparsely distributed throughout the intertidal, with less than a handful of worm casts spotted within a typical $1m^2$ area. The intertidal area was vast however and clearly supported large numbers of vertebrates (birds and fish).

Dense concentrations of Infauna burrows, assumed to be crab burrows, were observed in short sections towards the middle of the transect (Plate 4-5).

Plate 4-5 Infauna holes in soft sediment

4.4.2.2.3 *VEGETATION*

No macro algae or sea grass were seen throughout the survey. Sparse patches of terrestrial vegetation were observed however. Small shrubs and fleshy plants were located close to the small wadi inlet near the lee breakwater and along the inlet separating the shore from the sand spit (Plate 4-6)

Attributable to dinoflagellate plankton, a possible Harmful Algal Bloom was observed in the waters of the inlet leading to the sand spit. This was characterized by red coloration to the water (Plate 4-6). It should be noted that no fish fatalities were spotted in the proximity of this water.


Plate 4-6 Salt tolerant terrestrial vegetation (left) and possible harmful algal bloom (right).

4.4.2.2.4 Birds

At the time of the survey, sea birds were seen in large numbers. Flamingos were seen in the wadi close to the lee breakwater together with small waders, terns and gulls (Plate 4-7). Large concentrations of gulls were encountered close to the fishing village north of the Port.

It was observed that the fishermen had discarded fish on the shore that were of little value such as small catfish (Plate 4-9). Although not directly observed, it is assumed that the gulls were concentrated at this location to take advantage of any discards from the fishermen.


Plate 4-7 Flamingos and waders close to the lee breakwater


Plate 4-8 Terns and gulls on fine sand north of the lee breakwater


Plate 4-9 Gulls near the fishing village and discarded catfish

5 DISCUSSION

The proposed site of the liquid berths terminal, close to the lee breakwater in the Port of Duqm, is situated on coastal supratidal sabkha (saline mud flats). Low hills, rocky outcrops and the rocky headland Ras Duqm are located to the south and east. Coastal upwelling of deep, cold water takes place from May to September as a result of the southwest monsoon. This is the dominant environmental influence on marine life in the region and makes the shallow shelf offshore from Duqm a highly productive environment for all marine organisms and an internationally important habitat for whales and dolphins.

5.1 Physicochemical Water Quality

5.1.1 Inside the Port

Maximum depths at sites sampled inside the port ranged from 2 m to 19 m. Depth was greatest in the shipping channel that runs through the centre of the Port and shallowest nearshore. Depth decreased rapidly outside of the shipping channel and then gradually towards shore. The pronounced increase in depth at the location of the shipping channel is due to the capital dredging that has been completed as part of the Port's general construction to allow vessel access to the port.

Temperature varied between sites and depth. Surface temperatures were generally warmer at shallower sites. This is attributable to the sun's warming effects, an effect which is strongest at the surface. Temperature decreased with depth at all sites and was most noticeable at the deepest site in the shipping channel, where clear stratification was observed between 4 m and 6 m forming a thermocline. The sun's warming effects decrease with depth due to attenuation of heat as it passes through the water column. Stratification was observed in deeper water due to a separating of warm surface waters from relatively cold and dense bottom waters and low physical mixing from low currents speed and small wave conditions. Stratification was not observed in shallower waters due to a more even distribution of water density, largely a factor of wind, wave and current driven mixing of the water column.

Turbidity was generally high inside the Port. This is a consequence of a number of contributing factors. There are several wadis located close to the study area that deposit fine suspended particles into the Port, the surface sediment of the Port is fine silty and muddy sand which is re-suspended when disturbed by currents and waves, and the Port is largely enclosed from the sea preventing large scale flushing. Turbidity was lowest in the deep water of the shipping channel. This is expected as this location has the greatest influence from the open sea. Turbidity increased nearshore with decreasing depth and was highest towards the seabed at all sites. This is generally due to the re-suspension of fine sediments from the seabed.

Dissolved Oxygen (DO) values ranged from mean values of 97.9 % to 59.3 %. DO levels reduced with depth at all sites. DO levels in some parts of the Port are lower than would be expected in an open system with good circulation and mixing. The low DO sites, WQ03 and WQ04, are situated close to the shipping channel and away from shore. The reason for reduced mean DO at these sites is as a consequence of stratification and low values in the bottom layer.

Results at all sites, both inside and outside of the Port are within the ranges described by Royal Haskoning in 2007, as part of a study to characterise the area before the Port's construction.

However the differences in the data collected in this recent study reveal that physicochemical water conditions have been altered by the presence of the Port. In particular, the breakwaters have reduced circulation and flushing with open sea water. This has likely led to the slight but noticeable changes in the physicochemical condition of waters inside the Port.

5.1.2 Nearshore Area Outside of the Port

Depth outside the Port in the nearshore area ranged from 3.6 m closest to shore to 22.6 m further offshore. Depths at all sites followed this trend, with shallow sites located nearshore and deeper sites offshore.

Mean temperature values were largely comparable at all sites at around 24.5 ºC.

Turbidity increased with depth at all sites and increased most notably on approach to the sea bed. Sites closest to shore had higher surface and water column turbidity values than deeper sites. Turbidity values were markedly reduced compared to levels inside the Port. This is attributable to circulation and flushing with open waters outside the Port.

DO levels ranged from 66.2 % to 85.3 %. DO levels were lowest at sites opposite the mouth of the Port. This is probably as a result of escaping bottom water from the Port. DO levels were observed to be low inside the Port in deep water close to the shipping channel and mouth of the Port.

No unexpected differences were observed between control sites (WQ 13 and WQ 16) and other sites.

5.1.3 Offshore Disposal Area

As expected, depth was greater offshore and remained fairly consistent ranging from 25.3 to 26.7 m.

Mean temperature values were slightly reduced compared to nearshore values at around 23.8 ºC at all sites. This is expected as water depth has increased and temperature decreased with depth at all sites.

Mean turbidity values were notably reduced compared to nearshore values. Throughout the water column turbidity values were comparable. This is expected as the influence of flushing with clearer water is greater offshore.

DO values were higher than general values nearshore and mean values ranged from 72.2 to 85.9 %. This is expected and shows evidence of high levels of mixing.

5.1.4 Offshore Borrow Area

Located furthest offshore of the study locations, depth was greatest at the offshore borrow area than any other location. This is to be expected as the continental shelf gradually slopes away from the shore. Depth increased with distance from shore, ranging from between 29 m and 33.2 m.

Mean temperature values were similar at all sites at around 25 ºC. A thermocline was observable at sites in the area. This shows that offshore waters are calm enough for stratification at this time of the year.

Turbidity values were further reduced compared to measurements from sites closer to shore. This is expected and shows levels that are indicative of offshore open water.

DO values were higher than general values nearshore and mean values ranged from 76.7 to 90.4 %. This is expected and shows evidence of high levels of mixing.

5.2 Chemical Water Quality

Chemical water quality results derived from physical sampling and laboratory analysis reveal no exceedances against identified guideline values, with some very minor exceptions in copper and zinc. At such low concentrations and representing a minor exceedance of only one of the three adopted guideline values, it is likely that copper and zinc are within naturally occurring concentrations. There were no discernible differences in chemical water quality between sites located inside the port or outside of the port. No unexpected differences were observed between control sites (WQ 13 and WQ 16) and other sites. These results reveal chemical water conditions that are homogenous and unpolluted.

Compared to past data collected before the Port's construction (Royal Haskoning, 2007), chemical water quality concentrations show no substantial differences. Compared to a recent study during construction of the dry dock yard inside the existing Port (Five Oceans, 2012) our results show no substantial differences.

5.3 Physical Sediment Quality – HOLD-4

5.4 Chemical Sediment Quality – HOLD-5

5.5 Subtidal Benthic Habitat

The subtidal benthic habitats identified during the survey were largely homogenous unconsolidated sediments with no biological cover. The vast majority of the benthic habitat surveyed inside the Port was unconsolidated fine sediment with no biological cover. Outside of the port in the nearshore area, the surveyed benthic habitat was entirely homogenous unconsolidated sand sediments with no biological cover.

At the offshore disposal area, sediments were fine sand but included rock rubble. This is expected as the site has been previously used to dispose consolidated sediment dredged during development of the port.

The offshore borrow area comprised fine sand sediment throughout. The sediment type was homogenous and supported no biological cover.

No coral, seagrass or substantial areas of macroalgae were identified as part of this survey. It is likely that neither coral nor macroalgae were observed due to the absence of hard substrates, which is required for recruitment, settlement and colonisation. All benthic communities including seagrass species require sunlight for survival, a means of primary production known as photosynthesis. Photosynthetic rates vary depending on the level of Photosynthetically Active Radiation (PAR) at the seabed, which is in turn dependent on depth and turbidity levels. Increased turbidity was observed throughout the Port and nearshore areas. This is likely to have caused a decrease in PAR at the seabed which may have resulted in PAR being below the threshold for survival (Kaiser *et al*., 2011).

Similarly, light and substrate type are likely to be the main limiting factors at both offshore areas. Light is attenuated through the water column and as a consequence PAR decreases with depth. Additionally, recent disposal material within the disposal area will have likely smothered any previously existing benthic habitat.

A recent environmental study conducted inside the Port revealed very similar conditions to those encountered on this survey, infauna holes were observed inside the Port (WorleyParsons, 2015). One difference is that some of the sediment inside the Port was described as fine mud; the location of that study was, however, on the opposite side of the Port and close to the main breakwater. Another previous study collected infauna and sediment data before the Port’s construction (Royal Haskoning, 2007). The report describes the seabed as relatively flat and featureless, consisting of a large shallow coastal plain that extends for 10 km offshore before rapidly increasing in depth.

Anecdotal evidence gathered from a local dive operator revealed that no coral or seagrass habitat was known in proximity to the study area, inside the Port or along the adjacent coastline.

5.6 Intertidal Habitat

The intertidal habitat of the study area comprised soft sediment muddy sand and fine sands. Intertidal sediment within the Port was finer than sediments along the adjacent coastline to the north of the Port. No evidence of cetacean strandings or turtle nesting was observed during the intertidal surveys. Although no direct observations were made, the fine sand sediment along the adjacent northern coastline may be suitable habitat for nesting turtles.

One turtle sighting was made from the survey vessel close to the Government Quay. The sighting was only fleeting as the animal surfaced momentarily before disappeared back in to the highly turbid waters of the Port. It is thought that due to the relatively small size and oval shape of the carapace that it was either a hawksbill or Olive Ridley turtle.

It was evident that a large number of seabirds use the intertidal area of the Port and adjacent coastline. Exposed sandbanks in particular were frequented by large numbers of terns, gulls and other unidentified bird species. Inside the Port the main area of bird activity appeared to be a large sandbank immediately north of the Government Quay. Bird footprints were clearly visible throughout the intertidal area of the Port.

Outside of the Port, a section of wadi inlet close to lee breakwater was populated by a modest number of flamingos and other wading birds. Gulls were evident throughout the sandy intertidal of the adjacent coastline and concentrated around the fishing village close to the desalination plant north of the Port.

6 CONCLUSIONS

No protected areas are located in close proximity to the Project Area. The closest protected area, Ras Madrakah, is located 70 km to the southeast followed by Barr al Hikman 90 km to the northeast and Masirah Island 100 km in the same direction. All other marine protected areas are located over 300 km from the proposed Project.

Aside from the visible presence of the Port's infrastructure there is further evidence of the effects of the Port. Nearshore depths were greater inside the shipping channel due to dredging work undertaken to accommodate vessel drafts. Dissolved oxygen levels were reduced in the bottom layers of the Port and this influence has spread to bottom waters outside of the Port and close to the mouth. Turbidity levels were elevated inside the Port and remained high in the nearshore areas adjacent to the Port. Chemical water quality was good throughout the study area, with only very minor exceedances of some adopted guideline values for copper and zinc outside of the Port.

No significant sensitive habitat was found as part of this survey. The majority of the benthic habitat within the Port was found to be unconsolidated sediments of fine sand with no epifauna or flora cover. Outside the Port, the benthic habitat was homogenous unconsolidated sand with no epifauna or flora. The disposal area revealed evidence of past disposal with rock rubble visible with fine sand sediment.

No cetaceans were seen during the course of this baseline survey. One olive ridley or green turtle was seen in the Port close to the Government Quay. Although no tracks or signs of nesting were recorded, it is possible that the fine sand sediment of the adjacent coastline north of the Port is considered to be suitable for turtle nesting.

The intertidal area of the Port and the adjacent coastline is an important habitat for seabirds. In particular exposed sandbanks were populated with large number of small birds including terns and gulls.

Turtles have been shown to nest and feed on the coastline to the north of the Port, and certain cetacean and turtle species are known to transit through waters offshore from the Port, on route to breeding and feeding grounds in the region. However, these species are not known to concentrate in the nearshore area that the Project will operate in. It is possible that increased marine traffic during the construction phase will disturb marine mammals and turtles. However this level of disturbance is not considered to be significant above background levels of existing marine traffic in the Port and will result in little disturbance outside of the Port.

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Appendix 1 - Water & Sediment Laboratory Certificates

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CHEMICAL REPORT

Date Received	05 April 2015
Date Reported	30 April 2015

Lab Ref.	M15-03062
Client Ref.	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	WQ1
Sample Description	Sea Water	**Date & Time of Sampling**	03/04/15 at 19:11
Exova Sample No.	M15-03062/S1	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.18	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.080	0.030

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CHEMICAL REPORT

Date Received	05 April 2015
Date Reported	30 April 2015

Lab Ref.	M15-03062
Client Ref.	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	BO3. Bottom
Sample Description	Sea Water	**Date & Time of Sampling**	06/04/15 at 18:00
Exova Sample No.	M15-03062/S33	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039		0.22	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As			<0.010	0.010
*Cadmium as Cd		mg/L	<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu	ICP [APHA 3120B] SW-DXB		<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.144	0.030

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Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

For and on behalf of Exova

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Lab - Manager
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CHEMICAL REPORT

Date Received	05 April 2015
Date Reported	30 April 2015

Lab Ref.	M15-03062
Client Ref.	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	BO2. Top
Sample Description	Sea Water	**Date & Time of Sampling**	06/04/15 at 18:00
Exova Sample No.	M15-03062/S34	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039		0.22	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As			<0.010	0.010
*Cadmium as Cd		mg/L	<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu	ICP [APHA 3120B] SW-DXB		<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.070	0.030

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Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

Sub Contracted to Al Futtaim Exova Dubai

Tejali Parsekar

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
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CHEMICAL REPORT

Date Received	05 April 2015	**Lab Ref.**	M15-03062
Date Reported	30 April 2015	**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	BO2. Bottom
Sample Description	Sea Water	**Date & Time of Sampling**	06/04/15 at 18:00
Exova Sample No.	M15-03062/S35	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.28	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.140	0.030

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Contd. *Exova Sample Ref. M15-03062/S35*

Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

Tejali Parsekar

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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CHEMICAL REPORT

Date Received	05 April 2015	**Lab Ref.**	M15-03062
Date Reported	30 April 2015	**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	BO1. Top
Sample Description	Sea Water	**Date & Time of Sampling**	06/04/15 at 18:00
Exova Sample No.	M15-03062/S36	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.22	0.1
Nitrite as NO_2	HACH 8507	mg/L	0.03	0.01
Total Dissolved Solids (Dried @180°C)	APHA 2540 C	mg/L	<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB	mg/L	<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB	mg/L	<0.010	0.010
*Cadmium as Cd	ICP [APHA 3120B] SW-DXB	mg/L	<0.001	0.001
*Chromium as Cr	ICP [APHA 3120B] SW-DXB	mg/L	<0.003	0.003
*Copper as Cu	ICP [APHA 3120B] SW-DXB	mg/L	<0.003	0.003
*Lead as Pb	ICP [APHA 3120B] SW-DXB	mg/L	<0.010	0.010
*Nickel as Ni	ICP [APHA 3120B] SW-DXB	mg/L	<0.003	0.003
*Phosphorus as P	ICP [APHA 3120B] SW-DXB	mg/L	0.046	0.030

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Contd. **Exova Sample Ref. M15-03062/S36**

Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Contd. **_Exova Sample Ref. M15-03062/S36_**

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
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CHEMICAL REPORT

Date Received	05 April 2015	**Lab Ref.**	M15-03062
Date Reported	30 April 2015	**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	DO1. Bottom
Sample Description	Sea Water	**Date & Time of Sampling**	06/04/15 at 18:00
Exova Sample No.	M15-03062/S27	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.22	0.1
Nitrite as NO_2	HACH 8507	mg/L	0.04	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C	mg/L	<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB	mg/L	<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB	mg/L	<0.010	0.010
*Cadmium as Cd	ICP [APHA 3120B] SW-DXB	mg/L	<0.001	0.001
*Chromium as Cr	ICP [APHA 3120B] SW-DXB	mg/L	<0.003	0.003
*Copper as Cu	ICP [APHA 3120B] SW-DXB	mg/L	<0.003	0.003
*Lead as Pb	ICP [APHA 3120B] SW-DXB	mg/L	<0.010	0.010
*Nickel as Ni	ICP [APHA 3120B] SW-DXB	mg/L	<0.003	0.003
*Phosphorus as P	ICP [APHA 3120B] SW-DXB	mg/L	0.086	0.030

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Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

For and on behalf of Exova

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CHEMICAL REPORT

Date Received	05 April 2015	**Lab Ref.**	M15-03062
Date Reported	30 April 2015	**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	BO5. Top
Sample Description	Sea Water	**Date & Time of Sampling**	06/04/15 at 18:00
Exova Sample No.	M15-03062/S28	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.22	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.051	0.030

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Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

Tejali Parsekar

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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CHEMICAL REPORT

Date Received	05 April 2015	**Lab Ref.**	M15-03062
Date Reported	30 April 2015	**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	BO5. Bottom
Sample Description	Sea Water	**Date & Time of Sampling**	06/04/15 at 18:00
Exova Sample No.	M15-03062/S29	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.22	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.129	0.030

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Contd.

Exova Sample Ref. M15-03062/S29

Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection (LOD) value will increase from the method LOD*

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Contd.

Exova Sample Ref. M15-03062/S29

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

Sub Contracted to Al Futtaim Exova Dubai

Tejali Parsekar

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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CHEMICAL REPORT

Date Received	05 April 2015
Date Reported	30 April 2015

Lab Ref.	M15-03062
Client Ref.	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	BO4. Top
Sample Description	Sea Water	**Date & Time of Sampling**	06/04/15 at 18:00
Exova Sample No.	M15-03062/S30	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039		0.18	0.1
Nitrite as NO_2	HACH 8507		0.02	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As			<0.010	0.010
*Cadmium as Cd		mg/L	<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu	ICP [APHA 3120B] SW-DXB		<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.107	0.030

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Exova

Contd.

Exova Sample Ref. M15-03062/S30

Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Contd.

Exova Sample Ref. M15-03062/S30

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

Tejali Parsekar

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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CHEMICAL REPORT

Date Received	05 April 2015	**Lab Ref.**	M15-03062
Date Reported	30 April 2015	**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	BO4. Bottom
Sample Description	Sea Water	**Date & Time of Sampling**	06/04/15 at 18:00
Exova Sample No.	M15-03062/S31	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.18	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.061	0.030

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Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection (LOD) value will increase from the method LOD*

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene		<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene	µg/L	<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
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CHEMICAL REPORT

Date Received	05 April 2015
Date Reported	30 April 2015

Lab Ref.	M15-03062
Client Ref.	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	BO3. Top
Sample Description	Sea Water	**Date & time of Sampling**	06/04/15 at 18:00
Exova Sample No.	M15-03062/S32	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.18	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.082	0.030

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Contd.

Exova Sample Ref. M15-03062/S32

Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Contd.

Exova Sample Ref. M15-03062/S32

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

Tejali Parsekar

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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CHEMICAL REPORT

Date Received	05 April 2015
Date Reported	30 April 2015

Lab Ref.	M15-03062
Client Ref.	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	DO5. Bottom
Sample Description	Sea Water	**Date & Time of Sampling**	06/04/15 at 18:00
Exova Sample No.	M15-03062/S19	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.22	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.121	0.030

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Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

Contd. *Exova Sample Ref. M15-03062/S19*

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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CHEMICAL REPORT

Date Received	05 April 2015		**Lab Ref.**	M15-03062
Date Reported	30 April 2015		**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	DO4. Top
Sample Description	Sea Water	**Date & Time of Sampling**	06/04/15 at 18:00
Exova Sample No.	M15-03062/S20	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.22	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.086	0.030

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Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Contd.

Exova Sample Ref. M15-03062/S20

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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CHEMICAL REPORT

Date Received	05 April 2015	**Lab Ref.**	M15-03062
Date Reported	30 April 2015	**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	DO4. Bottom
Sample Description	Sea Water	**Date & Time of Sampling**	06/04/15 at 18:00
Exova Sample No.	M15-03062/S21	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.27	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.120	0.030

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Contd. **Exova Sample Ref. M15-03062/S21**

Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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CHEMICAL REPORT

Date Received	05 April 2015	**Lab Ref.**	M15-03062
Date Reported	30 April 2015	**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	DO3. Top
Sample Description	Sea Water	**Date & Time of Sampling**	06/04/15 at 18:00
Exova Sample No.	M15-03062/S22	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.22	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.080	0.030

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Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

Tejali Parsekar

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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CHEMICAL REPORT

Date Received	05 April 2015	**Lab Ref.**	M15-03062
Date Reported	30 April 2015	**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	DO3. Bottom
Sample Description	Sea Water	**Date &Time of Sampling**	06/04/15 at 18:00
Exova Sample No.	M15-03062/S23	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.18	0.1
Nitrite as NO_2	HACH 8507		0.04	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.069	0.030

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Contd.

Exova Sample Ref. M15-03062/S23

Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Contd.

Exova Sample Ref. M15-03062/S23

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

Tejali Parsekar

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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CHEMICAL REPORT

Date Received	05 April 2015
Date Reported	30 April 2015

Lab Ref.	M15-03062
Client Ref.	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	DO2. Top
Sample Description	Sea Water	**Date & Time of Sampling**	06/04/15 at 18:00
Exova Sample No.	M15-03062/S24	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.18	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.091	0.030

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Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Contd. *Exova Sample Ref. M15-03062/S24*

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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CHEMICAL REPORT

Date Received	05 April 2015	**Lab Ref.**	M15-03062
Date Reported	30 April 2015	**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	DO2. Bottom
Sample Description	Sea Water	**Date & Time of Sampling**	06/04/15 at 18:00
Exova Sample No.	M15-03062/S25	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.18	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.100	0.030

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Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Contd. Exova Sample Ref. M15-03062/S25

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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CHEMICAL REPORT

Date Received	05 April 2015
Date Reported	30 April 2015

Lab Ref.	M15-03062
Client Ref.	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	Sample ID	DO1. Top
Sample Description	Sea Water	Date & Time of Sampling	06/04/15 at 18:00
Exova Sample No.	M15-03062/S26	Sampled by	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	Test date	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.18	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.123	0.030

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Contd. **Exova Sample Ref. M15-03062/S26**

Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Contd. *Exova Sample Ref. M15-03062/S26*

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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CHEMICAL REPORT

Date Received	05 April 2015
Date Reported	30 April 2015

Lab Ref.	M15-03062
Client Ref.	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	BO1. Bottom
Sample Description	Sea Water	**Date & Time of Sampling**	06/04/15 at 18:00
Exova Sample No.	M15-03062/S37	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.22	0.1
Nitrite as NO_2	HACH 8507	mg/L	0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C	mg/L	<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB	mg/L	<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB	mg/L	<0.010	0.010
*Cadmium as Cd	ICP [APHA 3120B] SW-DXB	mg/L	<0.001	0.001
*Chromium as Cr	ICP [APHA 3120B] SW-DXB	mg/L	<0.003	0.003
*Copper as Cu	ICP [APHA 3120B] SW-DXB	mg/L	<0.003	0.003
*Lead as Pb	ICP [APHA 3120B] SW-DXB	mg/L	<0.010	0.010
*Nickel as Ni	ICP [APHA 3120B] SW-DXB	mg/L	<0.003	0.003
*Phosphorus as P	ICP [APHA 3120B] SW-DXB	mg/L	0.043	0.030

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Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemist

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CHEMICAL REPORT

Date Received	05 April 2015	**Lab Ref.**	M15-03062
Date Reported	30 April 2015	**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	WQ11
Sample Description	Sea Water	**Date & Time of Sampling**	03/04/15 at 19:11
Exova Sample No.	M15-03062/S11	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.22	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			0.009	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.070	0.030

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Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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CHEMICAL REPORT

Date Received	05 April 2015		**Lab Ref.**	M15-03062
Date Reported	30 April 2015		**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	WQ12
Sample Description	Sea Water	**Date & Time of Sampling**	03/04/15 at 19:11
Exova Sample No.	M15-03062/S12	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.22	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.060	0.030

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Contd. **Exova Sample Ref. M15-03062/S12**

Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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CHEMICAL REPORT

Date Received	05 April 2015	**Lab Ref.**	M15-03062
Date Reported	30 April 2015	**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	WQ13
Sample Description	Sea Water	**Date of & Time of Sampling**	03/04/15 at 19:11
Exova Sample No.	M15-03062/S13	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.22	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.050	0.030

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Contd. *Exova Sample Ref. M15-03062/S13*

Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

Tejali Parsekar

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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اكسوفا Exova

CHEMICAL REPORT

Date Received	05 April 2015	**Lab Ref.**	M15-03062
Date Reported	30 April 2015	**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	WQ14
Sample Description	Sea Water	**Date & Time of Sampling**	03/04/15 at 19:11
Exova Sample No.	M15-03062/S14	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039		0.18	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As			<0.010	0.010
*Cadmium as Cd		mg/L	<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu	ICP [APHA 3120B] SW-DXB		<0.003	0.003
*Lead as Pb			<0.10	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.090	0.030

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Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

Contd.

Exova Sample Ref. M15-03062/S14

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

Tejali Parsekar

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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CHEMICAL REPORT

Date Received	05 April 2015
Date Reported	30 April 2015

Lab Ref.	M15-03062
Client Ref.	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	WQ15
Sample Description	Sea Water	**Date & Time of Sampling**	03/04/15 at 19:11
Exova Sample No.	M15-03062/S15	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.22	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.050	0.030

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Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

إكسوفا Exova

Contd.

Exova Sample Ref. M15-03062/S15

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

Tejali Parsekar

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
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CHEMICAL REPORT

Date Received	05 April 2015	**Lab Ref.**	M15-03062
Date Reported	30 April 2015	**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	WQ16
Sample Description	Sea Water	**Date & Time of Sampling**	03/04/15 at 19:11
Exova Sample No.	M15-03062/S16	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.18	0.1
Nitrite as NO_2	HACH 8507	mg/L	0.02	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C	mg/L	<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB	mg/L	<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB	mg/L	<0.010	0.010
*Cadmium as Cd	ICP [APHA 3120B] SW-DXB	mg/L	<0.001	0.001
*Chromium as Cr	ICP [APHA 3120B] SW-DXB	mg/L	<0.003	0.003
*Copper as Cu	ICP [APHA 3120B] SW-DXB	mg/L	<0.003	0.003
*Lead as Pb	ICP [APHA 3120B] SW-DXB	mg/L	<0.010	0.010
*Nickel as Ni	ICP [APHA 3120B] SW-DXB	mg/L	<0.003	0.003
*Phosphorus as P	ICP [APHA 3120B] SW-DXB	mg/L	0.050	0.030

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Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

Contd. *Exova Sample Ref. M15-03062/S16*

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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CHEMICAL REPORT

Date Received	05 April 2015
Date Reported	30 April 2015

Lab Ref.	M15-03062
Client Ref.	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	WQ17
Sample Description	Sea Water	**Date & Time of Sampling**	03/04/15 at 19:11
Exova Sample No.	M15-03062/S17	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039		0.18	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As			<0.010	0.010
*Cadmium as Cd		mg/L	<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu	ICP [APHA 3120B] SW-DXB		<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.070	0.030

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Contd. ***Exova Sample Ref. M15-03062/S17***

Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Contd. *Exova Sample Ref. M15-03062/S17*

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

Tejali Parsekar

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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CHEMICAL REPORT

Date Received	05 April 2015		**Lab Ref.**	M15-03062
Date Reported	30 April 2015		**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	DO5. Top
Sample Description	Sea Water	**Date & Time of Sampling**	06/04/15 at 18:00
Exova Sample No.	M15-03062/S18	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.18	0.1
Nitrite as NO_2	HACH 8507		0.02	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.094	0.030

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Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

Tejali Parsekar

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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Contd. *Exova Sample Ref. M15-03062/S1*

Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	μg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	μg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	μg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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إكسوفا
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Contd.

Exova Sample Ref. M15-03062/S1

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

Tejali Parsekar

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
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CHEMICAL REPORT

Date Received	05 April 2015	**Lab Ref.**	M15-03062
Date Reported	30 April 2015	**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	WQ2
Sample Description	Sea Water	**Date & Time of Sampling**	03/04/15 at 19:11
Exova Sample No.	M15-03062/S2	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.22	0.1
Nitrite as NO_2	HACH 8507	mg/L	0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C	mg/L	<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB	mg/L	<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB	mg/L	<0.010	0.010
*Cadmium as Cd	ICP [APHA 3120B] SW-DXB	mg/L	<0.001	0.001
*Chromium as Cr	ICP [APHA 3120B] SW-DXB	mg/L	<0.003	0.003
*Copper as Cu	ICP [APHA 3120B] SW-DXB	mg/L	<0.003	0.003
*Lead as Pb	ICP [APHA 3120B] SW-DXB	mg/L	<0.010	0.010
*Nickel as Ni	ICP [APHA 3120B] SW-DXB	mg/L	<0.003	0.003
*Phosphorus as P	ICP [APHA 3120B] SW-DXB	mg/L	0.080	0.030

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Contd. *Exova Sample Ref. M15-03062/S2*

Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Contd. Exova Sample Ref. M15-03062/S2

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

Tejali Parsekar

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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CHEMICAL REPORT

Date Received	05 April 2015	**Lab Ref.**	M15-03062
Date Reported	30 April 2015	**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	WQ3
Sample Description	Sea Water	**Date & Time of Sampling**	03/04/15 at 19:11
Exova Sample No.	M15-03062/S3	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.18	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.070	0.030

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Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Contd. Exova Sample Ref. M15-03062/S3

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

Sub Contracted to Al Futtaim Exova Dubai

Tejali Parsekar

For and on behalf of Exova

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إكسوفا Exova

CHEMICAL REPORT

Date Received	05 April 2015
Date Reported	30 April 2015

Lab Ref.	M15-03062
Client Ref.	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	Sample ID	WQ4
Sample Description	Sea Water	Date & Time of Sampling	03/04/15 at 19:11
Exova Sample No.	M15-03062/S4	Sampled by	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	Test date	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.18	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.070	0.030

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Contd. *Exova Sample Ref. M15-03062/S4*

Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Contd. *Exova Sample Ref. M15-03062/S4*

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

Tejali Parsekar

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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CHEMICAL REPORT

Date Received	05 April 2015	**Lab Ref.**	M15-03062
Date Reported	30 April 2015	**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	WQ5
Sample Description	Sea Water	**Date & Time of Sampling**	03/04/15 at 19:11
Exova Sample No.	M15-03062/S5	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.18	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.080	0.030

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Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Contd.

Exova Sample Ref. M15-03062/S5

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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CHEMICAL REPORT

Date Received	05 April 2015	**Lab Ref.**	M15-03062
Date Reported	30 April 2015	**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	WQ6
Sample Description	Sea Water	**Date & Time of Sampling**	03/04/15 at 19:11
Exova Sample No.	M15-03062/S6	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.22	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.080	0.030

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Contd. *Exova Sample Ref. M15-03062/S6*

Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

Exova (Cayman) Limited L L C
C.R. No. 1726773

Contd. *Exova Sample Ref. M15-03062/S6*

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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اكسوفا Exova

CHEMICAL REPORT

Date Received	05 April 2015	**Lab Ref.**	M15-03062
Date Reported	30 April 2015	**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	WQ7
Sample Description	Sea Water	**Date & Time of Sampling**	03/04/15 at 19:11
Exova Sample No.	M15-03062/S7	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.27	0.1
Nitrite as NO_2	HACH 8507		0.04	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.080	0.030

Contd. *Exova Sample Ref. M15-03062/S7*

Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

إكسوفا
Exova

Contd. *Exova Sample Ref. M15-03062/S7*

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

Tejali Parsekar

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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CHEMICAL REPORT

Date Received	05 April 2015	**Lab Ref.**	M15-03062
Date Reported	30 April 2015	**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	WQ8
Sample Description	Sea Water	**Date & Time of Sampling**	03/04/15 at 19:11
Exova Sample No.	M15-03062/S8	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.18	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.010	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.080	0.030

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Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

Exova (Cayman) Limited L L C
C.R. No. 1726773

Contd. **Exova Sample Ref. M15-03062/S8**

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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CHEMICAL REPORT

Date Received	05 April 2015	**Lab Ref.**	M15-03062
Date Reported	30 April 2015	**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	WQ9
Sample Description	Sea Water	**Date & Time of Sampling**	03/04/15 at 19:11
Exova Sample No.	M15-03062/S9	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.18	0.1
Nitrite as NO_2	HACH 8507		0.03	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.10	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			<0.003	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.060	0.030

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Contd.

Exova Sample Ref. M15-03062/S9

Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			<0.030	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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Contd. *Exova Sample Ref. M15-03062/S9*

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

Tejali Parsekar

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
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CHEMICAL REPORT

Date Received	05 April 2015	**Lab Ref.**	M15-03062
Date Reported	30 April 2015	**Client Ref.**	Project Code: 303060-00098

Client	Worley Parson Oman Engineering LLC		
Project Name	SEZAD/DPTC DLBB Project	**Sample ID**	WQ10
Sample Description	Sea Water	**Date & Time of Sampling**	03/04/15 at 19:11
Exova Sample No.	M15-03062/S10	**Sampled by**	Client
Test Location	Exova, Azaiba Lab & Al Futtaim Exova, Dubai	**Test date**	10/04/15-27/04/15

Analytical Results

Constituents	Test method	Units	Results	Detection Limits
Nitrate as NO_3	HACH 8039	mg/L	0.18	0.1
Nitrite as NO_2	HACH 8507		0.04	0.01
Total Suspended Solids (Dried @105°C)	APHA 2540 C		<1.0	1.0
*Total Nitrogen	[ASTM D5176]-DXB		<0.5	0.5
*Arsenic as As	ICP [APHA 3120B] SW-DXB		<0.10	0.010
*Cadmium as Cd			<0.001	0.001
*Chromium as Cr			<0.003	0.003
*Copper as Cu			0.009	0.003
*Lead as Pb			<0.010	0.010
*Nickel as Ni			<0.003	0.003
*Phosphorus as P			0.060	0.030

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Contd. ***Exova Sample Ref. M15-03062/S10***

Constituents	Test method	Units	Results	Detection Limits
*Vanadium as V	ICP [APHA 3120B] SW-DXB	mg/L	<0.005	0.005
*Zinc as Zn			0.039	0.030
*Mercury as Hg	PSA [EPA.245.7] SW-DXB	µg/L	<0.300	0.300

BTEX Test Method: EPA 8015B by GC-FID-HS*

Constituents	Units	Results	Detection Limits
Benzene	µg/L	<10	10
Toluene		<10	10
Ethyl benzene		<10	10
m&p-Xylene		<20	20
o-Xylene		<10	10

Total Petroleum Hydrocarbons Test Method: EPA 8015B by GC-FID *

Constituents	Units	Results	Detection Limits
Volatile Petroleum Hydrocarbons (VPH) (C5-C10)	µg/L	<10	10
Extractable Petroleum Hydrocarbons (EPH) (C10-C40)		<50	50

**Samples diluted due to matrix, the reported Limit of Detection(LOD) value will increase from the method LOD*

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إكسوفا
Exova

Contd. *Exova Sample Ref. M15-03062/S10*

Petroleum Aromatics Hydrocarbons Test Method: EPA 8270D-DXB*

Constituents	Units	Results	Detection Limits
Acenaphthene	µg/L	<0.25	0.25
Acenaphthylene		<0.25	0.25
Anthracene		<0.25	0.25
Benzo(a)anthracene		<0.25	0.25
Benzo(a)pyrene		<0.25	0.25
Benzo(b)fluoranthene		<0.25	0.25
Benzo(g,h,i)perylene		<0.25	0.25
Benzo(k)fluoranthene		<0.25	0.25
Chrysene		<0.25	0.25
Dibenzo(a,h)anthracene		<0.25	0.25
Fluoranthene		<0.25	0.25
Fluorene		<0.25	0.25
Indeno(1,2,3-c,d)pyrene		<0.25	0.25
Naphthalene		<0.25	0.25
Phenanthrene		<0.25	0.25
Pyrene		<0.25	0.25

**Sub Contracted to Al Futtaim Exova Dubai*

Tejali Parsekar

For and on behalf of Exova

Tejali Parsekar
Lab - Manager
Chemistry

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				Client ID	WQ1	WQ2	WQ3	WQ4	WQ5	WQ6	WQ7	WQ8	WQ9	WQ10	WQ11	WQ12	WQ13	WQ14	WQ15	WQ16	WQ17
				Sample Description	**M15-03062 / S1**	**M15-03062 / S2**	**M15-03062 / S3**	**M15-03062 / S4**	**M15-03062 / S5**	**M15-03062 / S6**	**M15-03062 / S7**	**M15-03062 / S8**	**M15-03062 / S9**	**M15-03062 / S10**	**M15-03062 / S11**	**M15-03062 / S12**	**M15-03062 / S13**	**M15-03062 / S14**	**M15-03062 / S15**	**M15-03062 / S16**	**M15-03062 / S17**
				Matrix	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water
Report Res	**Method**	**Parameter Nam**	**Unit**	**Detection Limit**	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text
Inorganic P	Nitrogen (Total) [AST	Total Nitrogen	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Metals	Metals ICP [APHA 31	Arsenic	mg/L	0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Metals	Metals ICP [APHA 31	Cadmium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Metals	Metals ICP [APHA 31	Chromium	mg/L	0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Metals	Metals ICP [APHA 31	Copper	mg/L	0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.009	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Metals	Metals ICP [APHA 31	Lead	mg/L	0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Metals	Metals ICP [APHA 31	Nickel	mg/L	0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Metals	Metals ICP [APHA 31	Phosphorus	mg/L	0.03	0.08	0.08	0.07	0.07	0.08	0.08	0.08	0.08	0.06	0.06	0.07	0.06	0.05	0.09	0.05	0.05	0.07
Metals	Metals ICP [APHA 31	Vanadium	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Metals	Metals ICP [APHA 31	Zinc	mg/L	0.03	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	0.039	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Metals	Mercury by PSA [EPA	Mercury	µg/L	0.3	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300
BTEX	BTEX by GC-FID-HS [	Benzene	µg/L	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
BTEX	BTEX by GC-FID-HS [	Toluene	µg/L	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
BTEX	BTEX by GC-FID-HS [	Ethyl benzene	µg/L	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
BTEX	BTEX by GC-FID-HS [	m&p-Xylene	µg/L	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
BTEX	BTEX by GC-FID-HS [	o-Xylene	µg/L	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Hydrocarb	VPH C5-C10 by GC-F	VPH C5-C10	µg/L	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Hydrocarb	EPH C10-C40 by GC-I	EPH C10-C40	µg/L	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
PAH's	PAH in Water [EPA 8	Acenaphthene	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA 8	Acenaphthylene	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA 8	Anthracene	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA 8	Benzo(a)anthrac	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA 8	Benzo(a)pyrene	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA 8	Benzo(b)fluoran	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA 8	Benzo(g,h,i)pery	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA 8	Benzo(k)fluoran	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA 8	Chrysene	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA 8	Dibenzo(a,h)antl	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA 8	Fluoranthene	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA 8	Fluorene	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA 8	Indeno(1,2,3-c,d	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA 8	Naphthalene	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA 8	Phenanthrene	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA 8	Pyrene	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Inorganic P	Nitrate	Nitrate as NO3	mg/L	0.1	0.18	0.22	0.18	0.18	0.18	0.22	0.27	0.18	0.18	0.18	0.22	0.22	0.22	0.18	0.22	0.18	0.18
Inorganic P	Nitrite	Nitrite as NO2	mg/L	0.01	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.02	0.03
Physical pa	Total Suspended Soli	Total Suspendec	mg/L	1	1	<1	<1	<1.0	<1.0	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	1

				Client ID	DO5 -Top	DO5 -Bottom	DO4 -Top	DO4 -Bottom	DO3-Top	DO3-Bottom	DO2 -Top	DO2 -Bottom	DO1-Top	DO1-Bottom	BO5 -Top	BO5 -Bottom	BO4 -Top	BO4 -Bottom	BO3 -Top	BO3 -Bottom	BO2 -Top	BO2 -Bottom	BO1 -Top	BO1 -Bottom
				Sample Description	**M15-03062 / S18**	**M15-03062 / S19**	**M15-03062 / S20**	**M15-03062 / S21**	**M15-03062 / S22**	**M15-03062 / S23**	**M15-03062 / S24**	**M15-03062 / S25**	**M15-03062 / S26**	**M15-03062 / S27**	**M15-03062 / S28**	**M15-03062 / S29**	**M15-03062 / S30**	**M15-03062 / S31**	**M15-03062 / S32**	**M15-03062 / S33**	**M15-03062 / S34**	**M15-03062 / S35**	**M15-03062 / S3**	**M15-03062 / S37**
				Matrix	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water	Saline Water
Report Res	**Method**	**Parameter Name**	**Unit**	**Detection Limit**	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text	Result Text
Inorganic F	Nitrogen (Total) [A	Total Nitrogen	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Metals	Metals ICP [APHA	Arsenic	mg/L	0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Metals	Metals ICP [APHA	Cadmium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Metals	Metals ICP [APHA	Chromium	mg/L	0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Metals	Metals ICP [APHA	Copper	mg/L	0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.045	<0.003	<0.003	<0.003	<0.003	<0.003
Metals	Metals ICP [APHA	Lead	mg/L	0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Metals	Metals ICP [APHA	Nickel	mg/L	0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Metals	Metals ICP [APHA	Phosphorus	mg/L	0.03	0.094	0.121	0.086	0.12	0.08	0.069	0.091	0.1	0.123	0.086	0.051	0.129	0.107	0.061	0.082	0.144	0.07	0.14	0.046	0.043
Metals	Metals ICP [APHA	Vanadium	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Metals	Metals ICP [APHA	Zinc	mg/L	0.03	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Metals	Mercury by PSA [E	Mercury	µg/L	0.3	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300	<0.300
BTEX	BTEX by GC-FID-HS	Benzene	µg/L	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
BTEX	BTEX by GC-FID-HS	Toluene	µg/L	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
BTEX	BTEX by GC-FID-HS	Ethyl benzene	µg/L	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
BTEX	BTEX by GC-FID-HS	m&p-Xylene	µg/L	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
BTEX	BTEX by GC-FID-HS	o-Xylene	µg/L	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Hydrocarb	VPH C5-C10 by GC	VPH C5-C10	µg/L	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Hydrocarb	EPH C10-C40 by G	EPH C10-C40	µg/L	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
PAH's	PAH in Water [EPA	Acenaphthene	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA	Acenaphthylene	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA	Anthracene	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA	Benzo(a)anthracene	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA	Benzo(a)pyrene	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA	Benzo(b)fluoranthene	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA	Benzo(g,h,i)perylene	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA	Benzo(k)fluoranthene	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA	Chrysene	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA	Dibenzo(a,h)anthracen	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA	Fluoranthene	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA	Fluorene	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA	Indeno(1,2,3-c,d)pyren	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA	Naphthalene	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA	Phenanthrene	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
PAH's	PAH in Water [EPA	Pyrene	µg/L	0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Inorganic F	Nitrate	Nitrate as NO3	mg/L	0.1	0.18	0.22	0.22	0.27	0.22	0.18	0.18	0.18	0.18	0.22	0.22	0.22	0.18	0.18	0.18	0.22	0.22	0.28	0.22	0.22
Inorganic F	Nitrite	Nitrite as NO2	mg/L	0.01	0.02	0.03	0.03	0.03	0.03	0.04	0.03	0.03	0.03	0.04	0.04	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Physical pa	Total Suspended S	Total Suspended Solids	mg/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

Appendix 2 - Video Data (provided on separate DVD)

Appendix 3: Socio-Economic Setting and Stakeholder Consultation

WorleyParsons
resources & energy

شركة الدقم للمستودعات البترولية ش.م. م
DUQM PETROLEUM TERMINAL COMPANY LLC

DUQM LIQUID BULK BERTHS PROJECT

Report

Socio-Economic Setting and Stakeholder Consultation

SEZAD-DPTC-00-WP-EV-REP-2003-B1

2-Jul-2015

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SYNOPSIS

This document presents the Report on the Socio-Economic Setting and Stakeholder Consultation undertaken for DUQM LIQUID BULK BERTHS PROJECT. The consultations were carried out as part of the primary baseline surveys for the Environmental Impact Assessment of the DUQM LIQUID BULK BERTHS PROJECT. Other primary surveys conducted for the project are the ambient air quality survey, ambient noise level monitoring, terrestrial ecological survey and marine environmental baseline survey. Separate documents are prepared for these surveys. This document presents the methodology of the Socio-Economic Setting and Stakeholder Consultation, the data collected from the consultations, interpretation of the collected data and conclusions. The intent of the consultations was to establish the baseline social status of the project area and to understand the perception of the institutions and local community members about the industrial zone in general and the DUQM LIQUID BULK BERTHS PROJECT in particular. The baseline social data will facilitate assessment of potential social impacts from the DUQM LIQUID BULK BERTHS PROJECT.

PROJECT # 303060-00098: REPORT – SOCIO-ECONOMIC SETTING AND STAKEHOLDER CONSULTATION

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
A1	Issued for IDC	D Simic/A Al Riyami/ S Poonacha	A Concesso	N/A	14-May-2015	N/A	
A2	Issued for Client Review	D Simic	A Concesso	J Akhtar	21-May-2015		N/A
B1	Approved for Use	D Simic	A Concesso	J Akhtar	2-Jul-2015		N/A

CONTENTS

REVISION DESCRIPTION LIST

Rev.	Para.	Revision Description
A1		Issued for Inter-Disciplinary Check
A2		Issued for Client Review (Incorporated Comments from IDC)
B1		Approved for Use (ICR comments resolved by issuing and approving Comments Resolution Sheet)

Hold No.	Para.	Description of Hold

1 INTRODUCTION

1.1 Project Description

Duqm Petroleum Terminal Company (DPTC), a joint venture company between Oman Oil Company (OOC) and the Port of Duqm (PDC), has been established to develop and operate the Liquid Bulk Berths Terminal, in the Duqm Port (titled Duqm Liquid Bulk Berths (DLBB) Project). WorleyParsons has been retained by DPTC for the Consultancy Services for Project Definition, FEED and Supervision of the New Liquid Bulk Berths in the Port of Duqm.

The DLBB Project involves the development of liquid bulk berths and tank facilities for the export of finished products, from the Duqm Refinery. Phase 1 of the Duqm Refinery, with a capacity of 230,000 BPD, is currently being planned. The finished products handled are Naphtha, Jet A1, Diesel, High Sulphur Fuel Oil, Pressurized Liquefied Petroleum Gas, Pet coke and Sulphur.

The project is planned on the existing Lee Breakwater (LBW) within the Port of Duqm, which is designated by a Royal Decree for industrial use as part of the overall Duqm industrial zone and port development.

1.2 Purpose of the Baseline Surveys

The baseline surveys are carried out in order to identify the existing environmental conditions of the project site. This includes the status of the ambient air quality, ambient noise levels, terrestrial and marine ecology, seawater and sediment qualities, soil and groundwater qualities, climate and meteorology, hydrology, hydrogeology, geology, topography, society and archaeology. The baseline environmental information for the project site will be used during the assessment of the potential impacts from the DLBB Project.

The baseline information is gathered through the following two methods:

- By visiting the project site and its vicinity to undertake surveys and record observations, conduct monitoring and sampling, and hold interviews with concerned stakeholders. This is termed as ‘primary survey’.
- By desktop research and literature survey. Herein previous environmental reports and published information are reviewed. This is termed as ‘secondary survey’.

For the DLBB Project the primary surveys were undertaken to collate data on air quality, ambient noise level, terrestrial and marine ecology, seawater quality and socio-economic setup. The sediment quality data will be obtained from the Metoceans survey for the project, and the soil and groundwater quality data will be obtained from the geotechnical investigation for the project.

Data on the remaining environmental elements will be collated through secondary survey, i.e., through review of previous reports and published information.

1.3 Purpose of this Report

This report documents the socio-economic setting of the Duqm wilayat, and the results of the stakeholder consultations held at the Wali's office in Duqm, the ROP, the Duqm Municipality, the boys' and girls' schools in Duqm and the office of the Oman Women Society in Duqm.

The information and conclusions will be used later during the assessment of impacts in the Environmental Impact Identification (ENVID) workshop and in the Environmental Impact Assessment (EIA) study.

1.4 About Stakeholder Consultation[1]

Consultation is a two-way process of dialogue between the project company and its stakeholders. Constructive relationship between the company and the stakeholder once initiated through stakeholder consultations maybe continued over time. It is considered that the companies that start consultations early are developing their local "social licence to operate" in the long term. The consultation is an opportunity (or series of opportunities) to create understanding of those that likely will be impacted by the project. The impact might be environmental and/or social. It is an opportunity to learn how external parties view the project, its impacts, and opportunities, and their concerns. The feedback information can help the company to improve design, outcomes and control external risks (if any). For the stakeholder it is an opportunity to get information and to educate company's staff about the local context, raise issues, ask questions and make suggestions to the company for potential project improvement.

A good consultation process will be:

- Targeted at stakeholders most likely to be affected by the project
- Early enough to scope key issues and have effect on project decision to which they relate
- Informed as a result of dissemination of the relevant information in advance
- Meaningful to those consulted because the content is presented in readily understandable format and the techniques used are culturally appropriate
- Two–way, so that both sides have the opportunity to exchange views and information, to listen and to have their issues addressed
- Gender inclusive through awareness that men and women often have different views and needs
- Localised to reflect appropriate timeframe, context and in local language
- Free from manipulation and pressure
- Documented to keep track of who has been consulted and key issues raised

[1] **Source**:
http://www.ifc.org/wps/wcm/connect/5a4e740048855591b724f76a6515bb18/PartOne_StakeholderConsultation.pdf?MOD=AJPERES

- Reported back in a timely way to those consulted, with clarification of next steps
- Ongoing as required during the life of the project

The purpose, requirements, stakeholders, scoping priority issues, techniques, responsibilities and documentation should be specified while planning the consultation.

1.5 Report Structure

This chapter is the introduction to the report the subsequent chapters are arranged as below:

- **Chapter 2** – presents the demographic setting for the area collated through published material.
- **Chapter 3** – presents the methodology adopted for stakeholder consultations and review of the participation
- **Chapter 4** – summarizes discussions held with community members
- **Chapter 5** – presents the results of consultations with civil society association
- **Chapter 6** – summarizes the discussions held with institutional stakeholders
- **Chapter 7** – presents conclusions of and recommendations to the study

1.6 Abbreviations

BPD	Barrels per day
DLBB	Duqm Liquid Bulk Berths
DPTC	Duqm Petroleum Terminal Company LLC
EIA	Environmental Impact Assessment
ENVID	Environmental Impact Identification
FEED	Front End Engineering Design
IFC	International Finance Corporation
LBW	Lee Breakwater
MoAF	Ministry of Agriculture and Fisheries
NGO	Non-Governmental Organisation
ODC	Oman Dry-dock Company
OESHCo	Oman Environmental Services Holding Company (also known as be'ah)
OOC	Oman Oil Company
PDC	Port of Duqm Company
PMC	Project Management Consultancy
RAECo	Rural Authority for Electricity Company
ROP	Royal Oman Police
SEZ	Special Economic Zone
SEZAD	Special Economic Zone Authority at Duqm

2 SOCIO-ECONOMIC SETTING

2.1 Overview

This section has been prepared and presented based on the desktop review of the published information. For this purpose, publically available information like the Statistical Year Book 2014, by National Centre for Statistics and Information, and the Oman Social Atlas have been used.

2.2 Background

The DLBB Project is located on the LBW within Duqm Port on the coast of Oman in the Duqm Wilayat in Al Wusta Governorate. The nearest inhabited village is the Say village located on the banks of Wadi Say. The name Say village is often used in synonym with Duqm Town and is the administrative headquarters of Duqm Wilayat.

The Al Wusta Governorate is located in the centre of the Sultanate and borders the Dhofar Governorate to the south, the Arabian Sea to the east, the Kingdom of Saudi Arabia to the west and the Governorates of Adh Dhahirah, Ash Sharqiyah and Ad Dakhiliyah to the north. Al Wusta is dominated by a flat, featureless, barren rock desert. It has an un-spoilt desert and beautiful quiet beaches. Majority of the population within the Al Wusta region lives in the coastal zone in small towns or villages. The Governorate is divided into four Wilayats, viz., Mahout, Al Jazer, Duqm and Haima (in the order of the population number). Traditionally, during the monsoon season, when the coastal area along Duqm is too rough for fishing, the local populace migrates to villages south of the mountain ranges, mainly in the Adam, Sinaw and Mudhaibi areas. There they live in palm-frond shelters (*rishah*) and stay there for the date harvest. Many have invested in date palms and collect their crops for storage to supply their families and livestock through the upcoming winter. Locals also derive income from livestock growing (goats, sheep and camels) and by working in government and the private sector. Some families receive financial support from the Ministry of Social Development.

The local people rely heavily on fishing for its income. However, a number of Government-planned initiatives for industrial and tourism developments in Al Wusta are expected to supplant the traditional reliance on agriculture and fisheries.

The Al Wusta Governorate makes up 25.8% of the land area of Oman, however only represents about 1% of the population in the Sultanate with population density of 0.5 persons/km^2 (c. 2013).The population of Al Wusta rose from 30,624 in 2011 to 40,151 in 2013 representing a 31% increase[2]. This population increase could be attributed to Government development schemes.

[2] Source: Statistical Year Book 2014 by National Centre for Statistics and Information

Figure 2-1: Settlements in the Al Wusta Governorate

2.3 Demographic Profile

Among all the villages in Duqm Wilayat, Say village is the largest with a population of 6,183 followed by As Sadanat and Al Hawiyah (Census of Oman 2010). The rest of the villages within the study area are sparsely or seasonally populated. The population of the identified localities within the study area is presented in Table 2-1, overleaf.

Figure 2-2 presents the population in Duqm Wilayat between 2011 and 2013 as published in the Statistical Year Book 2014 by National Centre for Statistical & Information.

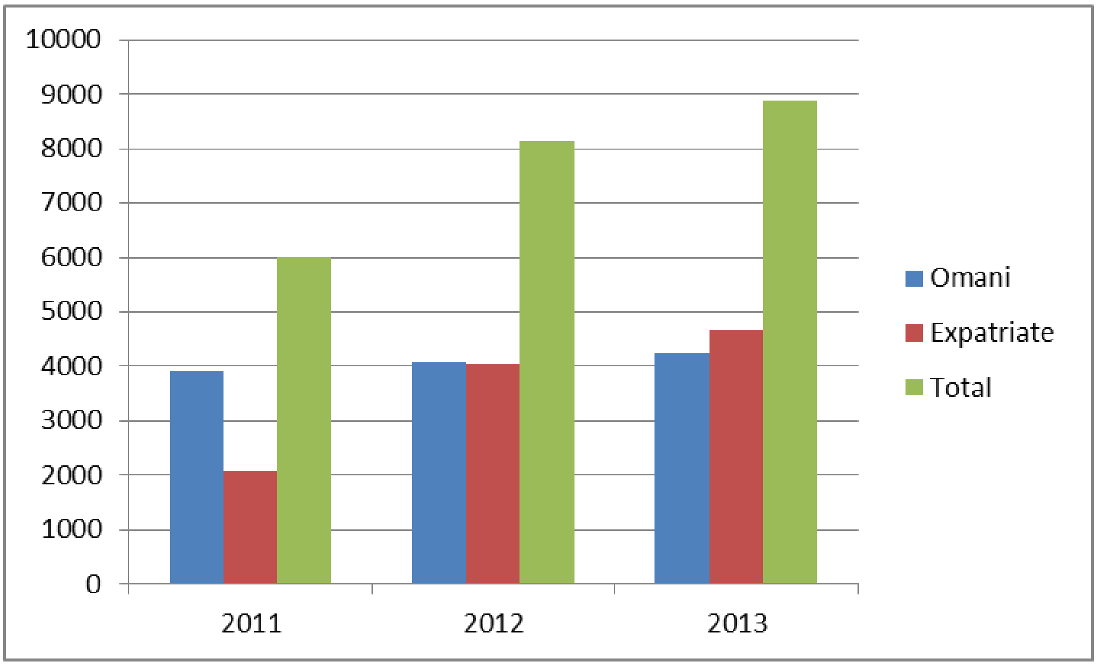


Figure 2-2: Population in Duqm Wilayat (<u>Source</u>: Statistical Year Book 2014 by National Centre for Statistics and Information)

The above figure shows a rapid increase in the population in Duqm Wilayat as a result of development activities. The majority of the expatriates in Duqm Wilayat are expected to be construction workers, building infrastructure for the SEZ development. As development in the SEZ area intensifies a large increase in the population of the Wilayat is expected followed by a drop as the construction work force are demobilised from the site. As the SEZ development lies adjoining the Say village, the population of the village is expected to vary due to mobilisation and demobilisation of the construction workers; unless separate accommodation camps are built within the SEZ area.

2.3.1 Omani and Non-Omani Population

Table 2-1 shows that the expatriate population in Say village is approximately 10 times the size of the Omani population. Due to the upcoming economic development in SEZ it is expected that the number of expatriate working force will increase over time peak and then gradually decline.

Table 2-1: Population of Identified localities in Duqm Wilayat

Locality Name	Population				Total	Number of Households			Number of Houses		Water Supply	Electricity	Phone Land Line	Hospitals	Schools	Farms
	Omani		Expatriate			Omani	Expatriate	Total	Occupied	Total						
	Male	Female	Male	Female												
Wilayat Duqm																
WADI SAY(DUQM TOWN)	558	533	4990	102	**6183**	146	123	**269**	287	**511**	×	✓	×	1	2	0
AS SADANAT	0	0	1123	1	**1124**	0	1	**1**	2	**13**	×	✓	×	0	0	0
AL HAWIYAH	0	0	498	2	**500**	0	0	**0**	1	**36**	×	✓	×	0	0	0
WADI DHANJART	5	5	0	0	**10**	1	0	**1**	1	**27**	×	✓	×	0	0	0
WADI QADIH	0	0	0	0	**0**	0	0	**0**	0	**0**	×	×	×	0	0	0
WADI AL KHABAN	0	0	0	0	**0**	0	0	**0**	0	**0**	×	×	×	0	0	0
WADI AD DISHAYSHAH	0	0	0	0	**0**	0	0	**0**	0	**3**	×	✓	×	0	0	0
WADI MUDRAB	0	0	0	0	**0**	0	0	**0**	0	**0**	×	×	×	0	0	0
WADI ASKLAT	0	0	0	0	**0**	0	0	**0**	0	**0**	×	×	×	0	0	0
ASH SHUAYR	0	0	0	0	**0**	0	0	**0**	0	**51**	×	✓	×	0	0	0
AL KHALAF	0	0	0	0	**0**	0	0	**0**	0	**35**	×	✓	×	0	0	0
QARN FUAD	0	0	0	0	**0**	0	0	**0**	0	**0**	×	×	×	0	0	0
AN NAAMIYAH	0	0	0	0	**0**	0	0	**0**	0	**0**	×	×	×	0	0	0
WADI QUTNAH	0	0	0	0	**0**	0	0	**0**	0	**0**	×	×	×	0	0	0
Total	**563**	**538**	**6611**	**105**	**7817**	**147**	**124**	**271**	**291**	**676**				**1**	**2**	**0**

Notes: 1- Most of the populations of the towns and villages located within the study area, are working in the companies within Duqm.
2- Census data might include Bedouin families who move between Wilayat in Sultanate according to the seasons.

Source: Socio economic 2010 Census data, National Center for Statistics and Information (2012)

2.3.2 Gender Ratio

The gender ratio in the Omani population within the study area can be described as almost 1:1. However, the gender ratio among the non-Omani population of the study area cannot be defined because only males were counted which signifies immigration of male workforce without families.

2.3.3 Family Size

The family pattern in Duqm is typical for Oman. The average number of people in each household is 8, while the average family size is 5. Few appear to marry before the age of 20 and multiple wives are rare.

2.3.4 Land Use

Animal husbandry is practiced by some of the local people in Say village. Produce from the animal husbandry is mostly for household consumption, though occasionally it may be used as a secondary source of income.

Although there are areas within the villages that supports grazing (natural vegetation in the form of shrubs and small trees), animal fodder is usually purchased from the local market and livestock are fed in temporary sheds (either in homes or *azbah*).

As per the 2010 census the number of houses in Say village has increased between 2003 and 2010. The majority of the settlements locate themselves after 7 to 9 km far from project location.

There are several open areas and vacant lands scattered within Duqm Wilayat. These are either owned by the government sector, private companies, community or individuals. Open areas and vacant lands within settlements act as assembly grounds for elders or play playgrounds for children.

2.4 Utilities, Civil and Social Infrastructure

Basic amenities and utilities of an area give an indication of the development status and quality of life. An evaluation of the available infrastructure in Say village shows that most services are available.

2.4.1 Water Supply

The water in Say and the surrounding villages is supplied by the Municipality from a desalination plant in Jaluni, which is located 12 km from Say village. Tankers transport water from the desalination plant to storage tanks located at individual households.

2.4.2 Sanitation and Sewerage

All houses have bath and water closets. All the toilets have water taps and are said to be equipped with basic sanitation requirements. The sewerage system is in the form of septic tank which is emptied as and when required by vacuum trucks belonging to the Municipality. The general sanitation condition is considered to be adequate.

2.4.3 Waste Disposal

The Municipality is responsible for waste disposal system in Duqm. Residents dispose solid waste in community garbage collection bins, provided by the Municipality. The frequency of garbage collection from the community bins is between 3 and 4 times a week.

2.4.4 Street Lighting and Power Supply

All the villages are connected with power supply network. However, not all villages have street lights on internal roads.

2.4.5 Access to Market

The main market is located in Say village and provides shopping facilities for the local community. Other villages have small petty shops which cater to daily household requirements.

2.4.6 Health Facility

There is a 12-bed local hospital in Say village, with health centres at Heytam and Ra's al Madrakah. The hospital is currently being expanded to include a dental clinic and the current national 5-year development plan has proposed a health care centre at Al Aja'iz. The hospital at Say village has two ambulances to attend to emergencies. During the Khareef season, to cater to increased accidents as a result of increased road traffic towards Salalah, an ambulance from Haima is redeployed to serve the area.

2.4.7 Education Facility

Say village has separate girls and boys Government Schools providing education to Grade XII. These schools are adequate to meet the educational needs of the Omani population. There are no education facilities for the expatriates living in the area.

2.4.8 Transportation

Most households have cars to fulfil their transportation needs. Local transport is also available in the form of a taxi service. Additionally, bus services to Muscat and Salalah are available. School buses ferry school children to and from school.

2.4.9 Housing

The villages have varied type of housing units, depicting the economic and social status of each individual. The government provides Buyut Sahabiyah (social housing) for Omanis who need support from the government. The housing typology ranges from small traditional Omani house to a contemporary building with modern amenities. Expatriates typically rent houses or stay in hotels in Say village. Construction workers are housed in purpose built project related construction camps.

2.5 Future Economic Development in Duqm

The Government of Oman is developing the coastal area of Duqm into a fully integrated export centre, complete with supporting urban facilities for balanced national developments. This development began in 2001 with the Government of Oman selecting Duqm as the location for a new shipyard and port complex.

The Port of Duqm will be one of the major ports in Oman due to its strategic geographical location, situated midway between Muscat and Salalah, on the Arabian Sea. This makes it an attractive destination for commercial shipping and route between Asian, European and Middle Eastern ports. The project is a catalyst for development locally and regionally within the Al Wusta region. The port and shipyard is expected to enhance the Omani economy in terms of diversification and creation of job opportunities for Omani citizens.

Already operational within the port area is the world-scale ship repair yard operated and managed by Oman Dry-dock Company (ODC), enterprise owned by the Omani government. While ODC has operational control over dry-dock complex, PDC is responsible for providing navigational assistance. An aerial photograph of the Port of Duqm and Dry-dock complex is shown in Image 2-1.

Image 2-1: Port of Duqm and Dry-dock Complex

Conceived as a multipurpose facility, Port of Duqm will cater to a wide range of cargoes and vessels. Envisioned in the master-plan are dedicated terminals for General Cargo, Containerized Cargo, Liquids and Petroleum Products, and Bulk Commodities. Construction of the marine substructure of a 2.2-km-long commercial quay has been completed.

There is a plan to add a further 10 km of commercial berths during Phase 2 of the port's development. Depending upon specific demand, these additional berths will be earmarked for general container, liquids and bulk cargo as the case may be.

In addition to the sea port, the area will be developed to include an industrial area, new town, fishing harbour, tourist zone, a logistics centre and an education and training zone, all of which are supported by a multimodal transport system that connects Duqm to other economic hubs.

The socio-economic setting in the study area is expected to go through a drastic change with the continued development of the study area.

3 METHODOLOGY FOR STAKEHOLDER CONSULTATIONS

3.1 Overview

The applied procedure and methodology for the social consultation was as specified in the Procedure document for Social Survey for Environmental Impact Assessment (Doc. No.SEZAD-DPTC-00-WP-EV-PRO-2001).

Stakeholder consultations were conducted in Duqm on 24-Mar-2015. The information presentation that was made to all the participants, the community survey and the institutional questionnaires are included in the Procedure document for Social Survey for Environmental Impact Assessment (Doc. No.SEZAD-DPTC-00-WP-EV-PRO-2001).

Stakeholder consultations for DLBB Project were prepared based on the IFC good practice and principals described in Section 1.4. The stakeholder consultation team included representatives from SEZAD, DPTC and WorleyParsons (refer Appendix 2). Summary of Stakeholders, Consultation Objective, Methodology and Approach is enclosed in Appendix 3.

3.2 Stakeholders

The overview of consulted stakeholders, completed questionnaires collected and interviews are presented in Table 3-1.

Table 3-1: Consulted Stakeholders, Completed Questionnaires Collected and Interviews

Stakeholders	Number of Completed Questionnaires	Questionnaire Code
COMMUNITY MEMBERS		
Duqm School for girls	2	(SG-1), (SG-2)
Duqm School for boys	9	(SB-1) to (SB-9)
Oman Women Society –Duqm participants	6	(OWS-1) to (OWS-6)
Wali office participants	11	(WO-1) to (WO-11)
Sub Total	***28***	
INSTITUTIONS		
Majlis Ash –Shura member of Duqm	1	Questionnaire- 1
Wali of Duqm -Deputy	1	Questionnaire- 2
Royal Oman Police (ROP) Duqm Wali office meeting	1	Questionnaire- 3.1
ROP Duqm station	1	Questionnaire- 3.2
Duqm Municipality –Deputy Director	1	Questionnaire- 4.1
Duqm Municipality – Head of Administration and Finance	1	Questionnaire- 4.2

Stakeholders	Number of Completed Questionnaires	Questionnaire Code
be'ah (Muscat)-Department Head of Environment and Sustainability	1	Questionnaire- 5*
Ministry of Manpower-Duqm, Wali office meeting	1	Questionnaire- 6
Directorate of Agriculture and Fisheries-Duqm, Wali Office Meeting	1	Questionnaire- 7
Sub Total	***9***	
CIVIL SOCIETY ASSOCIATION		
NGO -Oman Women Society- Duqm	1	Questionnaire- 8
Sub Total	***1***	
Grand Total	***38***	
Note: Consultation with be'ah was conducted through e-mail communication		

The total number of filled questionnaires and interviews is 38.

4 RESULTS OF CONSULTATIONS WITH COMMUNITY MEMBERS

4.1 Overview

This section presents a summary of the consultation with the community members held on 24-Mar-2015. Appendix 1 - presents the Social Survey Graphical and Descriptive Statistics.

4.2 Socio-Economic Profile

The group consisted of 66% participants of age between 26 to 35 years. 55% of the whole group had university education. Family status shows 72% of married participants, 54% of them lived in family of 1 to 5 members. 37% of all participants lived in families with one employed member. 89% of respondents depend on employment as a source of income. 85% of all participants work in government sector.

4.3 Duqm Development and Project Perception of Participants

Of all participants, 70% already recognize positive impact on their livelihood due to Duqm Port activities. 56% of them think that their livelihood has been impacted by existing development. 85% of participants perceive this change as a positive one. In relation to the DLBB Project, 52% of all survey participants have already heard about the DLBB Project. 92% of respondents expect the improvement in living after project completion. Better infrastructure, utilities, services, school and hospitals are expected by 89% of all respondents. 61% of them expect employment opportunities from DLBB Project.

4.4 Gender-wise Results of the Survey

The respondents group consisted of 71% of men and 29% of women.

4.4.1 Female Participants

<u>Socio–Economic Profile</u>

The 61% of women were between 26 to 30 years of age, 67% of them were single and 75% of them had primary school education. 57% of women participants lived in average family of 6 to 10 members. In 50% of families 3 members were employed while in 25% of families 2 members were employed. The source of income was employment in 100% responses and it was with government in 100% of responses.

<u>Duqm Development and Project Perception of Participants</u>

85% of all female participants recognize already positive impact on their livelihood due to Duqm Port activities. 71% of them think that their livelihood has been impacted by existing development. 75% of participants perceive this change as positive one. In relation to DLBB Project, half of the participants (50%) have already heard about the DLBB Project. 100% of respondents expect the improvement in living after project completion. Better infrastructure, utilities, services, school and hospitals are expected by 100% of all respondents. 70% of them expect employment opportunities and 20% of them contract opportunities from DLBB Project.

4.4.2 Male Participants

Socio–Economic Profile

The 42% of men were between 31 to 35 years of age and 21% of 26 to 30 years of age, 84% of them were married and 71% of them had university and above education. 63% of men participants lived in average family of 1 to 5 members. In 47% of families, one member was employed while in 21% of families two members were employed. The source of income was employment in 87% responses and it was with government in 80% of responses.

Duqm Development and Project Perception of Participants

63% of all male participants recognize already the positive impact on their livelihoods due to Duqm Port activities. 50% of them think that their livelihood has been impacted by exiting development. 89% of participants perceive this change as positive one. In relation to DLBB Project, 53% of the participants have already heard about the DLBB Project. 89% of respondents expect the improvement in living after project completion. Better infrastructure, utilities, services, school and hospitals expect 84% of all male respondents. 56% of them expect employment opportunities and 22% of them contract from DLBB Project.

4.5 Summary and Concluding Findings – Consultations with Community Members

Respondents group consisted of male and female participants of different socio-economic background covering a variety of age ranges, various education types, marital status and family size. Predominant age range was from 26 to 35 years, family size in the range of 1-5 to 6-10 members with one or two or three employed, predominantly in government sector. This shows that strong government structure exists in Duqm.

The participants perceive the overall development in Duqm as positive for socio economic development. They expect better infrastructure, utilities and services in the area along with the development. They require to be informed about coming developments. They require adaptation of education system to educate young generations for future jobs in Duqm and to provide scholarships. In general and DLBB Project wise they expect more job opportunities and business contracts for local people. Women participants are especially concerned, on safety and cultural conflicts with expat labour force coming to Duqm. It is required that expat labour force does not use community facilities such as hospitals, schools, etc. The men pointed out importance of healthy environment, without pollution and diseases. They expect quick return of benefits for community in Duqm. The overall perception of the development in Duqm is positive.

Community members did not identify any existing issues with DLBB Project and there are no existing environmental concerns in general.

5 RESULTS OF CONSULTATIONS – CIVIL SOCIETY ASSOCIATION

5.1 Overview

Oman Women Society (Duqm), a Non-Governmental Organization (NGO), was included in the consultation process. The meeting took place in the NGO's office premises in Duqm.

The results of the interview are presented in Table 5-1.

Table 5-1: Consultations with NGO

NGO	Summary of interview
Oman Women Society -Duqm	The NGO had some slight idea about the projects through the development going around. The expectations from General project –SEZ and DLBB Project are better future, better job opportunities and increase of land price. Issues might happen if the expat labour force interferes with locals leading to some cultural conflicts. Lots of drug dealings and safety cases are appearing in the area. The heavy bus and truck traffic can be dangerous in Duqm area. Future advantages might be higher rents, job opportunities and better contracts. Challenges will be to introduce good /appropriate education in schools of Duqm. The women in Duqm don't go fishing but in local culture and tradition some women fish abalone from the coastline rocks and its done only seasonally. Activities of women in Duqm are: taking care of old people without families, run kindergartens, teach/take care of small children by developing their handmade skills, contribute to any social activities/events, etc. The NGO representative hopes that this development will not cause any harm to society and will result in better opportunities for Duqm community overall.

5.2 Summary and Concluding Findings - Consultation with NGO

The discussion was constructive and various questions were posed. The participants were pleased with this consultation and the received information about the project.

The NGO as a representative of civil society recognizes the positive impact of future developments on society, overall better future, and more jobs for local population, increased land prices and better contracts for local people / companies. The challenge will be to introduce better and appropriate education to young people of Duqm to match market requirements. However there were concerns in relation to local culture, customs and safety related to living and traffic in Duqm once the expat labour force moves in Duqm.

Overall findings of the consultation with this NGO match pretty well with response of community members who participated in the survey.

6 RESULTS OF CONSULTATIONS WITH INSTITUTIONS

6.1 Overview

As highlighted earlier the institutions that were consulted in Duqm were the Office of the Majlis Ash Shura, Office of the Wali, ROP, Municipality, Ministry of Manpower, and Directorate of Agriculture and Fisheries and be'ah. All the institutions listed above, excluding be'ah, were engaged through face-to face interviews. be'ah was engaged through email communication. It should be noted that be'ah declined to comment on the DLBB Project, in absence of a waste management agreement between SEZAD and be'ah.

The results of the interviews with institutions are presented in Table 6-1.

Table 6-1: Consultations with Institutions

Institution	Summary of interviews
Majlis Ash Shura member of Duqm	It is expected that the upcoming development will be huge benefit for the society. The challenge is to overcome issues faced at the start of the development in order to achieve a promising future at the end. The Majlis Ash Shura office received some complaints and concerns from the local population regarding the developments; It is required to educate young generation adequately for future employment in Duqm. As part of the broader Duqm development the government should provide facilities, utilities and relevant community services to local population.
Wali of Duqm - Deputy	The expectations from the upcoming project are to improve living standards, give the region a chance to develop and/or improve in all sectors and fields, especially industrial sector. It should provide opportunities to local people to employ in future industries and institutions. Advantages are in improving living conditions and overall city development. Issues might be social and environmental harm/damage. Complaints received from local population are requests to be more involved in the development and to use more of associated advantages. Community is asking for awarding contracts to the local companies and to educate young generation in order get jobs in Duqm economic zone. The government should provide compensation for land use and accommodation and to contribute to community services/utilities. Specific concerns regarding vulnerable local population are environmental quality, opportunities in future employment and scholarships for education.
ROP	As a result of the development in the area, there will be massive increase of labour force. To manage that, new ROP office is being built to accommodate more stuff with better facilities. The issues of the development might be if the companies employ big number of workers of one nationality. For safety purpose it would be better that the companies engage various nationalities of less numbered groups. Also ROP proposes that big companies organize induction courses for expats, about living in country interior, about driving, to raise their awareness on local culture and customs in order to accommodate quickly.
be'ah	be'ah has not yet started any activities in Duqm. SEZAD plans to construct the engineered landfill in Duqm and currently all information is with SEZAD. be'ah did not express any expectations from this particular project related to the waste management (industrial or communal) nor has identified any advantages / issues/challenges in this context that might result from the upcoming development.

Institution	Summary of interviews
Ministry of Manpower – Duqm (Wali office meeting)	The Ministry of Manpower expected that the upcoming developments in Duqm will create employment and contracting opportunities for the local people living in Al Wusta as well as the Sultanate. The Ministry pointed out that people/contractors living in Al Wusta have not benefited much as result of the ongoing development. The Ministry wanted employment to Omanis living in Al Wusta and Oman as whole to be a focus of the project.
Municipality - Deputy Director and Head of Administration and Finance	The expectations from the upcoming development which will be each organization have its own duty for managing HSE and waste management and the municipal competency will be taken over by SEZAD as per law. Municipality will continue to be in charge for municipal area out of SEZ and will support SEZAD for the time being until full hand over. Even for existing situation municipal capacities are limited, during last 5 years municipality was asking the government for higher budget in order to increase capacities/staff and perform all duties. However, it was a good decision to create SEZAD to be responsible for managing the industrial area and main roads in Duqm. Minor roads are managed by local people and Duqm wilayat. The issue we are facing is that many projects are coming; it requires good planning to manage all people. The activities will affect fisheries and growing animals. These two areas have been already affected hugely over last seven years. When fishing place was taken by dry dock, people were upset. Now people were asked again to shift boats outside the port. For example, backfilling materials are quarried from surrounding land, thus effecting top soil and vegetation/grass. This caused the loss of land area for animal growing. Due to this some people are badly affected, they cannot grow animals and at the same time they are not compensated for this loss of income. On the other hand, there are people who are not impacted by this issue. There are now two schools in Duqm (1 for girls, 1 for boys) up to 11th grade. There were no complaints on environmental quality, there are no issues about. The administrative procedures are long; minimum 3 years is required to get a permit. Duqm Municipality hopes that there will be no impact on fish and animal wealth and community. Also hopes that the development of SEZAD will not have the same impact as what happened at Sohar industrial zone.
Directorate of Agriculture and Fisheries-Duqm (Wali Office Meeting)	Directorate of Agriculture and Fisheries expect the development might have positive impact on the fish stock for the short term, while in the long term it might reduce the fish stock since some fish are sensitive. The challenge from the development will be to ensure protection of marine environment thus ensuring the quality of fish and minimize the fish loss, to create good facilities and plants and create jobs. The office hopes that there will be an integrated project/campaign to promote projects and raise environmental awareness.

6.2 Summary and Concluding Findings – Consultations with Institutions

During constructive discussion in Wali office, many representatives of institutions as well as community members, raised questions about the storage tanks safety and firefighting measures, types of liquid and bulk materials to be handled, whether risk assessment was conducted for the project, whether H_2S gas will be generated in this facility, environmental study of the projects, type of contractors to be mobilized for DLBB Project and employment opportunities, materials to be processed in refinery and how they will be transferred to vessels. Participants highlighted previous (smaller) projects when they were not consulted in advance but could have provided good advice. Overall response was positive and participants were pleased that these consultations were carried out to inform them about the upcoming project.

The summary and concluding findings are:

- Institutions see the upcoming developments in Duqm as highly positive for overall economic and social development in Duqm
- They expect / require from companies coming to the SEZ to provide job opportunities for people of Duqm in the long term and more contracts to be awarded to Duqm companies. These requirements were imposed to authorities in Duqm already by local population.
- They expect / require more information about the upcoming developments, promotion of industry requirements in order to plan education curricula for young generation to match the local professional requirements. This should involve education authorities
- Participants expect development and upgrade of all city facilities, infrastructure, utilities and services
- The challenge of the development will be not to impact environmental quality and to protect the fish wealth and fish stock
- By law, SEZAD is going to take over all municipal competencies in Duqm. Municipality will help during hand over and will remain in charge for municipal area out of Duqm
- Fishing and animal growth has been impacted since construction of port started (last seven years). Fishery people are upset by frequent change of available location for fish landings on the coast
- It is expected that government will compensate for the loss of grazing land to the affected population and that vulnerable families will be supported
- The institutions are concerned about overall safety once the massive expat labour force moves in. To prepare for this, the ROP is going to move into new office. Safety wise, the ROP requires companies to organize induction programs for expats about living in the interior of Oman and about local culture and customs, and to prevent interference to local culture, etc.
- No complaints were recorded on environmental quality in Duqm
- Institutions have neither specific expectations nor potential conflicting issues from DLBB Project. Overall expectations and some recorded issues are related to the whole development in SEZ.
- The opinion about the overall development in Duqm is positive and the projects are very welcome, and
- be’ah did not express any expectations from this particular project related to the waste management (industrial or communal) nor has identified any advantages / issues/challenges in this context that might result from the upcoming development.

7 OVERALL CONCLUDING FINDINGS AND RECOMMENDATIONS

7.1 Findings from the Consultations

The stakeholder consultations were in line with principals of best practice and recommendations from International Finance Corporation (IFC) Guidelines as described in the methodology specified in the Procedure document for Social Survey for Environmental Impact Assessment (Doc. No.SEZAD-DPTC-00-WP-EV-PRO-2001).The consultations with stakeholders in Duqm were carefully planned to match the DLBB Project purpose and requirements. The methodology and procedure were discussed and approved by DPTC and SEZAD. The stakeholders included in consultation were community members, institutions and civil society association NGO, Omani Women Society – Duqm. The NGO was consulted to provide inclusion of all genders and the whole consultation process was prepared with special attention to cultural appropriateness during communication of information. The consultations were held in Arabic language.

Concluding findings are:

- Institutions see the upcoming developments in Duqm as highly positive for overall economic and social development in Duqm
- They expect/ require from companies coming to the SEZ to provide job opportunities for people of Duqm in the long term and more contracts to be awarded to Duqm companies. These requirements were imposed to authorities in Duqm already by local population
- They expect/require more information about the upcoming developments, promotion of industry requirements in order to plan education curricula for young generation to match the local professional requirements. This should involve education authorities
- Participants expect development and upgrade of all city facilities infrastructure, utilities and services
- The challenge of the development will be not to impact environmental quality and to protect the fish wealth and fish stock
- By law, SEZAD is going to take over all municipal competencies in Duqm. Municipality will help during hand over and will remain in charge for municipal area out of Duqm
- Fishing and animal growth has been impacted since construction of port has started (last 7 years). Fishery people are upset by frequent change of available location for fish landings on the coast
- It is expected that government will compensate for the loss of grazing land to the affected population and that vulnerable families will be supported
- The institutions are concerned about overall safety once the massive expat labour force moves in. To prepare for this, the ROP is going to move into new office. Safety-wise, ROP requires companies to organize induction programs for expats about living in country interior and about culture and customs, etc. Also in order to prevent interference to local culture

- No complaints were recorded on environmental quality in Duqm
- Institutions have neither specific expectations nor potential conflicting issues from DLBB Project. Overall expectations and some recorded issues are related to the whole development in SEZ of Duqm
- The opinion about the overall development in Duqm is positive and the projects are very welcome
- be'ah did not express any expectations from this particular project related to the waste management (industrial or communal) nor has identified any advantages/issues/challenges in this context that might result from the upcoming development

It is worth noting that the overall expectations and identified issues are related to the whole Duqm SEZ development.

7.2 Recommendations

In line with the consultation best practices mentioned in Section 1.4, as a gesture of good faith and to build relationships with stakeholders in Duqm, it is recommended that DPTC as project proponent inform the stakeholders in Duqm about survey results and next steps of the project.

Furthermore, considering that the consultation is an ongoing process, DPTC is recommended to develop a Community Engagement Plan during the operation phase which would dictate the method of community consultation, the frequency, channel (through SEZAD or directly) and content of communication. The Community Engagement Plan would also specify a Grievance Mechanism (e.g., web-based submission of complaints, dedicate a telephone number to register complaints, award an office for personal submission of complaints, complaints box, etc.) to capture community concerns or complaints and relay these concerns to DPTC Project Manager.

In line with requirements identified during stakeholder consultation process in Duqm, it is recommended that DPTC should consider, as a minimum, to implement the following during the next phases of the DLBB Project:

- Preferential employment to personnel living in Duqm as part of its human resource
- The human resource strategy would also need to consider the feasibility of hiring a diverse labour force of multiple nationalities
- Examine the feasibility of involving local contractors
- Create a program to induct all staff and contractors prior to mobilizing to site, and
- Development of Corporate Social Responsibility (CSR) program in Duqm.

Appendix 1 - Social Survey Graphical and Descriptive Statistics

A4.1 Social Survey Descriptive and Graphical Statistics

A4.1.1 Socio-Economic Information

Questions No. 1, 2 & 3 Survey Participants

Total number of survey participants was 27. The group consisted of 71% of men and 29% women from Duqm. The survey was conducted from 24-Mar-2015.

Table A4-1: Gender of Participants

Gender	Male	Female
Number	19	8
% of total	*71*	*29*

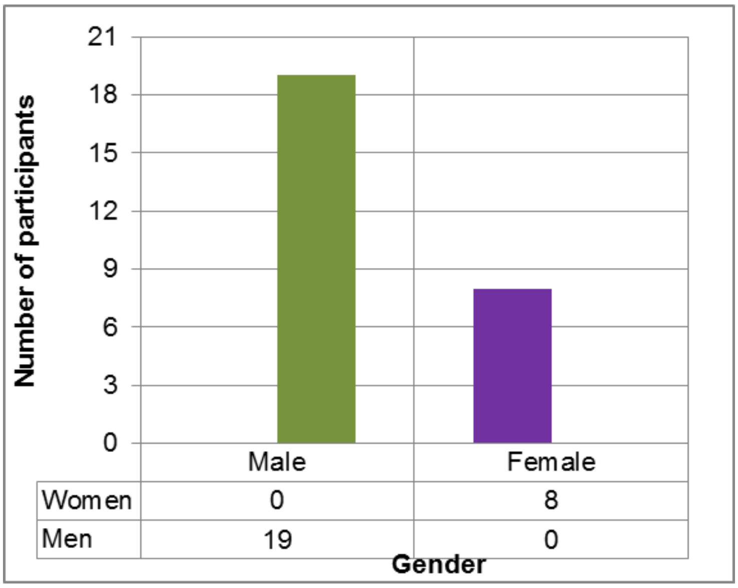


Figure A4-1: Gender of Participants

Question No.3 – The Age Range of Survey Participants

Overall 33% participants were in age range of 26 to 30 years, 33% in age range of 31-35, 15% of them were in age range 36 to 40 and 15% were above 40 years.

The majority of women respondents, 61%, were in age range 26 to 30 years. 42% of men were of age range 31 to 35 years. There were no participants from 18-20 years old.

Table A4-2: Age Range of Participants (%age)

Age	18-20	21-25	26-30	31-35	36-40	>40
Women	-	-	61%	13%	13%	13%
Men	-	5%	21%	42%	16%	16%
Overall	-	*4%*	*33%*	*33%*	*15%*	*15%*

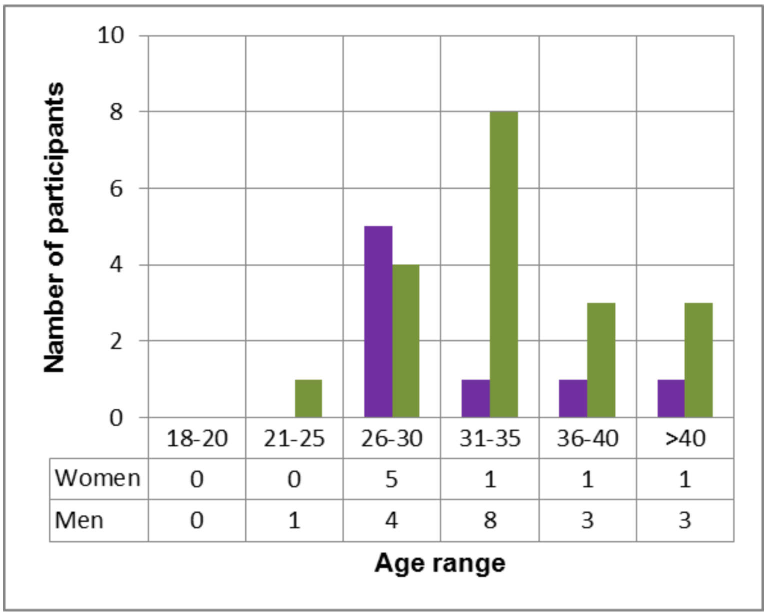


Figure A4-2: Age Range of Participants

Question No.5 – Education Level of Survey Participants

55% of all survey participants had university or above education, 18% secondary school and 27% primary school education.

The majority of the women that participated in the survey, 75%, had primary school education while the majority of men, 65%, had university and above education.

Table A4-3: Education Level

Education	None	Primary School	Secondary School	University and above
Women	-	75%	-	25%
Men	-	5%	25%	65%
Overall	-	*27%*	*18%*	*55%*

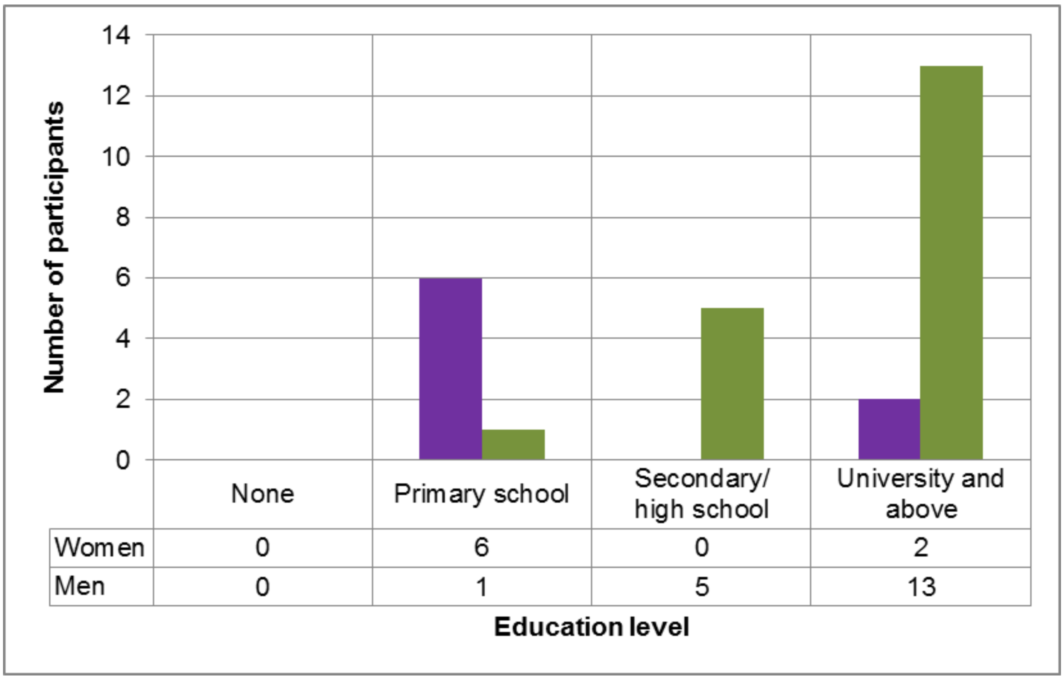


Figure A4-3: Education Level

Question No.6 – Marital Status of Participants

Overall the respondents group had 72% of married and 28% single persons.

The majority of the women respondents, 67%, were single while the majority of men, 84%, were married.

Table A4-4: Marital status

Status	Married	Single
Women	33%	67%
Male	84%	16%
Overall	*72%*	*28%*

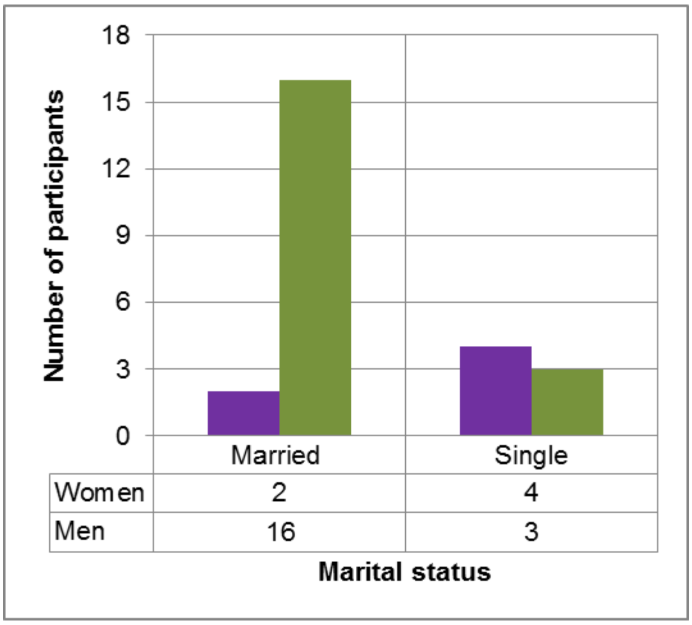


Figure A4-4: Marital status

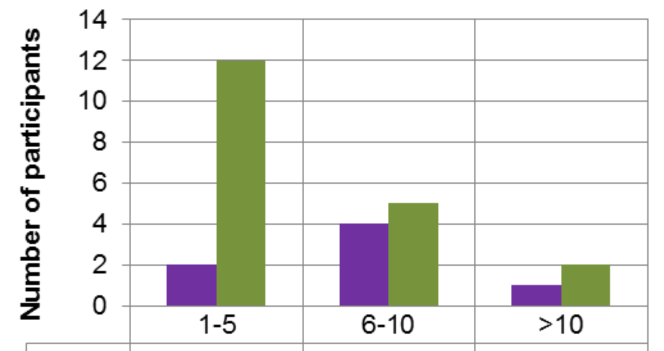
Question No.7 – Number of Family Members

54% of all participants live in families of 1 to 5 members, 35% in families of 6 to 10 members and remaining 11% in families with more than 10 members.

The majority of the women respondents (57%) live in families of 6 to 10 members and majority of men, 63%, live in families of 1 to 5 members.

Table A4-5: Family Size

No of family members	1-5	6-10	>10
Women	29%	57%	14%
Men	63%	26%	11%
Overall	*54%*	*35%*	*11%*



	1-5	6-10	>10
Women	2	4	1
Men	12	5	2

Figure A4-5: Family Size

Question No.8 – Number of Employed Members in a Family

Overall, participants 37% of families had 1 employed person, 22% of families had 2 employed members, 26% had 3 employed members and 15% reported more than 3 employed members.

50% of women participants live in families with three employed members, while 47% of men have family with 1 employed member. Two employed family members are found in 25% of women survey group and 21% of the men survey group.

Table A4-6: Number of Employed Members in a Family

Number	1	2	3	>3
Women	13%	25%	50%	12%
Men	47%	21%	16%	16%
Overall	*37%*	*22%*	*26%*	*15%*

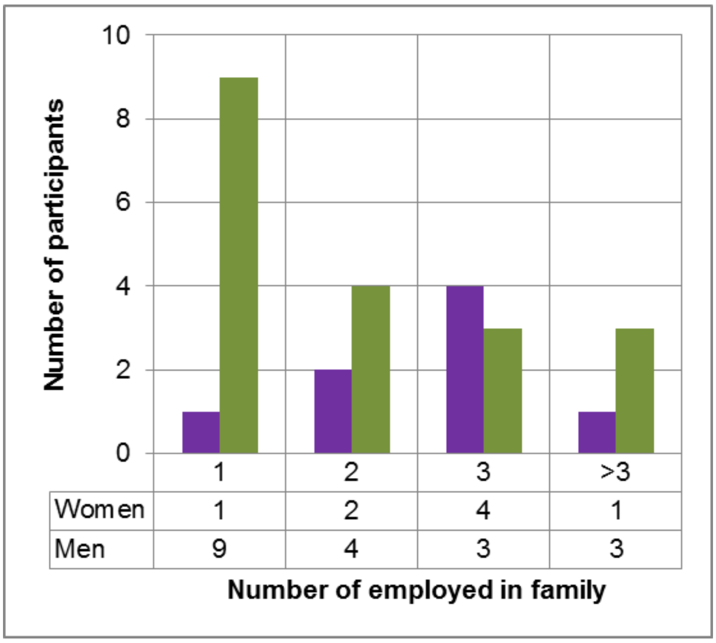


Figure A4-6: Number of Employed Members in a Family

Question No.9 – Source of Family Income

Employment is the source of income for 89% of overall survey participants. Business is represented as source of income with 11% of the overall group.

Employment is the source of family income in 100% of women survey group and in 86% of men survey group.

Table A4-7: Source of Family Income

Status	Employment	Business	Other
Women	100%	-	-
Men	86%	14%	-
Overall	*89%*	*11%*	-

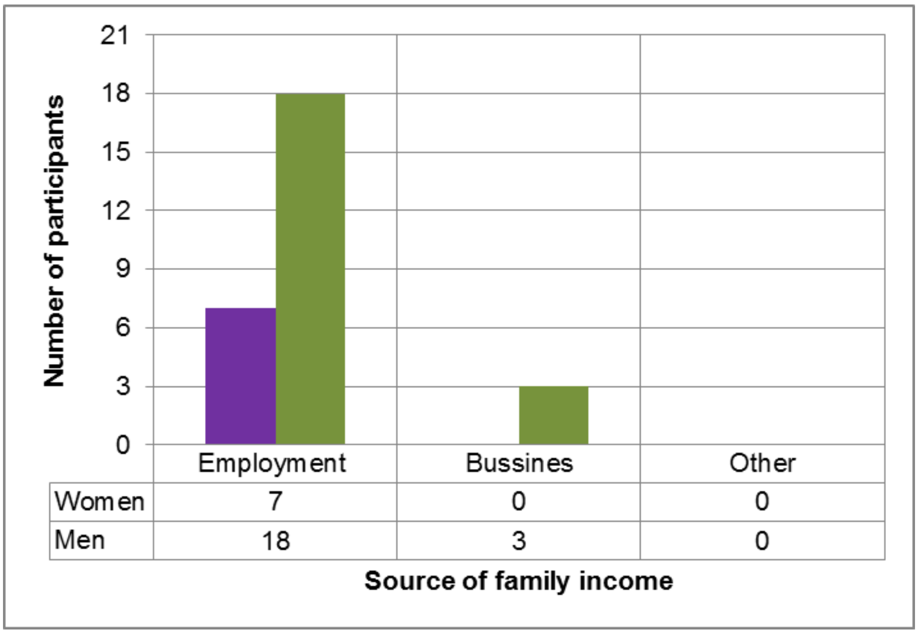


Figure A4-7: Source of Family Income

Question No.10 – Category of Employment

85% of all participants worked in government sector, 4% of all participants worked in private sector, 7% of participants worked in fishing and 4% in agriculture.

Government employment was represented in 100% of the women survey group and 80% in the men survey group. Other categories of employment represented in men group are private employment (5%), fishing (10%) and agriculture (5%).

Table A4-8: Category of Employment

Sector	Government	Private	Fishing	Agriculture	Animal Husbandry
Women	100%	-	-	-	-
Men	80%	5%	10%	5%	-
Overall	*85%*	*4%*	*7%*	*4%*	-

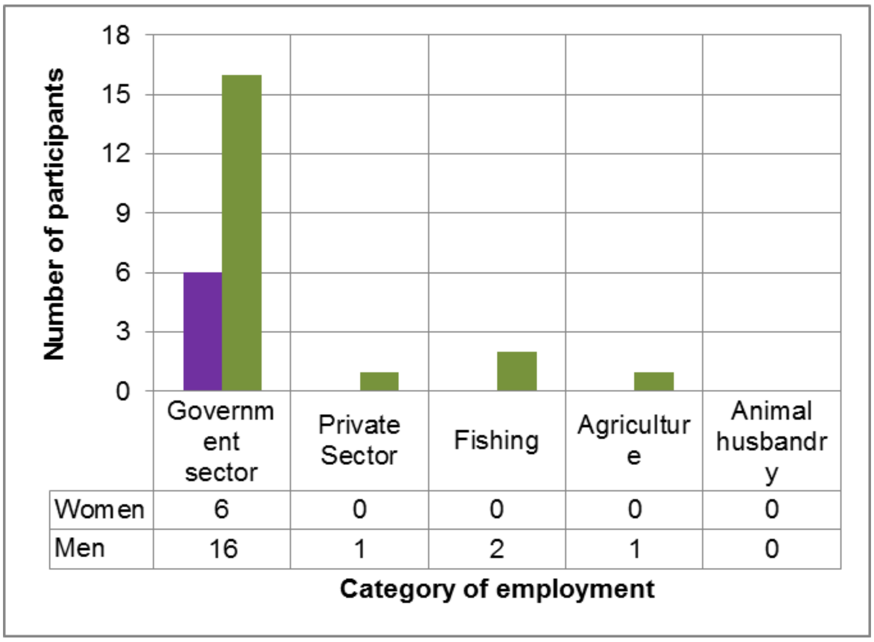


Figure A4-8: Category of Employment

A4.1.2 Duqm Development and Project Perception

Question No.11 – Is there any positive impact on your living/livelihood due to Duqm port development?

70% of all participants recognized positive impact on their livelihood due to Duqm port development while 30% of them did not recognize any positive impact.

85% of women that participated the survey and 63% of men were thinking that there has been positive impact on their living/livelihood due to existing Duqm port development.

Table A4-9: Response to Question No. 11

Response	Yes	No
Women	85%	15%
Men	63%	37%
Overall	*70%*	*30%*

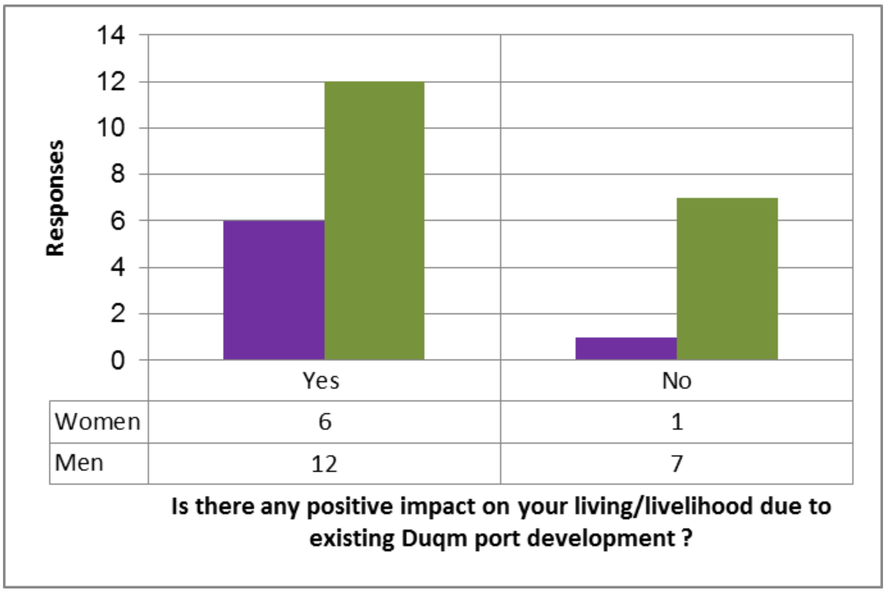


Figure A4-9: Response to Question No. 11

Question No.12 – Has your livelihood been impacted due to existing port of Duqm activities?

56% of all participants think that their livelihood has been impacted by existing activities in the port of Duqm, while 44 % did not find any impacts.

71% of women and 50% of men think that their livelihood has been impacted by the existing Duqm port activities. The remaining participants think that there is no impact on their livelihoods due to existing activities.

Table A4-10: Response to Question No. 12

Response	Yes	No
Women	71%	29%
Men	50%	50%
Overall	*56%*	*44%*

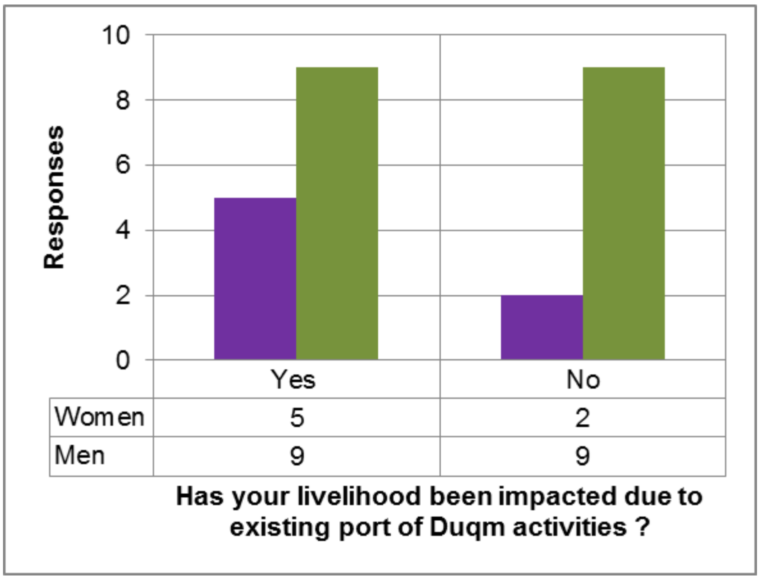


Figure A4-10: Responses to Question No. 12

Question No.13 – Has do you see / view the change?

85% of all participants recognize positive change in their livelihood due to existing activities, 4% think that impacts are negative and 11% think that there are none impacts.

The 75% of women and 89% of men assess positive change due to existing activities in the Port of Duqm.

Table A4-11: Response to Question No. 13

Response	Positive	Negative	None
Women	75%	13%	12%
Men	89%	-	11%
Overall	*85%*	*4%*	*11%*

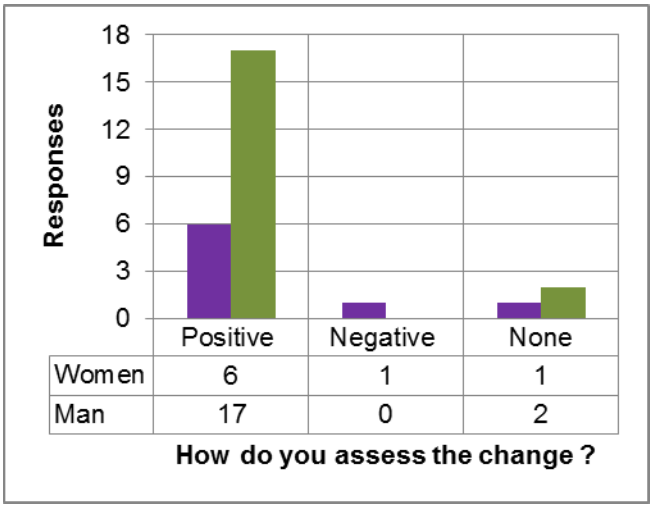


Figure A4-11: Responses to Question No. 13

Question No.14 – Have you heard about DLBB Project?

52% of all participants have heard about the DLBB Project while 48 % have not heard about the project before the consultations.

50% of the women and 53% of men who participated in the survey have heard about the DLBB Project before the consultation.

Table A4-12: Response to Question No. 14

Response	Yes	No
Women	50%	50%
Men	53%	47%
Overall	*52%*	*48%*

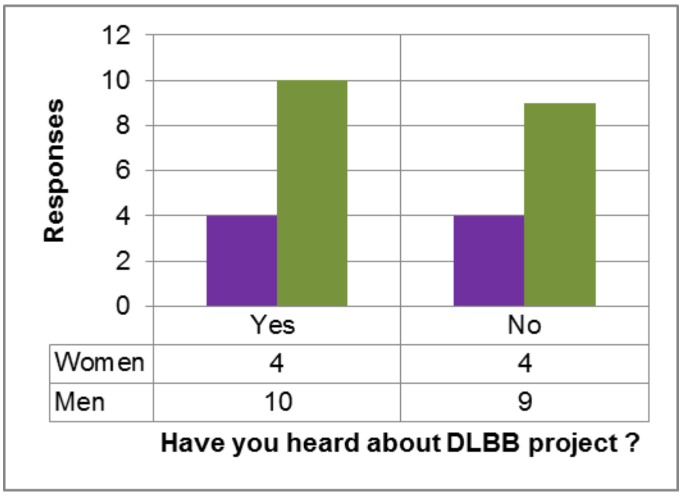


Figure A4-12: Responses to Question No. 14

Question No.15 – Do you expect improvement in your living after the project is completed?

92% of all participants expect improvement in their living after completion of the project, while 8% have no expectations.

100% of the women and the majority of men, 92% expect improvement of their living after the project is completed. 11 % of men that participated in the survey do not expect any improvement in their living after project completion.

Table A4-13: Responses to Question No. 15

Response	Yes	No
Women	100%	-
Men	89%	11%
Overall	*92%*	*8%*

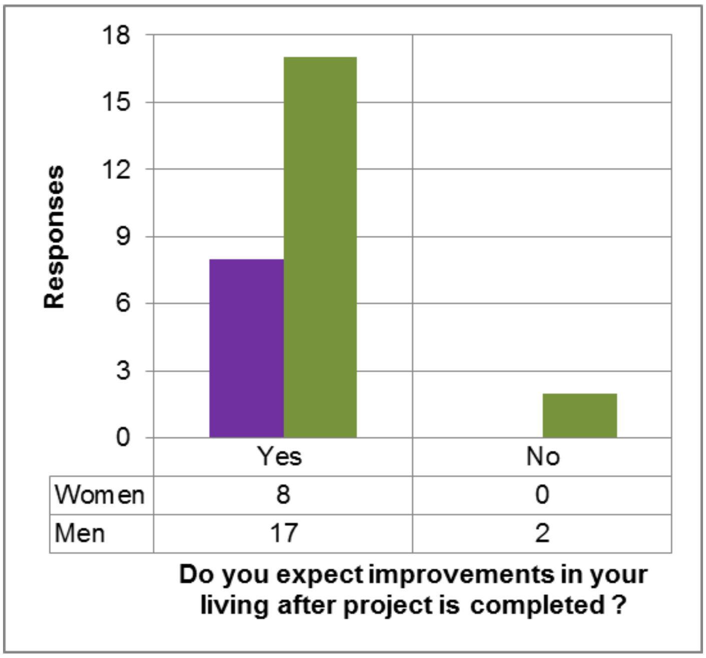


Figure A4-13: Responses to Question No. 15

Question No.16 – Do you expect better infrastructure, utilities, schools, hospitals and etc. In wider area after the project is completed?

After the project is completed 89% of participants expect better infrastructure, utilities, schools, hospitals and etc. 7% do not expect improvements and 4% did not know whether there will be any improvements after project completion.

100% of the women and 84% of men are expecting better infrastructure, utilities, schools, hospitals and etc. after the project is completed. Table 7-14 11% of men who participated in the survey do not expect better infrastructure, etc.

Table A4-14: Responses to Question No. 16

Response	Yes	No	Don't Know
Women	100%	-	-
Men	84%	11%	5%
Overall	*89%*	*11%*	*4%*

Figure A4-14: Responses to Question No. 16

Question No.17 – What is your expectation from the DLBB Project?

61% of all survey participants expect employment opportunities from the DLBB Project, 21 % expect contracting/business opportunities and 18 % have no expectations.

The majority of women, 70%, and 56% of men expect that the DLBB Project will increase employment opportunity. 20% of women and 22% of men expect that the DLBB will increase contracting and /or business opportunities. 10% of women group and 22 % of men group have no expectations from DLBB Project.

Table A4-15: Responses to Question No. 17

Response	Employment opportunity	Contracting /business	No Expectations	Other
Women	70%	20%	10%	-
Men	56%	22%	22%	-
Overall	*61%*	*21%*	*18%*	-

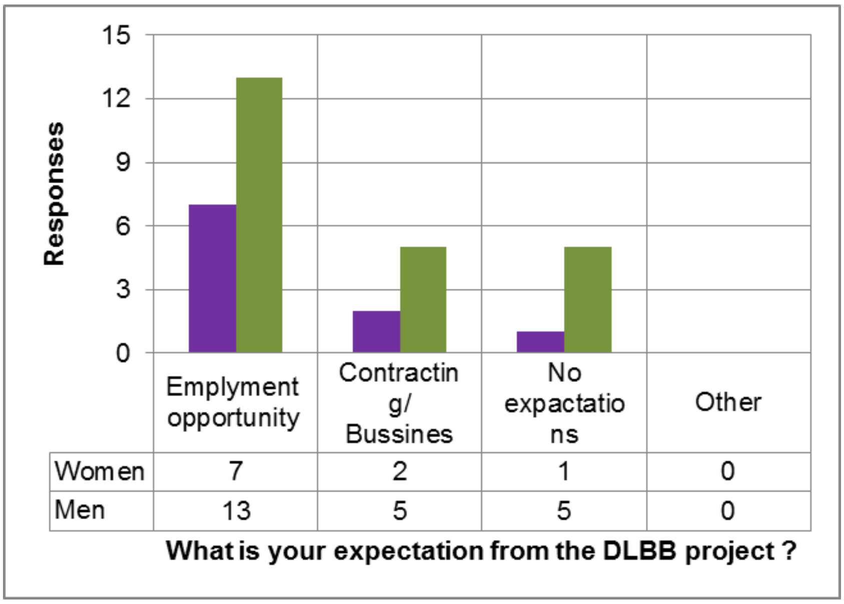


Figure A4-15: Responses to Question No. 17

Question 18 - Any other comments.

Summary of comments from women participants (NGO) and teachers in the school for girls in Duqm:

The participants were unaware of the DLBB Project and were only informed about the project during the consultation. The participants expected that the overall development in Duqm would provide infrastructure, employment, scholarships, hospitals, etc.to the people at the Wilayat. They believed that the project would enhance the development and it would have positive implication to local community. On the other hand, the participants were concerned were concerned about:

- Safety
- Possible Stress on local infrastructure such as schools and hospitals
- Changes in the local culture

Summary of comments from men participants, teachers in school for boys:

The participants highlighted the importance schools can play in preparing the local community for this project and the school suggested that SEZAD should undertake awareness programs/workshops in the school. They were keen to know about job prospects from the development and the potential for students getting employment after completing school. Further they felt that local students, after completing university should be encouraged to seek employment Duqm. They expected that the development in Duqm and DLBB Project would offer such opportunities.

The participants further requested:

- Greater communication from SEZAD and tenants about proposed and ongoing development
- Tenants periodically communicate with progress and other information to the local community
- Tenants offer jobs to local students

General observations made by the participants were:

- The SEZ occupied a large area
- There already was a large expatriate workforce already in the area
- The consultation questionnaire did not include environmental impacts of the project

Summary of comments from men participants from Wali office meeting:

The participants were positive about the development in the SEZ and looked toward benefits such as rehabilitation, employment, contracts and investment opportunities. As the DLBB Project was of national importance they looked for its expeditious completion and improve the lives of the citizens of Duqm and the Country. At the same time the participants wanted to live in a clean environment without emissions or health impacts. They believed that adequate studies need to be undertaken to ensure this.

Appendix 2 - Lists of Stakeholders and Consultation Team

The List of Consulted Stakeholders, Duqm, 24-Mar-2015

No	Institution	Focal point-name	Contact details
1.	Majlis ash-Shura Member of Duqm	Authorized with the competent authority	92522266
2.	Wali of Duqm	Deputy Wali (name not available)	25425252
3.	ROP Duqm	-	25415204
4.	ROP Duqm	First Sergeant Khalid Ali Al-Jabri	25415282
5.	Duqm Municipality /	Aziz Suliman Salim Al-Mahrooqi , Deputy Director	25415262
6.	Duqm Municipality	Abdula Al Junaibi, Head of Administration	96112296
7.	be'ah	Salim Al Shidi, Head of Environment and Sustainability	24618200/24228442
8.	Ministry of Manpower	Department of Labour Force in Duqm	99444047
9.	Directorate of Agriculture and Fisheries, Duqm	Ahmed Ya'qub Al-Mahrooqi	99330715/25427090
10.	Duqm School for Boys	Teachers (9)	-
11.	Duqm School for Girls	Teachers (2)	-
12.	NGO –Oman Women Society	Nathema Salim Al-Jenabi	926229892

The List of Project Consultation Team, Duqm, 24-Mar-2015

No	Organisation	Name	Designation
1.	SEZAD	Azzan Al Hasni	Mechanical Engineer
2.	SEZAD	Amrita Anub	EIA Specialist
3.	SEZAD	Mousa Al Subeihi	Assistant Environmental Specialist
4.	SEZAD	Nasser Al Satmi	Environmental Inspector
5.	SEZAD	Waleed Al Junaibi	Assistant Environmental Inspector
6.	DPTC	Ahmed Al-Amry	Project Director
7.	DPTC	Jamal Al-Naamani	Project Manager
8.	WorleyParsons	Fayek Ejjeh	Project Interface Manager
9.	WorleyParsons	Dobrila Simic Aleksic	EIA Social Expert
10.	WorleyParsons	Ancil Concesso	Environment Lead
11.	WorleyParsons	Sabreen Al Badai	Jr. Civil Engineer
12.	WorleyParsons	Ishaq Al Busaidi	Process Engineer

Appendix 3 - Summary of Stakeholders, Consultation Objective, Methodology and Approach

Stakeholder consultations for DLLB project were prepared based on the IFC good practice and principals described in Section 1.4 of the report.

The following main groups of stakeholders were consulted as part of Environmental Impact Assessment (EIA) process:

- Institutions in Duqm and Muscat
- Duqm community members, and
- Civil society organizations such as non-governmental organization (NGO) Oman Women Society Duqm

The objective of the consultations with institutions and organizations:

- To understand existing institutional/administrative institutional concerns about the project undergoing EIA
- To understand social and demographic profile of the community members
- To identify potential community concerns / issues related to the existing developments (like Port of Duqm) and future project development of the DLBB Project
- To identify and assess the potential positive / negative impacts of the development to local community, and
- To identify any project related concerns of local civil society associations, e.g. NGO members

Methodology:

The pre-designed interview template was used for consultations with representative of each institution: Majlis Ash-Shura member of Duqm, Wali of Duqm–Deputy, ROP Duqm Wali office meeting, Duqm Municipality –Deputy Director Duqm and Head of Administration and Finance, Ministry of Manpower-Duqm, Directorate of Agriculture and Fisheries-Duqm, be’ah-Muscat.

The social survey pre-designed questionnaires were used for consultation with community members. These were: participants of the meeting in Wali office, teachers from girls and boys school and participants of Oman Women Society (Duqm) meeting.

The consultation with representative of civil society association was conducted by use of pre-designed interview template: NGO Oman Women Society -Duqm.

It should be noted that special attention was paid to cultural appropriateness and sensitivity. The survey materials and presentations were prepared in Arabic.

The approach included:

- Preparatory work: planning, organizing, contacting Wali of Duqm inform about the consultation, survey purpose and setting-up meeting date, time and details

The activities undertaken were:

- The consultations were held in Duqm Wali office where it was relatively easy to assemble the invited representatives of institutions and prominent community members
- The survey was undertaken in presence of the Duqm Wali Deputy and/or Say Village Sheikh. The team conducting the interviews /surveys comprised personnel from DPTC and WorleyParsons. The survey team included Omani personnel (male and female) in order to facilitate communication in Arabic
- Separate meeting was set with members of NGO, Omani Women Society of Duqm in its premises to provide participation of women, both as NGO and community members, thus promoting gender awareness
- Separate meeting was held in ROP office and Municipality of Duqm, and
- Separate meeting was held with teachers in boys and girls schools in Duqm. The reason was to provide participation of teachers as community members employed in education sector and gender wise participation

The consultations were facilitated by WorleyParsons in presence of SEZAD and DPTC representatives. The applied process was:

- Introduction and information about the DLBB project, explanation of the objectives and methodology of the survey (through a power point presentation in Arabic)
- Dissemination of printed survey questionnaires (in Arabic)
- Facilitation of brief discussion / consultation with participants (in Arabic), and
- Collection of filled questionnaires and closing the survey

The interview templates, social survey questionnaires, detailed methodology, process and supporting project presentations were specified in the “Procedure-Social Survey for Environmental Impact Assessment” (Doc. No.SEZAD-DPTC-00-WP-EV-PRO-2001, 4-Apr-2015).