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CUMULATIVE IMPACT ASSESSMENT

DUQM REFINERY PROJECT, OMAN

Part of Consolidated Environmental and Social Impact Assessment

FOR DRPIC ONLY: CONFIDENTIAL

CUMULATIVE IMPACT ASSESSMENT

DUQM REFINERY PROJECT, OMAN

Duqm Refinery & Petrochemical Industries Company

Confidential

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1 INTRODUCTION

1.1 BACKGROUND AND PROJECT OVERVIEW

Duqm Refinery Petrochemical Industries Company (DRPIC) is developing an export refinery complex in the Special Economic Zone at Duqm (the “Duqm SEZ”) on the south eastern coast of the Sultanate of Oman. An Environmental Impact Assessment (EIA) study was conducted for Duqm Refinery (DR) in 2015.

The Duqm Refinery Project, comprises the Refinery itself and also its Off-site Facilities (see Table 1.1). The Duqm Refinery and Off-site Facilities together comprise the “Funded Project”.

The involvement of lenders in the Project requires reporting to the suite of international standards such as the IFC Environment and Social Performance Standards in its Sustainability Framework (IFC, 2012). Under IFC Performance Standard (PS) 1 on the ‘Assessment and Management of Environment and Social Risks and Impacts’, Associated Facilities (AF) are developments being progressed for a project by third parties. Lenders on the Duqm Refinery Project have identified the relevant AFs in the Duqm Refinery Project and these are also presented (in a third category, ‘C’) below. EIA Reports have previously been prepared for these AFs.

Table 1-1: Project Components of the Duqm Refinery Project and Associated Facilities

REF.	PROJECT COMPONENT	DESCRIPTION
A	Duqm Refinery	<p>A 230,000 barrels per day (BDP) complex refinery on a plot of 9km² area to the north of the main industrial area within SEZAD’s area of jurisdiction.</p> <p>Also includes:</p> <ul style="list-style-type: none"> • Site clearance and level (already complete) • Product pipelines and service lines to the Duqm Export Terminal • Construction accommodation/workers’ camps • Laydown areas.
B	Off-site Facilities	<ol style="list-style-type: none"> i. Crude oil tanks at the Ras Markaz (RM) Crude Oil Storage Terminal: eight tanks located within, and part of the wider Storage Terminal, some 80km from DR. The wider Storage Terminal and its supporting services will be operated by Oman Oil Tank terminal Company (OTTCO) and is in its entirety not part of the Project. ii. ‘DRPIC Crude Pipeline’: 28-inch diameter crude oil import pipeline, 80km pipeline to transport crude oil from RM to DR. iii. Product ‘Export Terminal’: on the lee breakwater of Port of Duqm, immediately to the south-east of DR. Topside works only, i.e., to establish storage for products and export handling facilities. For marine works, see Associated Facilities below.
C	Associated Facilities	<ol style="list-style-type: none"> i. Natural gas spur line/metering station used to supply gas feedstock to DR from the national gas network (Oman gas Company, OGC) ii. Export pipeline corridor – Construction of the corridor and infrastructure (pipe supports, bridges, fencing drainage, etc,

REF.	PROJECT COMPONENT	DESCRIPTION
		<p>including pipeline and services themselves under the refinery) (SEZAD / Marafiq). Note: SEZAD have overall responsibility for the Pipeline Corridor, excluding the DR pipelines and cables, extending from the Refinery Boundary Marker fenceline to the Port fenceline.</p> <p>iii. The marine scope including dredging and reclamation and jetty and quay wall construction of the Duqm Export Terminal. (DSEZ).</p> <p>iv. Haul road or dedicated lane (on Existing Road) for the transport of solid product from DR to Duqm Export Terminal. (DSEZ).</p> <p>v. Duqm Integrated Power and Water Plant (DIPWP) supplying electricity and desalinated water to DR (and in the future other consumers in DSEZ). (Marafiq, also known as Central Utilities Company, CUC). Note that this now includes items vi and vii below.</p> <p>vi. Seawater supply network (to DIPWP). (Marafiq).</p> <p>vii. Common wastewater outfall for industrial zone users. (DSEZ).</p> <p>viii. Offshore oil import facilities (including offshore single point mooring (SPM) and crude oil pipeline to shore at RM. (OTTCO).</p>

As part of Project financing, the Lenders' Independent Environmental and Social Consultant (IESC) identified a number of areas in the Project Environmental and Social Impact Assessment (ESIA) Reports and Project documentation that require supplementing and/or enhancing to bring them up to Lender standards, including the need to provide a Consolidated ESIA and associated package of documentation.

In March 2017, WSP UK Ltd. (WSP) was commissioned by DRPIC to carry out the development of this supplementary package of information comprising environmental, social and health assessment documentation in order to provide a holistic summary of the Project while consolidating the aspects, impacts and mitigation from historical reports and new data. This is to be supplemented with technical reports where required, including updated and new Management Plans and this Cumulative Impact Assessment.

Information for the CIA has been collated from previous EIAs prepared for the DRPIC Funded Projects in line with Omani national requirements and from individual ESIA's for the AFs. Supplementing this data is anecdotal information on third party projects that are being planned and/or underway but for which no publicly-available reports are yet available. Lastly, supplemental information collected as part of the Consolidated ESIA scope of work is included in the CIA.

This CIA focusses on the cumulative effects of the DRPIC Projects and the AFs for which EIAs are, in the main, available. Consideration has been also given to other third party projects (where such are known or readily available).

1.2 PREVIOUS CIA STUDIES AND ANALYSIS OF FURTHER STUDY REQUIREMENTS

1.2.1 Previous EIA Reports

Key sources of information for the CIA included the four EIAs commissioned by DRPIC for the Duqm Refinery components:

- Environmental Impact Assessment Study Report - Duqm Refinery (HMR, May 2015);
- Raz Markaz Oil Pipeline Concept Study & Front End Engineering Design (FEED) Environmental Impact Assessment Report (WorleyParsons, November 2016);

- ESIA for Ras Markaz Crude Oil Park (HMR, October 2015);
- Environmental Impact Assessment Report: Duqm Liquid Bulk Berths Project (WorleyParsons, September 2015); and
- Environmental Impact Assessment Study Report - Duqm Refinery Construction Camp (HMR, December 2014).

EIA reports are also available for the following AFs:

- Environmental and Social Impact Assessment, including Scoping Report, for the proposed Duqm Integrated Power and Water Plant (DIPWP), Duqm, Sultanate of Oman (BEYA, November 2016); and
- EIA for Service Corridor, Duqm (HMR, August 2015)

Several EIAs for AFs are understood to be in preparation or not started or not available in time for assessment:

- The Natural Gas Spur Line (and non-associated Gas Supply Station); and
- Haul road/lane for solid exports.

In addition, the Duqm Industrial and Free Zone Masterplan EIA (5OES, 2011) is available and its contents have been considered in this CIA.

1.2.2 Equator Principles Supplementary Report

An Equator Principles Supplementary Report (EPSR) for the Duqm Refinery Project was prepared (Gensis Technip, 2016) in order to perform an environmental screening of the cumulative impacts from the Project and its AFs against the Equator Principles III, 2013. The Equator Principles (EPs) are a credit risk management framework for determining, assessing and managing environmental and social risk in Project Finance transactions. This Report was developed in response to the acknowledgement that the DRPIC Project ESIA were prepared at a time when the project only comprised the Refinery, so had therefore not included all the requirements of the applicable EPs framework.

1.2.3 Environmental and Social Due Diligence Study

Late last year, an ESDD Report (Ramboll Environ, 2016) identified that within each of the available Project ESIA documents, no consideration was given to the cumulative impacts of the respective developments. The ESDD study comprised a review of all the relevant Project documentation, including the available EIAs.

The details of the implemented CIA aspects were assessed against the Project applicable standards.

The ESDD study identified omissions in key elements of the EPSR and limitations against the IFC requirements, including:

- Substantial changes had occurred to the scope of the Project, including alterations to the activities that are classified under Project Funded and AFs;
- The EPSR only addresses the cumulative impacts of the AFs;
- The scope of the assessment in the EPSR does not consider cumulative impacts from other (non-AF) developments, which is required under IFC PS1;
- It is not clear that a VEC approach has been undertaken in line the IFC CIA Good Practice Handbook. Although full compliance with the Handbook is not necessary to meet IFC PS1,

it does provide a comprehensive method for the identification key VECs of the cumulative impacts;

- Although it was identified in the Report, the scope of the assessment presented in the EPSR does not consider the construction phase;
- Within the EPSR there is little consideration of biodiversity and ecosystem services; and
- There is little attention given to how the cumulative impacts will be managed by DPRIC in liaison with third parties.

The ESDD concluded that the EPSR did not meet the requirements of the IFC PS1. As a result of the findings, recommendations were made that a CIA should be produced in order to address the omissions that have been highlighted above and that the CIA to be undertaken could be completed in support of an updated Project ESIA.

Further advice was given in regards to developing the assessments approach in liaison with third parties where appropriate, including Special Economic Zone Authority at Duqm (SEZAD) and Marafiq, in order for the cumulative impacts to be suitably managed in line with the lenders' standards.

Table 1-2: Summary of Comments on CIA made in ESDD Report (2016)

	FUNDED COMPONENTS				
	Duqm Refinery	Ras Markaz Crude Oil Park	Ras Markaz Crude Pipeline	Product 'Export Terminal'	Construction Camps
CIA Info.	<p>Only passing comments to cumulative impacts regarding both GHG emissions and noise. References only briefly state of their potential impacts to act cumulatively.</p>	<p>Section 8.3.13 relates to Cumulative Impacts. It addresses such impacts in a vague approach and to no clear national or internationally recognised performance standards. It concludes that the cumulative impacts from surrounding onshore and offshore activities are significant, especially in regard to the marine environment.</p>	No information available.	No information available.	The Environmental Management Plan, Table 8-1, contains some information in the Noise Management Plan on how to reduce the potential cumulative impacts arising from noise.

1.3 CONTENT OF CIA

This CIA has utilised both information, including baseline data, contained in the portfolio of earlier prepared Project EIAs and knowledge gained from research, surveys, observations and assessments as part of the supplementary work undertaken for the overall Consolidated ESIA package of work. In particular, the latter includes the collection of new primary data, for instance on ambient noise and air quality and subsequent assessment. The updates (i.e. new data collection to enhance what was collected in the previous EIAs) were necessary to allow new data and features of the Project to be accounted for and ensure the appropriate mitigation recommendations are made.

This CIA aims to address the disparities identified in the ESDD study and produce a comprehensive CIA for the DRPIC Projects so that the requirements of the IFC PS 1 can be met.

This CIA study will identify mitigation and enhancements that should be put in place by DRPIC as part of their development to prevent or reduce adverse cumulative impacts. In view of the complex and long-term nature of the Government-led strategic development of the economic area of Duqm, it will also identify those mitigation and enhancement measures which fall outside of DRPICs immediate influence and responsibility. These measures include those that should be implemented by organisations such as SEZAD and/or other proponents involved in the development and operation of facilities, initiatives and programmes of work in Duqm.

2 PROJECT DESCRIPTION

2.1 INTRODUCTION

The Duqm SEZ is located on the south eastern coast of Oman and is administered by the Special Economic Zone Authority at Duqm (SEZAD). The SEZAD was established pursuant to Royal Decree 119/2011 and the organisation is responsible for devising, regulating and implementing long-term strategies for Duqm SEZ.

The Duqm SEZ covers an area of approximately 40,000 hectares (ha). The masterplan sets out the preferred approach for land use and infrastructure planning for the Duqm SEZ. The proposals include the development of an airport, port and related facilities (established and operational), tourism area, industrial zone (see red and light pink shading) and a commercial and residential area. A schematic of the Duqm SEZ showing broad development categories is shown in Figure 2-1 below while an interactive map, showing each development type and the entire SEZ boundary, can be found at the website of SEZAD (<http://www.duqm.gov.om/duqm-sez/interactive-map>).

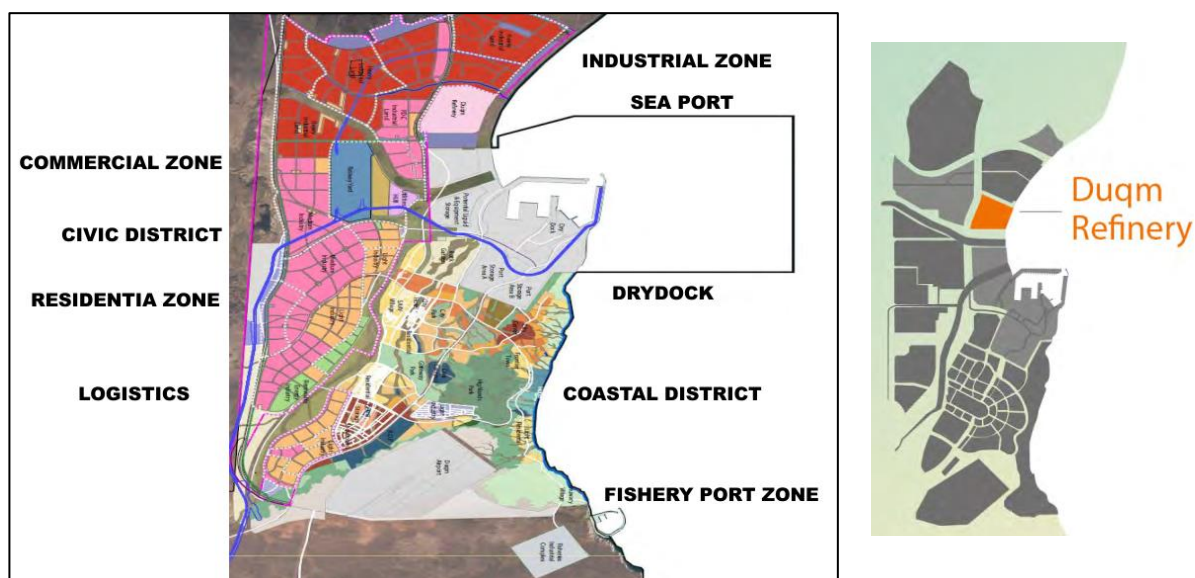


Figure 2-1: Schematic of Duqm SEZ (SEZAD, July 2017)

The development of the overall area will be undertaken in phases. It is proposed that Phase 1 development will take place within the next one to five years. The first phase of work will include the development of the following aspects:

- Key major utilities and infrastructure;
- Anchor industries, such as oil refinery and petrochemicals, cement industry, glass industry, soda ash and basalt;
- Logistics and warehouses and business park in the Free Trade Zone;
- Fisheries and Aquaculture related industries;
- Residential areas; and
- Non-industrial land uses.

These developments may not be fully developed in this phase and will be expanded during the following phases. The subsequent Phases 2 and 3 will also see the development of further industries in the area, including clean technology, food and beverage, metal, automotive, industrial logistics and life sciences. The timeframe proposed for the construction of Phases 2 and 3 is between six and 15 years from the commencement of development in the area.

The Duqm SEZ forms part of a wider master planning exercise, with the long-term intention to establish a sustainable economic hub at Duqm. This includes aims to develop a petroleum refining and petrochemical base, representing the first major industrial development in the area.

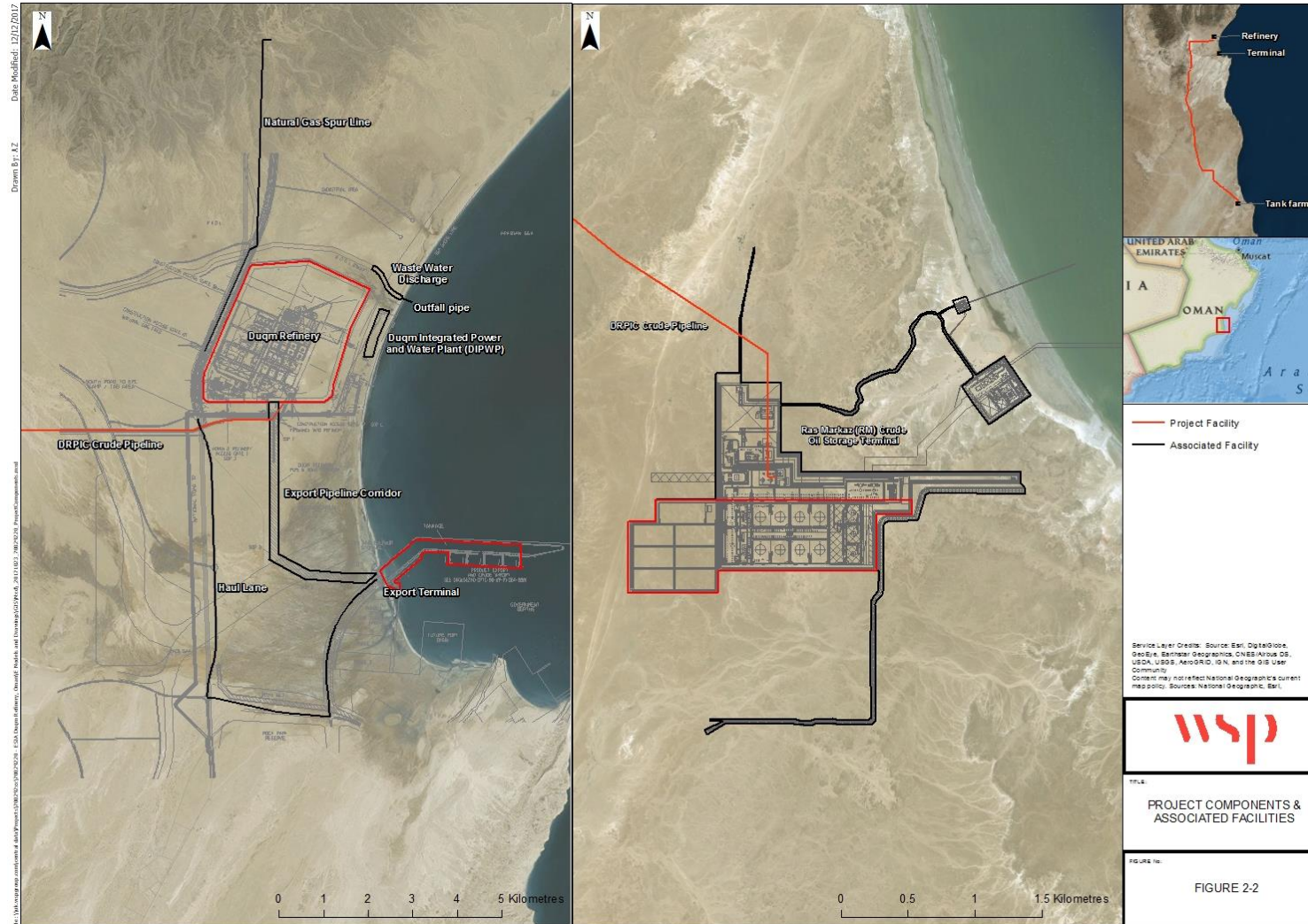
2.2 FUNDED PROJECT COMPONENTS

The funded project comprises:

- 230,000 barrels per day (BPD) complex refinery and on-site utilities, infrastructure and storage (the “Refinery”);
- Crude storage facility at the Ras Markaz Crude Oil Terminal (the “DRPIC Crude Storage Facility (Ras Markaz)”); and
- 28” 80km Crude Pipeline from Ras Markaz to the Refinery (“DRPIC Crude Pipeline” and together with the DRPIC Ras Markaz Crude Storage Facility and the Export Terminal, the “Offsite Facilities”).
- Product Export Terminal (“Export Terminal”) at the Port of Duqm.

Figure 2-2 shows the locations of the funded project, which are discussed below.

Figure 2-2: Project Components and Associated Facilities



2.2.1 Duqm Oil Refinery

The new export oil refinery complex will be designed and operated by DRPIC. An area covering 9km² will be dedicated to the Duqm Refinery, located within the Heavy Industry Zone in the wider Duqm SEZ. Once operational, the Refinery will have a nominal capacity of 11.5 million (M) tonnes per annum, i.e., approximately 230,000 barrels per stream day. The complex will generate a number of products for the export market that will conform to international standards, including liquefied petroleum gas (LPG), Naphtha, Diesel, kerosene jet fuel (Jet A-1), Petroleum coke and Sulphur. Figure 2-2 shows the proposed oil Refinery layout and location.

In addition to the refinery, the Funded project also includes the off-site facilities described in the section below.

Accommodation for the workers will be necessary during the various construction phases of the Duqm Refinery. There are currently two construction camp locations being considered, each containing their own infrastructural support services including, power generation, water supply and wastewater treatment utilities to house workers for the Refinery construction. The Camps will be exclusively for workers on the Duqm Refinery, with two facilities expected to hold a maximum workforce of 20,000 personnel during activities. It is understood that the two construction camps will be situated to the west and south-west of the Duqm Refinery within the Duqm SEZ, and others at locations to be determined (and further permitted).

Note, that additional locations are being considered for Workers' Camps as part of the offsite facilities.

2.2.2 DRPIC Crude Oil Storage - Ras Markaz

Duqm Refinery will have eight dedicated crude oil storage tanks within the overall Crude Oil Storage Terminal at Ras Markaz. The eight DRPIC tanks form the Project component. Each tank will be able to store 0.55 million barrels (Mbbbl) of crude oil. The wider Crude Oil Storage Terminal is an AF.

A worker camp is planned for the construction of the tanks at the Ras Markaz Crude Oil Storage Terminal which is expected to hold a maximum workforce of 4,300.

2.2.3 DRPIC Crude Pipeline

A buried 28" pipeline will transport blended crude from the DRPIC crude oil tanks at the Ras Markaz Crude Oil Storage Terminal to Duqm Refinery. The Crude Pipeline will be owned, constructed and operated by DRPIC. The Crude Pipeline corridor lies within an area that has already been approved by SEZAD and will not extend outside the boundaries of the Duqm SEZ. The route of the Crude Pipeline will connect the two facilities over a distance of 80.7 km.

2.2.4 Product Export Terminal

The Product Export Terminal involves the development a bulk berth along the length of the current lee breakwater, located to the north of the existing Port Duqm facilities, but within the Port boundaries. The works that fall within the Project description will include the construction of storage tanks, sheds and handling equipment for the products produced by the Duqm Refinery, including both bulk liquid and solid exports.

A Worker Camp is planned for the construction of the Duqm Liquid Bulk Berth (DLBB) – see Table 2-1 below. This particular construction activity is included in the Funded Project as it will be built by the contracted EPC Contractor. This Camp is anticipated to hold a maximum workforce of 5,000.

2.3 ASSOCIATED FACILITIES

The following AFs have been identified as third party facilities that will further supplement the DRPIC Project. According to the IFC guidance, such amenities – while not funded as part of the Project – would not be constructed or expanded without the Project, and without which the Project would not be viable.

The AFs locations are shown in Figure 2-2 and summarised in Table 2.1 below. The rationale for the selection as an AF and a note of the services/function provided are included.

Table 2-1: Associated Facilities

Associated Facility	Rationale/Service Provided
Duqm Liquid Bulk Berth (DLBB) jetty – marine scope including dredging, reclamation/ground improvement and berth construction	<p>While the product 'Export Terminal' development is a Project facility (see above), its establishment will include dredging activities on the berth/basin and to the south of the current lee breakwater, which will also consist of ground and foundation improvements.</p> <p>The DLBB EIA includes works for both the marine (AF) and topside (funded) facilities.</p> <p>A section of the jetty will hold the topside part of the DLBB Project facility. SEZAD will be responsible for the marine activities, which will include dredging, reclamation and construction of the jetties and quay wall.</p>
Natural Gas Spur Line from the Gas Supply Station (GSS) to Refinery	<p>The Duqm Refinery will be one of numerous users in the Duqm SEZ supplied by the GSS. It is currently understood that the GSS location and capacity would not be affected by the Duqm Refinery, consuming an estimated 15-20% of the GSS output.</p> <p>A Natural Gas Spur Line will be constructed in order to transport the GSS exports to the SEZ users. With the Duqm Refinery acting as a major consumer, it has influenced (i.e. the Refinery is 20% of the volume) the Spur Line's route direction and as such is identified as an AF.</p>
Export Pipeline Corridor	<p>The 200m wide multifunctional Export Pipeline Corridor will host the export pipelines that will transport exports from the Duqm Refinery to the DLBBDPIC will be responsible for the operation and maintenance aspects of the pipelines, but the service corridor is owned and operated by SEZAD and is therefore notified as an AF.</p>
Marafiq Duqm Integrated Power and Water Plant (DIPWP)	<p>The Duqm Refinery will act as the only external customer for the DIPWP at the current time. Due to this, the production rates of power and desalinated water (produced from a dedicated seawater intake) provided by DIPWP will be determined by the requirements of the Duqm Refinery.</p>
Waste water Discharge / Common Outfall	<p>The waste water Common Outfall to the immediate north of the Duqm Refinery plot forms an essential part of the Project, with the water releases from the Duqm Refinery co-mingling with the discharges from DIPWP (primarily brine), forming a portion of the combined outfall. .</p>
Ras Markaz Crude Oil Storage Terminal (Phase 1.2 and 1.3 Marine Scope/Infrastructure)	<p>The location of the Crude Oil Storage Terminal will cover a site of some 13 km² and is situated along the east coast, 70km south from the Duqm Oil Refinery. Phase 1.2 and 1.3 of the Crude Oil Storage Terminal is considered an AF.</p>

Associated Facility	Rationale/Service Provided
	<p>This AF comprises both marine and onshore works.</p> <p>Marine works includes the construction of a Single Point Mooring (SPM) system with connections to an onshore crude oil booster pumping station, seawater intake and outfall systems and potentially a service harbour.</p> <p>Onshore works includes a number of support facilities including, a power supply, utility systems (seawater pumps, firewater, desalination, potable water, slops system, wastewater collection and treatment), booster pumping station and crude oil metering.</p>
Use of Main Road from Duqm Refinery to the Duqm Export Terminal for transporting solid product.	An upgrade to the road network system in order to facilitate the transport of the Duqm Refinery's solid products will be considered an AF.

3 CIA METHODOLOGY OVERVIEW

3.1 INTRODUCTION

While the impacts of an individual project may be judged to be acceptable, there is also a need to consider the potential for a project's impacts to interact with those associated with other developments - so called 'cumulative' impacts.

Cumulative impacts comprise:

- **Site-specific** (or within-development) **cumulative impacts** which arise from each of the DRPIC Project components individually. Different aspects of each project component may themselves have additive, synergistic or interactive impacts on common receptors (and these impacts could be minor, or insignificant, in their own right but significant when combined). Examples might include the combined effects of noise, traffic, visual impact, and influx of workers on local communities.
- **Project-wide cumulative impacts** which arise from the combined effects (e.g. additive, synergistic or interactive) of the DRPIC Projects, that is, the cumulative impacts of any part of these Projects with all other Project components and AFs.
- **Wider cumulative impacts** between any component(s) of the DRPIC Projects and any other known development(s) in the study area.

Developing a CIA is considered an essential framework for risk management in projects and good international practice and requires that, as a minimum, developers assess cumulative impacts as

part of the ESIA process. The process of CIA seeks to determine whether the proposed facility will contribute to cumulative impacts on Valued Environmental and Social Components (VECs¹).

This is acknowledged by national authorities such as the Ministry for Environment and Climate Affairs (MECA) and lenders that use international standards (IFC and Equator Principles included) as discussed further below.

3.2 PROJECT PERFORMANCE STANDARDS

MINISTRY OF ENVIRONMENTAL AND CLIMATE AFFAIRS (MECA)

In July 2013, the Ministry of Environment and Climate Affairs (MECA) updated their 'Omani Environmental Regulations International References Documents SEU Guidance Notes'. Section 26 of this document refers to guidelines for investors and project owners on how to meet the necessary conditions in order to achieve an environmental permit for various development categories. More specifically, Appendix B 'Guideline on Environmental Impact Assessment', references the importance of considering cumulative environmental impacts in order to fully evaluate the nature of the impacts. Furthermore, it goes on to state:

'The proponent must assess any cumulative environmental impacts likely to result from the Project in combination with existing or planned projects or activities. Environmental impacts are not separate from one another; they interact over time and space. It is important to recognize that many critical impacts of the project may occur some distance from the project site itself, and the interests of all affected parties should be addressed.'

INTERNATIONAL FINANCE CORPORATION (IFC)

Further to the national recommendations, an internationally recognised framework has been established in order to assess a project's cumulative impacts. The IFC policy on 'Environmental and Social Sustainability' depicts the organisations eight Performance Standards (PS) that are directed towards clients, providing guidance on how to identify risks and impacts, and are designed to help avoid, mitigate, and manage risks and impacts in a sustainable business manner. In particular, IFC PS 1, 'Assessment and Management of Environmental and Social Risks and Impacts', identifies that best practice requires that, at a minimum, private sector developers need to consider cumulative impacts during the ESIA process.

If applicable, the IFC require developers to implement mechanisms that identify the magnitude and significance of the related cumulative impacts on VECs, and expect them to include appropriate mitigation measures within the project's environmental and social management system. The IFC 'Good Practice handbook for Cumulative Impact Assessment (CIA) and Management' (IFC, 2013) provides a practical and preliminary approach for developers in emerging markets to conduct a CIA that meets such requirements.

THE EQUATOR PRINCIPLES (EP)

The Equator Principles (EP) (version III, June 2013) is a recognised framework which promotes developments to be socially responsible and incorporate comprehensive environmental practices. The EPs refer to the IFC Sustainability Framework and its Performance Standards. The EP further highlights the value of conducting a CIA, referencing cumulative impacts of the proposed, existing

¹ VECs are environmental and social attributes that are considered to be important in assessing risks; they may be: physical features, habitats (e.g. biodiversity or ecosystem services), social conditions (e.g. health, economics), or cultural aspects (e.g. traditional spiritual ceremonies).

and anticipated projects to be considered; especially those that are of scientific concern or that affect the communities within the area under influence.

3.3 CIA METHODOLOGY OVERVIEW

The methodology in this CIA has been based on the principles of the IFC guidance, which sets out a six-step structure (i.e. the foundation) for conducting a comprehensive CIA, with the objectives from each step presented in Figure 3-1. It is not always possible to follow this methodology word-for-word and the IFC guidance document is exactly that – a useful guide. Where there are deviations from the guidance – because of the particular specifications of the Duqm Refinery Project and AFs – or lack of information about third party other projects/initiatives in the Duqm area, then the reasons are stated. The assessment was adapted and modified throughout the course of compiling the CIA.

The Report's sections which follow, present the findings of the six steps for the assessment of the cumulative impacts upon the relevant VECs of the Project.

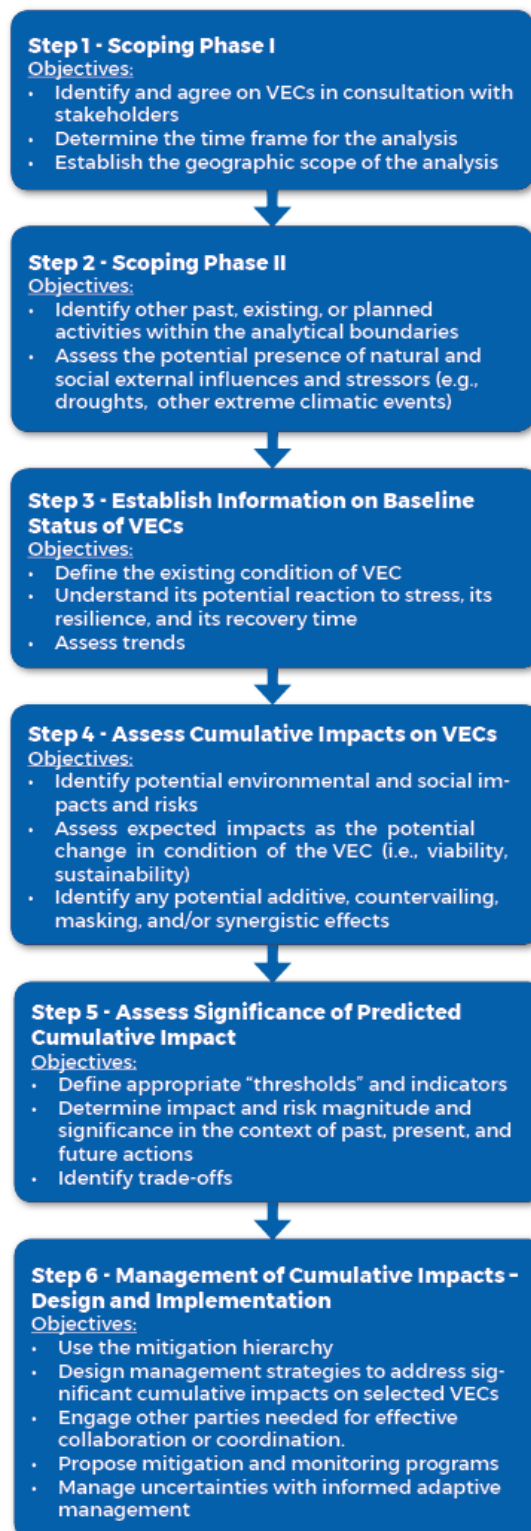


Figure 3-1: IFC (2013) CIA Guidance Process

4 CIA SCOPING STAGES I - II

4.1 INTRODUCTION

The initial phases of the IFC guidance are critical to the success of the CIA, as it establishes the scope of the cumulative impact analysis and allows the context to be appropriately classified.

The scoping stage will establish the dimensions (VECs of concern, spatial and temporal assessment scales) of the cumulative impact study, in addition to outlining an appropriate strategy for identifying the pressures from activities other than the proposed development. The outcome of such an early considerate analysis can mitigate the consequences of uncertainty and subsequently allow the cumulative impact management process to anticipate different future scenarios.

4.2 STEP 1 – SCOPING PHASE I

The guidance uses the concept of VECs in relation to CIA and these are the environmental and social attributes (or receptor groups) that are considered to be important in assessing risk and impact of a project. The VECs listed in the IFC guidance are:

- Physical features, habitats, wildlife populations (e.g. biodiversity);
- Ecosystem services;
- Natural processes (e.g. water and nutrient cycles, microclimate);
- Social conditions (e.g. health, socio-economics, and human rights); and
- Cultural aspects (e.g. traditional spiritual ceremonies or sacred sites).

The tasks carried out at this stage are to identify:

- The VECs to be included in the CIA;
- The spatial boundaries of the CIA; and
- The temporal extent of the CIA.

Establishing the VECs is one of the first steps in approaching the CIA. The specialists involved needed to have sight of the third party projects (see Section 4.3) – at least at a broad level – because the likely characteristics (e.g. particular sensitivities, spatial extent, potential interactions) also inform the selection of VECs. Conclusions were dawn by the team following discussions, internal workshops and communication between specialists, with local consultants (5OES), information provided by DRPIC, SEZAD and information gleaned from stakeholders (see above). At this stage, no VECs were screened out due to ZOI, temporal or potential interactions with third party projects. They would be later excluded during the assessment stage due to negligible or low risks.

The VECs considered in this CIA have been collated from information from within the original EIAs for the DRPIC Projects as well subsequent information available from the preparation of the Consolidated ESIA. The authors and specialists also used their experience of the area, which is extensive, and stems back to approximately year 2000, when both the Project Manager and members of the 5OES team worked together on the establishment of the Port of Duqm. Specialists contributing to the CIA had also visited Duqm as part of collating the enhanced baseline data sets and extensive visual observations. Opportunities to talk to a wide range of DRPIC staff and meet with SEZAD staff were also taken.

In addition, issues and aspects of potential interest to the CIA were mentioned and included in consultation activities during the collation of new baseline data. The engagement activities as part of collating information on the socio-economic and health aspects included discussion points with residents during the questionnaire and a Question and Answer session at the Duqm Women's Association evening event in April 2017 (see Socio-economic and health Baseline, DRPIC Report No. 70029220-05-C-BASE/SOC). Similarly, local fisherman were asked questions about strategic information in interviews conducted in the same month. Prior to the cultural heritage baseline work, our specialists at 5OES also communicated with the Ministry of Heritage and Culture about the broader regional (e.g. around Gunaim and Huqf), and indeed, national work that they had been carrying out, including an updated comprehensive site catalogue.

The collated VECs are presented in **Appendix A-1** of this report. For practicality, and to help simplify the assessment, the VECs being considered have been generalised. However, the detailed Biodiversity Assessment undertaken by WSP in 2017 to fill in the gaps in the previous baseline studies has identified VECs that will need to be considered under multiple sensitivity levels and may require a diverse range of mitigation. These VECs and their justification for inclusion are presented in **Appendix A-2** of this report.

A determination of the 'study area' or Zone of Influence (ZOI) was undertaken for each of the identified VECs in order to identify the spatial boundary within which other projects and their potential cumulative impacts will be considered. This was produced by carrying out a "Source-Pathway-Receptor" screening (SPR)² to ascertain the likely spatial extent over which they may interact in order to provide a geographical constraint to selection of 'other' projects.

The ZOI differs topic by topic, and can be highly variable for receptors depending on their spatial location. Consequently, given the significant range of the proposed receptors and the large spatial extent, a conservative judgement was taken. Specific ZOIs are not stated in the guidance; therefore justification has been provided over the assigned ZOIs where appropriate. The proposed ZOI for the various VECs and their justifications are presented in **Appendix A-3** of this report. The maximum assigned terrestrial and marine ZOI are presented diagrammatically in Figure 4-1.

The predicted project timescales (temporal scope) for the DRPIC project stages and temporal extent of the CIA is estimated below.

The timescale for the construction phase of the DRPIC Project components are as follows; it is assumed that all projects would be commenced concurrently once funding is obtained:

- Duqm Oil Refinery: 3.5 years;
- Ras Markaz Crude Oil Park, Phase I of development: three years;
- Ras Markaz Crude Pipeline: construction period TBC, assumed concurrent with the above;
- Duqm Liquid Bulk Berths Project: three years; and
- Construction Camps (as part of other funded assets): set-up and site mobilisations: (the exact duration is currently unknown though anticipated to be in place throughout the DRPIC Project construction phase; therefore, the duration is predicted up to 3.5 – 4 years).

The design operational life period for the DRPIC Projects is 35 years, with predicted full operation commencing at the end of 2021 and activity continuing until 2055.

² SPR – is assessment of potential relationship between the source (S) of a hazard, the pathways (P) by which exposure might occur, and the receptors (R) – those features of the environment that were defined as VECs (see Section 3.1) and that could be affected.

4.3 STEP 2 – SCOPING PHASE II

The tasks carried out and presented in this phase were:

- Identification of long list of other developments in the region;
- Obtaining available information on third party developments and plans;
- Identifying distances of third party developments from the DRPIC project components; and
- Screening projects out of the CIA if they are outside the various assigned ZOIs.

4.3.1 Development of Long List of Other Projects

Due to the nature of the surrounding designated industrial area, a list of third party projects has been identified through the available documentation and various online resources. Discussions with relevant authorities and team members helped to identify a long list of third party developments within the study area. The inclusion of third party developments has been based on the following criteria:

- Built and operational projects (see below for definition);
- Approved but uncompleted projects;
- Projects under construction;
- Projects for which an application has been made, that are under consideration by the consenting authorities and for which refined information and robust assessment outcomes are available; and
- Projects which are reasonably foreseeable, i.e., projects for which an application has not yet been submitted, but which are likely to progress before completion of the development and for which sufficient information and robust assessment outcomes are available at the date of any appropriate assessment in order to assess the likelihood of cumulative impacts.

Further information has been sought from SEZAD regarding third party projects, in particular whether any EIA and other related documentation is available. It was identified however that in general limited information was available for the majority of the long list of third party projects.

The long list of projects for consideration and a summary of third party project information is presented in **Appendix B-1** and **B-2** of this Report, respectively.

4.3.2 Screening of long list of Projects

The distances of the identified projects in relation to the DRPIC project components are presented in **Appendix B-3**. The locations of some third party developments are currently unknown but a conservative estimate of distance is estimated to provide context. The closest distance in relation to each development has been taken as a precautionary approach.

These distances were then compared to the ZOIs developed in Step 1. This has enabled us to identify those developments that spatially overlap with the various ZOIs for the VECs, potentially resulting in additive or synergistic cumulative impacts. If no spatial overlap was recognised, then the third party project can be screened out and is not considered any further in this assessment. The maximum ZOIs identified were 10 km and 250 km for terrestrial and marine related impacts, respectively.

The consideration of specific sensitivities and susceptibilities, spatial extent and temporal dynamics etc. continued into this stage of the CIA where the VECs are screened in.

Due to the absence of available information on the third party projects (listed in **Appendix B-2**), a very detailed and quantified assessment of cumulative impacts for the wider Duqm SEZ, and other regional development, is not possible. The IFC guidance states that '*ultimately governments are responsible for preparing CIA frameworks to assist private sector actors in the identification and management of cumulative impacts*'. Such a study or longer-term programme of ongoing work on cumulative impacts would be best conducted by SEZAD once further detailed information becomes available for the various developments that will be planned and built within the Duqm SEZ.

Third party projects are mentioned or noted, where relevant and any information available incorporated. A useful preliminary approach for developers and relevant government agencies, in this case SEZAD, is to complete a list of third party projects with qualitative information. The third party projects were evaluated to ascertain the relevancy and scale of the various developments and plans with an indication (using a matrix of the key receptors) to whether there is a potential for them to result in impacts of a similar nature to the DRPIC Project.

Appendix B-4 presents the relevant impacts that were considered in the screening and that will ensue over time. Therefore, this CIA continues to focus mainly on the cumulative impacts of the DRPIC Project and the AFs for which EIAs are available.

Suggestions and recommendations for further work required to manage such strategic-level impacts are provided in Section 8.2.

4.3.3 Natural and social external influences

According to the fifth assessment report of the International Panel on Climate Change (IPCC, 2014), the stressor of warming of the climate is a clear and unequivocal global challenge. Considering the current high level of water stress in Oman, the main climate change issues that have been highlighted at a national scale are projected temperature increases and precipitation decreases

Dust blows off the coast of the Gulf of Oman especially in winter, when dust storms are associated chiefly with the passage of westerly depressions in the Arabian Gulf. Sometimes called a "Shamal" (an Arabic word for "north") in the Gulf, such winds can reach 25 knots or more in an almost always north-westerly direction and thus produces the most widespread hazardous weather (including high seas) in the region. Associated with this is persistent dust and sandstorms. Shamal and heavy weather events are dealt with by smart design in buildings and infrastructure, and institutional (e.g. policy) and behavioural measures (e.g. staying indoors to keep safe). The Duqm Refinery Project has included provisions in the FEED design to counter the impacts of natural disasters and other anticipated vulnerabilities at a regional level on the Project components (HMR Consultants, Dec., 2014). For example, it was identified that the Refinery and seawater intake system could be particularly vulnerable to storms, high tides and sea level rise. In response, a detailed wave modelling study was conducted to assess the risks to the Refinery from coastal and fluvial flooding during FEED. The Project's design has therefore taken into account extreme events such as floods, cyclones, storms and tsunamis. Points relating to climate change adaptation were also mentioned in the Liquid Bulk Berth EIA (WorleyParsons Oman Engineering LLC, 2015), Crude Pipeline EIA (HMR Consultants and Amex Foster Wheeler, Oct. 2015) and EIA for Raz Markaz Crude Oil Park (WorleyParsons Oman Engineering, 2016).

Provisions that also need to be made in other projects and third party development to reduce the risk of damage against natural hazards and climate stressors are not known at this stage. It would be prudent for SEZAD to engage with other proponents and Ministries to develop a coordinated approach to countering the long-term impacts of these aspects and it is believed that this will be forthcoming from SEZAD in the form of monitoring visits, checking and annual reporting. SEZAD has invested significantly in civil works' improvements in and around wadis to enhance flood protection (broadly, from the 1-in-1,000 years' storm to 1-in-100) – see 'Groundwater; in Section 6.2.2 – for the Duqm SEZ, so it is assumed in this CIA that the authority is dealing with such strategic solutions, and will continue to do so in order to attract other operators and developers to Duqm.

5

BASELINE INFORMATION FOR VECs

5.1

STEP 3 – ESTABLISH VEC BASELINE INFORMATION

The tasks carried out at this stage included:

- Identification and description of the baseline in relation to all VECs (including relevant individual receptors) from existing documents;
- Identification of the sensitivity and value of the VECs; and
- Identification of any missing baseline information (e.g. site-specific, contextual, spatial, condition).

The VECs baseline environment was established based on the extraction of data within the existing DRPIC Project's EIAs, various other documentation provided by DRPIC and updated baseline data produced by WSP. The collated baseline is presented in **Appendix C-1**.

Information from the other developments has also been used to enhance or provide more contexts for the relevant VECs (in terms of presence and absence) and the condition of those VECs where available. Where information on quantities or condition of the VECs is unknown, this has been identified and any assumptions made have been provided. Furthermore, the baseline area beyond the Project components, i.e., in the vicinity of third party projects and, indeed, the Duqm SEZ is usefully summarised in Table format as **Appendix C-2**.

In determining and describing the baseline, we have identified:

- Spatial location and extent of the VECs both at the site specific (e.g. settlement) scale and regional (e.g. population and demographic) scale;
- Description of the VECs and their character;
- Context of the VECs in terms of rarity, function, and population at the local, regional and national level; Sensitivity, i.e. vulnerability, resilience (adaptability and tolerance) and recoverability; and
- Value/importance.

In order to gain a more complete understanding of the VEC baseline conditions, a further table containing information on the baseline has been established which considers the wider Duqm SEZ area. Information has been collated from key reference sources, such as Duqm Industrial and Free Zone Masterplan EIA (5OES, 2011) and is presented in **Appendix C-2**. It is acknowledged that the DSEZ masterplan (5OES, 2011) survey findings were reported in 2011 and have therefore only been used to supplement information from the updated survey results undertaken by WSP.

The VEC/receptor sensitivities have been characterised using the qualitative guide for representative 'levels' of sensitivity presented in Table 5-1. The sensitivity (and value) of the various VECs is presented in **Appendix C-3** of this report.

The respective sensitivities of the biodiversity VECs identified in Appendix A-3 are presented in **Appendix C-4** of this report. It must be noted that the Biodiversity Assessment (WSP, 2017) adopted the best practice method published by the Chartered Institute of Ecology and Environmental Management which attributes a value to VECs rather than a sensitivity to denote the level of VEC importance (e.g. rarity, conservation status). For biodiversity, the values originally assigned have been taken as their sensitivity for the purpose of this CIA.

Table 5-1: Guide for Classification of Sensitivity

SENSITIVITY	GUIDE DEFINITION FOR "SENSITIVITY" OF FEATURE/RECEPTOR
Very High	Has no capacity to accommodate physical or chemical changes or influences.
High	Has a very low capacity to accommodate physical or chemical changes or influences.
Medium	Has a low capacity to accommodate physical or chemical changes or influences.
Low	Has a moderate capacity to accommodate physical or chemical changes or influences.
Very Low	Generally tolerant of and can accommodate physical or chemical changes or influences.

The value of the VECs has been determined based on a geographical hierarchy where relevant and is presented in Table 5.2. The various VECs are presented in Appendix C-3 of this report.

Table 5-2: Guide for Classification of Value

VALUE	GUIDE DEFINITION FOR "VALUE" OF FEATURE/RECEPTOR
Very High	International
High	National (Oman)
Medium	Governorate (i.e. Al Wusta)
Low	Wilayat (i.e. Ad Duqm)
Very Low	Within zone of influence (which might be the development site or a larger area)

6

CUMULATIVE IMPACTS ON VECS

6.1

STEP 4 – ASSESS CUMULATIVE IMPACTS ON VECS

The tasks carried out at this stage of CIA are to:

- Define the potential impact relevancy and scale of the considered third party developments that can act cumulatively with the DRPIC funded projects;
- Identify the magnitude of effect for all VECs (including relevant individual receptors) from existing documents;
- Identify impacts where insufficient information/quantification is available; and
- Consider the duration of effect for all impacts on VECs.

Where the projects have been identified and listed as having a potential to impact on a VEC (see above), the magnitude of the effects (from sources of impact) has been collated, quantified and described. The cumulative magnitudes were defined using the following four factors:

- Extent – The area over which an effect occurs;
- Duration – The time for which the effect occurs;
- Frequency – How often the effect occurs; and
- Severity – The degree of change relative to the baseline level.

The magnitude of the impact has been linked to either quantified thresholds or qualitative descriptions depending on the nature of the impact and the receptor.

Table 6-1 represents the guide for the qualitative scale of magnitude that has been used where quantified information or magnitudes are uncertain or unknown.

Table 6-1: Guide for Classification of Magnitude

MAGNITUDE	GUIDE DEFINITION
Very High	Loss of VEC and/or integrity of the VEC; severe damage to key characteristics, features or elements (Negative). Permanent / irreplaceable change, which is certain to occur. Large scale improvement of resource or attribute quality; extensive restoration or enhancement (Beneficial).
High	Loss of VEC, but not affecting integrity of the resource; partial loss of or damage to key characteristics, features or elements (Negative). Permanent / irreplaceable change, which is likely to occur. Improvement to, or addition of, key characteristics, features or elements of the VEC; improvement of attribute quality (Beneficial).
Medium	Minor loss of, or alteration to, one (maybe more) key characteristics, features or elements; measurable change in attributes, quality or vulnerability (Negative). Long-term though reversible change, which is likely to occur. Minor improvement to, or addition of, one (maybe more) key characteristics, features or elements of the VEC; minor improvement to attribute quality (Beneficial).
Low	Very minor loss of, or alteration to, one (maybe more) key characteristics, features or elements; noticeable change in attributes, quality or vulnerability (Negative). Short- to medium-term though reversible change, which could possibly occur. Very minor improvement to, or addition of, one (maybe more) key characteristic, feature or element; very minor improvement to attribute quality (Beneficial).
Very Low	Temporary or intermittent very minor loss of, or alteration to, one (maybe more) characteristic, feature or element; possible change in attributes, quality or vulnerability (Negative). Short-term, intermittent and reversible change, which is unlikely to occur. Possible very minor improvement to, or addition of, one (maybe more) characteristic, feature or element; possible improvement to attribute quality (Beneficial).

Based on the proposed SEZAD masterplan for Duqm, the construction impact duration for the SEZAD is considered to be long term (in the region of 15 years plus). The construction impact duration for the DRPIC Projects is however considered in this assessment as medium-term (generally 3 - 4 years). Operational impacts for the DRPIC Projects and the wider SEZAD development are judged to be long-term.

6.2 CUMULATIVE IMPACT MAGNITUDE

As stated in Section 4.3, the absence of information available on third party projects has not allowed the assessment to quantify their influence on cumulative impact within the overall Duqm SEZ. Some qualitative assessment is made, where possible. The CIA focuses on the cumulative impacts of the DRPIC Projects and its AFs.

The cumulative impacts are considered under each VEC topic area below. The assessment also considers the probability/likelihood and duration of the impacts.

6.2.1 Ecosystem Services/Natural Resources

The cumulative impacts that have been assessed for the natural resources' VECs identified in **Appendix A-1** are Natural Capital and Land Use.

NATURAL CAPITAL

Construction Phase

It is expected that the DRPIC Projects will utilise some of the same natural resources as the AFs and the third party developments in the wider Duqm SEZ. This is also the case for commercial development activities in the region beyond the boundary of SEZAD's responsibility. Cumulative impacts on natural resources will occur as a result of sourcing of wood, metal, cement, rock, aggregates, fuel, water and foodstuffs. Driven by influences such as transportation costs and ease of access, it is envisaged that resources will, in the main, be sourced locally and/or regionally from reputable suppliers. Where there is poor availability or insufficient quantity and/or quality, procurement of such resources will extend to wider Oman, but besides national, there is likely to be some international sourcing of specialist materials and components.

Thus, the cumulative impacts of natural resources in construction are considered to be regional to national and of medium-term duration but of **Low** magnitude given that it is likely that there are sufficient natural resources nationally and internationally to supply the development of the DRPIC Project. The same is anticipated for the wider regional development of Duqm over the timescales of the Project.

Best practice principles are being adopted by DRPIC across all the proposed Projects elements in terms of strategies to avoid and minimise the use of natural resources and to adopt efficiency savings and reuse/recycling where possible. Examples of this include integration of the internationally renowned waste minimisation hierarchy to be adopted by all contracted EPC Contractors and initiatives for different Contractors to source water and reuse wastewater, where at all feasible and possible as well as the requirement for overall resource efficiency measures.

Operation Phase

The main natural resources that will be directly consumed by the DRPIC Projects, AFs and the wider DSEZ and other third party developments operation are fuel (feedstock, imported) and desalinated water. In addition, diesel and petrol will be needed for the vehicles that will be used for transportation of workforce and materials.

Desalinated water, provided by the dedicated DIPWP, will be further treated within the Refinery to meet the water use requirements and thus not draw on third party sources of water provision. The Refinery will reuse and recycle water internally to optimize the water use following good industrial practices.

Materials such as wood, metals, plastic and sand and cement will be required for the ongoing maintenance of the DRPIC Projects, AFs and other third party developments.

For ancillary requirements, Oman has good hydrocarbon reserves and the Project will facilitate the utilisation of this resource for industrial and economic development of the region and Oman. Diesel and petrol are available in the local market.

Impacts associated with natural resource requirements for operational phase and maintenance activities are considered to be local, regional and national and of a long-term duration. Cumulative impact is likely to be of **Low** magnitude given there will be sufficient natural resources nationally to support the DRPIC Project and the longer-term development of the Duqm SEZ.

Principles of best practice in operations will need to be adopted across all of the Project components to meet with lenders' requirements in the loan agreement particularly around the sustainable use of resources and materials, avoidance of waste and proactive approach to energy conservation/efficiency.

LAND USE

The DRPIC Project components are located on large areas newly developed plots of land within the industrial zone identified by SEZAD. The extensive geographical areas of land were allocated following Government study and planning and on the basis of the Royal Decree 119/2011 which stipulated the creation of the Duqm SEZ. Some villages which were identified as being affected by the overall development under SEZAD are being relocated by the Government to alternative residential sites (e.g. 150 Residential Units) while the land in the current Project area is not being used for any other material purposes (e.g. large-scale agriculture).

On this basis, there is potential minor land use conflict where the relocation process was started in 2011 for the wider area development, prior to the Duqm Refinery Project. The alternative land plots were also identified back in 2011 and the process follows the national legal process of land acquisition. Through its management system, DRPIC will implement mitigation measures, especially around stakeholder engagement, though these are not directly related to the Project. As such, it is predicted that there will be a minor negative cumulative impact arising for land use.

6.2.2 Physical Environment

The cumulative impacts that have been assessed for the Physical Environment VECs identified in **Appendix A-1** (and refined) are as follows and described in more detail in subsections below.

- Air Quality;
- Greenhouse Gas (GHG) Emissions
- Noise;
- Groundwater;
- Soil;
- Surface Water Quality; and
- Topography/Landscape.

AIR QUALITY

Air quality impacts and their magnitude are included in the Section on Community and Health below.

GREEN HOUSE GAS EMISSIONS

Construction Phase

Greenhouse Gas (GHG) emissions from the 47-month construction phase of the DRPIC Projects (largely from construction plant and vehicles) will contribute to the carbon footprint of the Project, and thus the GHG emissions contributed (by Oman) on an annual basis, to the global-scale problem of global warming from anthropogenic sources. An estimate of construction GHG emissions is shown in Table 6-2 below, which shows the relatively smaller proportion from construction compared to the first year of operation.

Table 6-2: Breakdown of Refinery GHG Emissions by Project Phase

SELECTED PROJECT COMPONENTS AND SCOPES	CONSTRUCTION (TCO2E) – SUM OF STATIONARY, MOBILE & FUGITIVE	OPERATION (TCO2E) – ANNUAL	TOTAL GHG EMISSIONS (TONNES CO2E) – CONSTRUCTION + SINGLE YEAR OPERATION
Scope 1 GHG emissions (e.g. from fossil fuels)			
Refinery (only)	3,921	3,135,384	3,139,305
Project Components (Refinery, Crude Pipeline, Export Terminal and Ras Markaz Crude Oil Tanks)	203,782	3,142,119	3,345,901
Associated Facilities (Crude Oil Storage, Service Corridor, DIPWP)	492,358	53,655	546,013
Total (Project components + AF) of Scope 1 GHG emissions	696,139	3,195,773	3,891,912
Scope 2 GHG emissions (i.e. from electricity and steam)			
Refinery (only)	N/A	Not avail.	N/A
Project Components	N/A	506,359	506,359
Associated Facilities	N/A	N/A	N/A
Total (Project components + AF) of Scope 2 GHG emissions	N/A	506,359	506,359
Total Project GHG Emissions (Scope 1 + 2)			
Refinery (only)	3,921	Electricity consumption included in row below	See below
Project Components	203,782	506,359	710,141
Associated Facilities	492,358	53,655	546,013
Total (Project components + AF) of Scope 2 GHG emissions	696,140	560,014	1,256,154

The nature of the cumulative impact is temporary (in duration) and the overall impact on climate change at the global scale is considered to be **Very Low**. Based on a baseline of 2010, the average 'annual' contribution of GHG emissions during construction (approximately 50,000 tonnes of CO₂ a year) for Project components is only a tiny fraction of the total CO₂ emissions in Oman (around 60 MtCO₂ per annum).

Despite the fact that a number of industrial third party projects are being progressed at the same time within Duqm SEZ, construction best practice principles will be adopted by DRPIC, via its EPC Contractors, to minimise the use of fossil fuels, where possible, and adopt – and monitor/manage, in order to reduce – techniques to avoid unnecessary GHG emissions. Examples include switching off plant and equipment to avoid idling engines when not in use, and minimising site trips and deliveries through resource efficiency.

Operation Phase

The first year of operations at Duqm Refinery itself is estimated to emit approximately 3.64 MtCO₂ of GHG emissions, and the total with other Project components and AFs is 3.70 MtCO₂pa. The Refinery (only) contribution in year one is approximately 6.02% of Oman's annual GHG emissions, whereas with all Project components and AFs, that percentage becomes around 6.12% of national contributions.

New projects in the wider Duqm SEZ will give rise to an increase in overall emissions (including both GHG emissions and other pollutants to air) while the connecting transportation links in the various supply chains, and use of transport and cooling by an increasing population will contribute further to GHG emissions. Much longer-term electrification and automation trends in industry and public life (e.g. electric vehicles that will require charging), encompassing one to two decades, will reduce the overall combined contribution of scope 1 GHG emissions (i.e. from fossil fuels) but with the population set to increase (and hence an increased contribution to carbon footprint) the long-term strategic impact remains of **Medium** magnitude.

It is expected that as environmental permitting and reporting procedures mature in the next few years, especially in respect of Oman's response to international initiatives (e.g. the Paris Framework on Climate Change, 2016, which Oman has signed, but not yet ratified – but is working towards this), individual industries will need to establish comprehensive calculations on their GHG emissions, while SEZAD collate the GHG emissions of the companies within its boundaries for reporting accurate figures into national data collection initiatives (e.g. to MECA). At the global scale such contributions are still considered to be **Very Low**.

DRPIC should seek to work with SEZAD and support the Government of Oman in achieving national initiatives for awareness around GHG emissions and air quality at large, education initiative and a response to reducing them in order to support collaborative efforts on mitigation of climate risks.

NOISE

The impact and magnitude associated with noise is covered in the Section on Community and Health below.

GROUNDWATER

Groundwater resources in the Region are limited and the groundwater is saline in nature, exceeding both the WHO and Omani Standard for a number of parameters. This deems the local groundwater resources unfit for human consumption without treatment. From the baseline work and observations in the field across the Duqm SEZ, groundwater abstraction was not observed. It is not thought to be a resource anyone is currently reliant on, so obtaining freshwater this way is not a viable option.

Furthermore, all water used by the Duqm Refinery Project components will obtain their own water during construction and likely be sourced from the existing or new desalination plant. During operation, water will be generated by the DIPWP, an AF which will also supply other future consumers in the wider Duqm SEZ.

The Duqm Refinery Project will have proactive control measures in place to prevent groundwater pollution from accidental spillages and contaminated discharges and the management plans for

implementation by EPC Contractors procedures have requirements for clean-up (e.g. of spills) to prevent pollutants entering groundwater.

During the construction phase, the Project components will have their own waste water treatment plants, which will need to be granted consent to operate by SEZAD. During operations, wastewater will be treated to MD159 standards and discharged to be co-mingled with DIPWP, and sent to the Common Outfall (situated north of the Duqm Refinery site).

Only if major spillages or incidents occurred at Project facilities or along the Crude Pipeline route, which is considered to be exceptionally unlikely, would there be any discernible effects on groundwater quality due to the Project. Should a significant accidental spill occur, appropriate spill control measures will be put in place by the EPC Contractor/s. Groundwater quality could be affected for a short duration while clean-up is underway.

Thus the magnitude for cumulative impacts on groundwater is predicted to be **Very Low** for both construction and operation.

SURFACE WATER

Construction Phase

In 2016, SEZAD awarded a pair of contracts (worth US\$197M) for the construction of a comprehensive flood protection system, designed to secure the zone's future investments.

The first contract was the 'Water Drainage Channels' Project' for the construction of two drainage channels:

- i. Wadi Jarf (also known as Jurf) Channel – in a valley of approximately 12km length and 340 – 650m wide at the exit point to sea; and
- ii. Wadi Saay (Sai) Channel – a second channel of up to 10km long up to the meeting point with Wadi Jarf Channel. 90 to 320m wide.

These works to divert and manage surfacewaters safely are being progressed by SEZAD as part of the overall development of the Duqm SEZ. The aims of the diversions are to protect the area from future flood events and convey any surface waters safely to sea via excavated channels within the natural terrain of the wadis.

The channels follow the natural wadi watercourses and collect secondary channels. Stretches of wadi have, and are being, protected further with gabion boxes and levees reinforced through of the existing Jurf and Saay channels have a combined outlet to sea at the approximate location of the current wadi deltas. As a result, the risk of flooding from the wadis has been greatly reduced, rainwaters are collected and released to the marine environment while new coastal areas, outside the wadis, are not affected.

Under a separate contract known as the 'Protection Dams Project, two flood protection dams/reservoirs are being built upstream of the Jurf and Saay wadis to stave off potential flood events that could affect (future) occupants downstream. The Wadi Jurf dam is 1.6km long, 19.4m high and with a storage capacity of 32.8m³. The dam for Wadi Saay is 3.3km long, 16.4m high, and with a storage capacity of 17Mm³. The works are scheduled to be completed in 2019.

The Duqm Refinery project is a beneficiary of the flood protection system and there will be a very limited risk of the presence of any surface waters in the vicinity of the Project. As rainfall in the area is very low (yearly average is around 36mm), it is recognised that with good practice in design and subsequent operations, the likely impact upon surface water quality due to run-off is estimated to be very low.

The DRPIC Projects will have in place control measures in place during construction to prevent pollution from surface water and runoff. As such, the magnitude for cumulative impacts associated with surface water is **Very Low**.

Operation Phase

The low rainfall (above) and good practice in design/operations mean that any negative impacts upon surface water quality due to runoff is estimated to be very low.

Only if major spillages or incidents occurred at Project facilities or along the Crude Pipeline route (considered to be exceptionally unlikely), would there be any discernible effects on surface water quality from the Project. Should this occur, appropriate spill control measures will be actioned by DRPIC. Surface water quality could be compromised for a short duration before clean-up.

As such, operation impacts associated with surface water are predicted to be localised, low occurrence and reversible, therefore any cumulative impact is likely to be of a **Very Low** magnitude.

SOIL

As is the case for Land use, the sites of Project locations are situated on land which is either purpose-built (i.e. prepared) or of low quality to sustain other uses such as grazing or agriculture. Therefore, it is predicted that there will be no cumulative impacts arising from land use and thus 'soil' has been screened out as a topic from further consideration in the CIA.

TOPOGRAPHY/LANDSCAPE

Low to medium landscape and visual impacts are anticipated during the construction and operation of the Duqm Refinery Project components in isolation. However the Duqm SEZ has been formally designated for industrial development as a whole and thus the Project has been allocated plots. As further facilities, features and commerce develop incrementally within the Duqm SEZ, the landscape will become increasingly developed.

As stated in the landscape and visual appraisal of the Project in the Consolidated Impact and Mitigation Report, moderate negative impacts were identified during construction at the AF Ras Markaz Crude Oil Storage Terminal for the landscape types 'LCA2 – Low lying alluvium plains' and 'LCA5 – Limestone/Dolomite coastal cliffs' and also at the Duqm Refinery site for LCA2. Moderate negative impacts were also predicted during the operation phase at Duqm Refinery (landscape and visual (the latter for high sensitivity receptors, of which there are relatively few), the topside development of the Duqm Export Terminal (landscape and visual) and at the Export Terminal including marine works (visual, high sensitivity receptors). The wide range of third party development at parts of the Duqm SEZ will continue to detract from the two landscape types (LCA2 and 5) and, in-combination, characterise what will be a developing (i.e. as it is being constructed), developed and industrial area. Most of the development will be set back from the coastal cliffs and construction will not be permanent, although it will be long-term.

In terms of the region, industrial and commercial development will be concentrated in the Duqm SEZ rather than zones and plots of land being developed along the west coast of the Al Wusta region in a more haphazard manner, therefore avoiding a large (geographical) scale impact.

6.2.3 Biodiversity

The cumulative impacts that have been assessed for the Biodiversity VECs identified in **Appendix A-1** (and refined) are:

- Marine habitats, flora and fauna; and
- Terrestrial habitats, flora and fauna.

A-3 has VEC descriptions provided in the ZOI justifications. Appendices D-1 and D-2 present a construction and operation phase cumulative impact assessment for all the identified biodiversity VECs.

Fishing and fishermen are included under the Socio-economics subheading below. They are also mentioned in Appendix C-1 under Socio-economics and Appendix C-2 in Marine ecology.

MARINE HABITATS, FLORA AND FAUNA

Appendices D-1 and D-2 state the magnitude of the potential construction and operation phase cumulative impacts for the marine VECs.

TERRESTRIAL HABITATS, FLORA AND FAUNA

Appendix D-1 and D-2 state the magnitude of the potential construction and operation phase cumulative impacts for the terrestrial VECs.

6.2.4 Socio-economics

The cumulative impacts, as have been assessed for the socio-economic VECs identified in **Appendix A-1** (and refined), are:

- Resident population/community health;
- Community safety and security;
- Livelihood activities involving ecosystem services, e.g., fishing (Note: all interviewed fishermen gave answers (see Section 5.2 of the Socio-economic and Health Baseline Report) that stated the size of their catch is steadily diminishing and hence fishing might not be providing sustainable income even without the Project);
- Road traffic/transport;
- Influx of workers – potential integration and cultural assimilation issues³;
- Local business/economy (includes competition for jobs possibly causing pressure on wages, increase in diversity for skills and tax contributions); and
- Local infrastructure.

The socio-economic and social impacts considered in this CIA report are mainly associated with impacts on local communities, jobs, community health, as well as local infrastructure and traffic during the construction and operational phases.

Construction Phase

The presence of approximately 20,000 migrant workers during the three and a half years of the DRPIC construction phase is one of the most important socio-economic impacts, which could include a potential increase of prices for basic commodities and services, potential impacts on local communities and also their health, safety and security, as well as local infrastructure and services.

³ Based on discussions with SEZAD during the field surveys, SEZAD is aware about potential impacts that could be caused by influx of a significant number of migrant workers into the area and will engage with developers requesting them to optimise the number of migrant workers where possible, and shift the workers between the sites, thus managing the numbers of workers present in any one place.

Based on discussion with SEZAD, it is estimated that the overall amount of migrant workers shared between all developments in the SEZAD area for the next five years will not exceed 22,000 people, including the number of workers required for the development of the DRPIC facilities. However, this is only an estimate, as the information on other development projects that are currently being planned by SEZAD is subject to change (based on the success of their negotiations with willing investors) and the socio-economic/social content of the EIAs for the AFs are limited to basic facts around demographics (e.g. increasing population) and Census data.

Tourism services in the area currently consist of the two elements:

- (i) Accommodation/hotels and other related services (food services, catering, etc) which bring the main share of the overall earnings in the tourism sector in the project area; and
- (ii) Activities involving sub-aqua diving/snorkelling and sightseeing – which often involves private arrangements between individuals (diving) or a by-product of the accommodation product (sea-view from a hotel room or an excursion to the wider project area by a car) and do not constitute to a significant input into the local tourism earnings.

These two elements are likely to be affected differently by the SEZAD area development. The accommodation and other related services are likely to thrive and experience increased earnings (positive impact), further boosted by the parallel development on the wider SEZAD territory. This positive impact will continue throughout into the operations phase of the Duqm Refinery Project. At the same time, although the diving and general tourism activities will not disappear because of the Project or wider development, the territory that is currently available to use for such activities could be reduced and very likely to be confined to the territories managed by the local hotels (minor negative impact on diving and sightseeing).

The socio-economic and health-related work prepared for the baseline (DRPIC Report No. 05-C-Base/Soc) and Consolidated Impact Assessment and Mitigation Report (DRPIC Report No. *12*/CESIA/Tech) investigated these topics further. Information on future planned investment projects is not readily available.

As part of mitigation measures, DRPIC has developed an Environmental and Social Management System, which includes a number of management plans relating to socio-economics and social aspects to be implemented by the appointed EPC Contractors. Provisions in these will help to reduce the impact of migrant workers upon the local community and infrastructure, look after their health and security. These management plans include:

- Workers Influx Management Plan;
- Community HSE Management Plan;
- Stakeholder Engagement Plan, and
- Grievance Procedure.

In addition, DRPIC will coordinate with SEZAD on all Project-related labour and community issues, which will help contribute to early identification of potential issues before they arise and assist with prompt response and optimisation of the above socio-economic/social management plans.

Assuming the above management plans and close coordination with SEZAD will be implemented, it is anticipated that cumulative (negative) impact from approximately 20,000 workers presence in the Project area will be minimised and managed and that their influx will support the wider strategic development goals of the Government to stimulate significant economic development in the region.

As the construction phase will last for three and a half years, the impacts will be temporary, but also potentially positive in terms of the economic benefits that local employment and spending in the economy will bring. On the other hand, the potential strain on existing infrastructure, increased traffic, safety and security risks and the potential for the spread of communicable diseases will still be potentially negative. In turn, SEZAD and DRPIC – for the Duqm SEZ and Duqm Refinery Project,

respectively) are investing (e.g. infrastructure, facilities) to make provision for this influx. Any additional influx of workers for third party development is likely to be staggered and has the potential to increase the pressures and problems mentioned above. The development and provision of public facilities – including entertainment (e.g. retail, leisure) needs to keep pace with such in-migration, which is likely to be in single-digit thousands over the next few years.

As for potential increase of basic commodities' and services' prices, this aspect will be somewhat mitigated by increased wages both for local workers and migrant workers, and by a new flow of investments, which will improve the quality of basic services. As a result, it is expected that the potential increase in prices will be counterbalanced by improved services and increased wages in the area.

The influx of workers is considered to have a medium severity due to the significant volume of migrant workers relative to the current population of Duqm (estimated to be around 11,000). Therefore, for the construction phase, the employment and local economy impacts are predicted to be of **Medium** (positive) magnitude and potential strain on local infrastructure, traffic, safety and security and potential communicable diseases spread are predicted to be of **Medium** (negative) magnitude – until the injection of new investment to improve the services, when this strain on the existing infrastructure will mostly be neutralised or turn to positive.

Operation Phase

The assessment of impacts on local employment and economy, as well as community health and local infrastructure during the operational phase has predicted that most impacts will be negligible, with the exception of Community Health and potential price inflation for basic commodities and services which would be Minor negative (without any mitigation).. However, the majority of workers engaged on the DRPIC project will leave the area after the construction phase. With regards to health, SEZAD is now finalising their preparations to open a new private clinic which to some extent will absorb the demand for healthcare at least among those who will be able to afford private medical fees. It is also assumed that SEZAD is currently looking for other investors in expanding healthcare facilities and other infrastructure in the wider Duqm area.

Despite the majority of workers leaving the project area after construction is completed, DRPIC's operation phase will continue to provide a **Medium** (positive) magnitude on local employment and economy. This includes the aims – embodied in the [DRPIC Corporate Social Responsibility](#) and In Country Value Programmes (e.g. 'education and training' – for instance in raising awareness and encouraging a profession in engineering, carried out at local and regional schools – is one of the pillars) – to attract local people into employment. The newly developed facilities will continue to play a significant and strategically-important economic role in the SEZAD area and the Al Wusta region.

Little information is available for the third party projects but it is assumed that, based on the standards that are evidently being adopted by Omani authorities, that all these projects will be required to meet Oman's planning, environmental and social legislation. Another important mitigating factor to consider is that SEZAD has finished planning significant parts of the development area, particularly that which is closer to the coastline – and there is physically little space available after the large developments (such as Duqm Refinery and the Port of Duqm) are completed. This means that when all these significant projects are completed, the cumulative impacts of third party development will reduce. Therefore, the cumulative impact on local security, traffic and infrastructure is predicted to be of a **Negligible** magnitude for the operational phase. However, due to a preserving risk from the spread of communicable diseases, the impact on community health is considered to remain at a **Medium** (negative) magnitude.

6.2.5 Community and Health

The cumulative impacts that have been assessed for the Community and Health VECs identified in **Appendix A-1** (and refined) are:

- Air Quality – Community;
- Noise – Community;
- Access – Community;
- Traffic – Community; and
- Visual Amenity.

AIR QUALITY - COMMUNITY

IFC guidance (IFC, 2007) requires projects with significant sources of air emissions, and the potential for significant impacts to ambient air quality, should prevent or minimize impacts by ensuring that:

- Emissions do not result in pollutant concentrations that reach or exceed relevant ambient quality guidelines and standards by applying national legislated standards, or in their absence, the current WHO Air Quality Guidelines
- Emissions do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards. As a general rule, this Guideline suggests 25 percent of the applicable air quality standards to allow additional, future sustainable development in the same airshed.

This project has assessed air quality impacts using the Omani Air Quality Standards, and in their absence the WHO Air Quality Guidelines.

Air Quality regulations in Oman were stated in Ministerial Decision No. 118/04 on the Control of Air Pollution from Stationary Sources until April 2017, when MD 41/2017 Regulations on Ambient Air Quality and redefined threshold limits and stated average periods of measuring pollutants. These are shown in Table 6-3 below:

Table 6-3: Air Quality Thresholds in Oman

POLLUTANT	NEW OMANI AIR QUALITY STANDARD (MD 41/2017)	AVERAGE PERIOD FOR MEASURING THE POLLUTANT	PREVIOUS OMANI AIR QUALITY STANDARD (MD118/04)	AVERAGE PERIOD FOR MEASURING THE POLLUTANT
	$\mu\text{g}/\text{m}^3$		$\mu\text{g}/\text{m}^3$	
Sulfur Dioxide SO ₂	350	1 hour		
	150	24 hours	125	24 hours
Hydrogen Sulfide H ₂ S	30	1 hour		
			40	24 hours
Nitrogen dioxide NO ₂	250	1 hour		
	130	24 hours	112	24 hours
Ozone (O ₃)	120	8 hours	120	8 hours
Particulate matter PM ₁₀	150	24 hours	125	24 hours
PM _{2.5}	65	24 hours		
Carbon Monoxide (CO)	30,000	1 hour		
	10,000	8 hours	6,000	8 hours
Non-methane Hydrocarbons (NMHC)	160	3 hours	160	3 hours
Lead (Pb)	1.5	3 months		3 months
Ammonia (NH ₃)	200	24 hours		

The new threshold for PM_{2.5} is higher compared to IFC/WHO standards, the latter of which is not to exceed 25 $\mu\text{g}/\text{m}^3$ over an annual period.

From the baseline air quality survey (May 20017 to August 2017), concentrations of Ozone, PM₁₀ and PM_{2.5} within the study area were observed to be elevated, and at times in exceedance of the provisional Omani and WHO/IFC ambient air standards (DRPIC Report No. 02-C-Base/AQ) . All other monitored pollutant concentrations were considered to be very low, and well below both the provisional Omani and WHO/IFC ambient air standards.

6.2.6 Air Quality Cumulative Impacts

The process of CIA seeks to determine whether the proposed facility will contribute to cumulative impacts on air quality impacts. A ZOI for each air quality impact was assigned around the Project Components in order to identify the spatial boundary within which other projects and their potential cumulative impacts will be considered. Specific ZOIs are not stated in the guidance; therefore justification has been provided over the assigned ZOIs and are presented below:

- A 5km ZOI has been used for air quality impacts around the Duqm Refinery and the project component sites. Operational activities will release critical pollutants (NO_x, CO, SO₂, and PM₁₀ and VOC from a multitude of on-site sources that will potentially deteriorate local ambient air quality and odour conditions within a 5km radius.
- A 1km ZOI has been used for the air quality and odour impacts from the Crude Pipeline construction works. This boundary has been defined based on the construction dust and related localised exhaust emissions. Furthermore, potential future leaks during Pipeline operation could result in negatively influencing local air quality and odour conditions.

A 500m ZOI has been assigned to the effects on air quality from road traffic. Within this area, it is envisaged that the enhanced traffic exhaust emissions may have direct impacts up to 200m, but indirectly effect VEC receptors up to 500m, such as deposition on ecological receptors. Emissions

from additional activities associated with other developments and industries in the area surrounding the Refinery are likely to result in emissions of pollutants thereby degrading local air quality. Through the available documentation, various online resources and discussions with relevant authorities and team members, a long list of third party developments within the study area was identified and where information not available, considered at a high level in this assessment.

The relative locations of the AFs and third party projects were compared to the ZOIs developed. This enabled the identification of developments that spatially overlap with the various ZOIs for the VECs, potentially resulting in additive or synergistic cumulative impacts. If no spatial overlap was recognised, then the third party project was screened out and not considered.

The absence of information available on third party projects has not allowed the assessment to quantify their influence on cumulative impact, however some qualitative assessment is made where relevant.

Construction Phase

Air quality effects arising as a result of impacts from the AFs outlined in Appendix B-2 of this report are highly likely during the construction phase of the project. This is in part due to site/plot and infrastructure preparation (e.g. new roads, SEZAD) activities in and around the Industrial Zone of the Duqm SEZ but more importantly the dusty and dry nature of the locality, increasing the potential for windblown dust from construction and further elevation of particulate matter concentrations locally. Other cumulative effects, due to emissions of NO₂, SO₂ and NMHCs from construction traffic and on-site plant, have been assessed as resulting in a minor risk of adverse impacts upon sensitive receptors, as the baseline concentration of these pollutants is currently very low, and their standards are unlikely to be affected by any cumulative emissions. Construction effects from the Raz Markaz Crude Oil Park were scoped out of the cumulative assessment due to the large distance between that facility and the sensitive receptors.

Air quality has been assessed within a number of the EIAs previously reported (**Appendix B-1**). Where air quality was assessed, there was a limited amount of information on emission sources and/or the contributions from each project to ambient air concentrations was inconsistent between each of the reports, but often lacking. The individual contributions to air from construction phase from each of the components within the contributing projects are outlined below (Table 6-4).

Phasing details of each project with respect to the construction of the Duqm Refinery and associated projects are not fixed at this stage. However the phasing of the Duqm Refinery construction camp is presumed to occur prior to the either construction and operational phase of the Duqm Refinery and AFs.

Several emission components have been predicted to occur at several projects co-incidently, resulting in a large aggregate emissions across the area of Duqm. In particular, emissions of PM, NO_x and VOCs have been predicted to occur from several components, at multiple projects sites across both the construction and operational phases.

Table 6-4 Cumulative emissions to air during construction from other projects in the Duqm Area

EMISSION SOURCE	AIR POLLUANTS	CONTRIBUTION PROJECTS	CO-INCIDENCE WITH DUQM REFINERY EMISSIONS
Construction Machinery	NO _x , SO ₂ , PMs, VOCs, CO ₂	• DUQM Construction Camp	No
		• Duqm DIPWP	Yes
		• Export Terminal	Yes
		• Crude Pipeline	Yes
		• Wadi development	Yes
		• Roads Development	Yes
		• OGC Gas Spur line Execution	Yes
Diesel Generators	NO _x , SO ₂ , PMs, VOCs, CO ₂	• DUQM Construction Camp	No
		• Duqm DIPWP	Yes
		• Duqm Liquid Bulk Berth Project	Yes
		• Wadi development	Yes
		• Roads Development	Yes
Transport vehicles	NO _x , SO ₂ , PMs, VOCs, CO ₂	• OGC Gas Spur line Execution	Yes
		• DUQM Construction Camp	No
		• Duqm DIPWP	Yes
		• Wadi development	Yes
Fugitive Emissions from Fuel Storage Tanks	VOCs	• Roads Development	Yes
		• OGC Gas Spur line Execution	Yes
		• DUQM Construction Camp	No
Traffic on Graded Roads & earth works	Dust	• Duqm DIPWP	Yes
		• Duqm Liquid Bulk Berth Project	Yes
		• DUQM Construction Camp	No
		• DUQM Construction Camp	No
Construction Materials & aggregate storage	Dust	• Wadi development	Yes
		• Roads Development	Yes
		• OGC Gas Spur line Execution	Yes
		• Duqm DIPWP	Yes
		• DUQM Construction Camp	No
Marine Vessels and Barges	NO _x , SO ₂ , PMs, VOCs, CO ₂	• Duqm DIPWP	Yes
		• Duqm Liquid Bulk Berth Project	Yes

In order to reduce the risk of adverse PM₁₀ and PM_{2.5} impacts at sensitive receptors, dust control measures should be incorporated into the environmental and construction plan of the Refinery and AFs. It is recommended that these measures should include control of particulate emissions and dust re-entrainment in areas close to boundaries of the project sites. Provision for the avoidance, minimisation and mitigation (e.g. use of water bowing) are included in the ESMP for use by EPC Contractors. The ESMP includes management measures such as:

- As part of EPC, a resource efficiency assessment shall be undertaken by Contractors to assess resources required during construction activities, potential sources and resource use reduction measures to be undertaken;

- Contractors shall monitor ambient air quality parameters (e.g. Sulphur Dioxide, Oxides of Nitrogen and Particulate Matter) from plant and equipment to ensure compliance with Project Standards; and
- Emissions inventories shall be developed and updated as needed. The discharge of pollutants are to be avoided at all locations in order to protect sensitivities in both the terrestrial and nearby marine environment in and around Duqm.

Where other construction sites may overlap the ZOI of the DRPIC Project components, the ZOI of the Crude Pipeline and the ZOI of traffic routes, amalgamated effects of large-scale construction activities could result in construction associated dust clouds occurring over extended periods. With these dust clouds, elevated PM_{2.5} and PM₁₀ concentrations could also occur.

Elevated particulate concentration impacts identified as associated with cumulative impacts of construction activities are likely to occur at locations in close proximity to site boundaries and key traffic routes. These air quality impacts would be negative, are likely to prevail for the whole construction period and have been predicted to be of **Medium** magnitude for the construction phase.

Operation Phase

From the assessment of air quality impact associated with the Duqm Refinery Project and third party facilities upon sensitive receptors within the study area during the operational phase, air quality standards were predicted to meet both Omani and IFC/WHO limits for all pollutants, with exception to Ozone, PM_{2.5} and PM₁₀ as the baseline for these parameters are at times exceeding the Omani Standards.

Of all the EIAs carried out on AFs, only the EIA for the DIPWP included a quantitative baseline. The ambient air quality monitored at five locations around the DIPWP site and observed that the SO₂, NO₂, O₃, H₂S and VOC parameters to be within Omani thresholds but displayed PM₁₀ and PM_{2.5} to exceed the permissible limit at one monitoring site. For the operation of DIPWP, all predicted incremental concentrations of air pollutants during in either operating scenario, i.e., the normal natural gas operations and backup fuel oil operation, do not contribute in significant quantities that could result in any non-compliant situation. The incremental contributions to air pollutant concentrations from the DIPWP are well below the permissible allowable standards of pollutants (Table 6-5) for all pollutants apart from PM (assumed to be PM₁₀). Contributions of air pollutants from the DIPWP operational phase were assessed as resulting in an increase in concentrations of air pollutants representative of a percentage increase in the air quality standards, resulting in concentrations still well below the air quality standards. Though the existing airshed was recognised as degraded with respect to PM's, the contribution of DIPWP to local PM₁₀ and PM_{2.5} concentrations was assessed as only a fraction of a percentage of the Omani Air Quality Standards. Contributions of DIPWP during operation to PM₁₀ and PM_{2.5} local concentrations would be at levels so low as to be considered as inconsequential.

It should be noted that the higher 24 hour average concentration of particulate matter is due to the wind directional shift carrying high suspended particulates in ambient air.

Table 6-5: Cumulative Maximum of Pollutants – DIPWP Operation

REF. NO.	POLLUTANT	AVERAGING PERIOD	DIPWP MAX. ($\mu\text{G}/\text{M}^3$)	BASELINE ($\mu\text{G}/\text{M}^3$) (FROM DIPWP EIA)	CUMULATIVE* ($\mu\text{G}/\text{M}^3$)	OMANI AMBIENT AIR STANDARD 2017 ($\mu\text{G}/\text{M}^3$)
During normal operations (Natural gas)						
1	NO ₂	24 hour	13.1	8.3	21.4	130
2	CO	8 hour	20.93	901 (Max.)	922	10,000
During backup fuel operations (Diesel oil)						
1	NO ₂	24 hour	28.6	8.3	36.9	130
2	PM	24 hour	21.73	506	527.7	150
3	SO ₂	24 hour	7.6	9.4	17.0	150
4	CO	8 hour	262	901(Max.)	926	10,000

* DIPWP baseline and DIPWP contribution.

The other EIAs for AFs predicted that there would be no significant releases of polluting air emissions in their operational phase, or that it was not possible to estimate or quantify them.

Table 6-6 summarises the cumulative impact from addition of pollutant emissions to air from both the Duqm Refinery Project and the DIPWP during their operational phase with the maximum baseline concentrations from the project baseline air quality survey.

Table 6-6: Cumulative Maximum Concentration of Pollutants – Duqm Refinery Project , Baseline and DIPWP Operation

POLLUTANT	Max BASELINE CONCENTRATION ($\mu\text{G}/\text{M}^3$) (REFINERY PROJECT EIA)	REFINERY PROJECT Max CONTRIBUTION TO POLLUTANT CONCENTRATIONS ($\mu\text{G}/\text{M}^3$)	DIPWP Max CONTRIBUTION TO POLLUTANT CONCENTRATIONS ($\mu\text{G}/\text{M}^3$)	Max CUMULATIVE CONTRIBUTION TO POLLUTANT CONCENTRATIONS* ($\mu\text{G}/\text{M}^3$)	OMANI AMBIENT AIR STANDARD (2017) ($\mu\text{G}/\text{M}^3$)
NO ₂ (24 hr)	10.29	8.55	28.6	47.4	130
PM ₁₀ (24hr)	488.9	0.30	21.73	510.9	150
SO ₂ (24hr)	15.9	0.57	7.6	24.1	150
CO (8hr)	880	4.41	262	884.5	10,000

* Refinery baseline, Refinery contribution and DIPWP contribution.

The cumulative impact of the maximum predicted DIPWP operational emissions to air with Duqm refinery maximum operational emissions to air and baseline concentrations does not appear at risk of resulting in an exceedance of the Omani air quality standards for NO₂, SO₂ or CO. However due to the elevated baseline concentration of PM₁₀ and PM_{2.5} (as well as O₃ which is not directly

emitted from DIPWP) in the study area, maximum PM₁₀ and PM_{2.5} concentrations were predicted to exceed the Omani air quality standards.

However, adverse air quality effects arising as a result of impacts from the other third party projects (outlined in Appendix B-1) are highly likely during the operational phase of the Project. This is in part due to the scale of activities in and around the Industrial Zone of the Duqm SEZ and, once again, the dusty and dry nature of the locality, increasing the potential for windblown dust from vehicular movements and further elevation of particulate matter concentrations locally. Other cumulative effects have been identified as emissions of NO₂ directly emitted from operational traffic. In addition emissions of SO₂ and NMHCs from on-site plant. All of the above have been assessed as resulting in a minor risk of adverse impacts upon sensitive receptors, as the baseline concentration of these pollutants is currently very low, and their standards are unlikely to be affected by any cumulative emissions.

Several emission components have been predicted to occur at several projects co-incidently, resulting in aggregate emission across the area of Duqm. In particular emission of PM, NO_x and VOCs have been predicted to occur from several components, at multiple projects sites during the operational phase of Duqm refinery (Table 6-7).

Table 6-7 Cumulative emissions to air during operation from other projects in the Duqm Area*

SOURCE	AIR POLLUTANTS	CONTRIBUTING PROJECTS	CO-INCIDENCE WITH DUQM REFINERY EMISSIONS
Machinery	NO _x , SO ₂ , CO, PMs, VOCs	<ul style="list-style-type: none"> Duqm DIPWP 	Yes
Diesel Generators	NO _x , SO ₂ , CO, PMs, VOCs	<ul style="list-style-type: none"> DUQM Construction Camp 	No
		<ul style="list-style-type: none"> Duqm DIPWP Duqm Liquid Bulk Berth Project – construction only 	Yes
Transport vehicles	NO _x , SO ₂ , CO, PMs, VOCs	<ul style="list-style-type: none"> DUQM Construction Camp 	No
		<ul style="list-style-type: none"> Duqm DIPWP Duqm Liquid Bulk Berth Project – construction only 	Yes
Fuel Storage Tanks	VOCs	<ul style="list-style-type: none"> DUQM Construction Camp 	No
		<ul style="list-style-type: none"> Duqm DIPWP Duqm Liquid Bulk Berth Project – construction only 	Yes
Traffic on Graded Roads & earth works	Dust	<ul style="list-style-type: none"> DUQM Construction Camp Operation 	No
Movement and storage of construction materials, aggregate or pet coke	Dust	<ul style="list-style-type: none"> DUQM Construction Camp Operation Duqm Liquid Bulk Berth Project – construction only 	No
Marine vessels, barges and tug boats (construction only)	NO _x , SO ₂ , CO, PMs, VOCs	<ul style="list-style-type: none"> Duqm Liquid Bulk Berth Project – construction only 	No

* Raz Markaz Crude Oil Park construction effects scoped out due to the large distance between that facility and the sensitive receptors

During the operational phase, cumulative emissions of NO_x, SO₂ and VOCs may increase, though emissions of PM are likely to significantly reduce in magnitude at all projects sites, from their concentrations during the construction phase.

Therefore, the potential for cumulative impacts from pollutant emissions to air from the Duqm Refinery Project together with the AFs has been considered and with exception to Ozone, PM_{2.5} and PM₁₀, cumulative impacts associated with the AFs are considered to be negligible. These latter parameters are predominantly from natural sources and are typical of results from air quality studies across the Arabian Gulf (e.g. Abu Dhabi, Dubai). Traffic movements during the operational phase of the Refinery and off-site facilities would result in an increase in vehicle emissions. However, predicted concentrations of Nitrogen Dioxide at sensitive receptor locations as a result of the Duqm Refinery and off-site facilities within the study area are very low, and the risk of the Omani and

where applicable IFC/WHO air quality standard being exceeded as a result of cumulative traffic emissions is low for Nitrogen Dioxide, though high for PM_{2.5} and PM₁₀.

Furthermore, even though the contribution of air pollution from the DIPWP has been assessed as low, the Project and other AFs identified (Table 2-1) and third party non-AFs will contribute by way of creeping (i.e. incremental cumulative increases) pollutant concentrations in the area as parts of the Duqm SEZ are completed and become operational. This can lead to longer-term air quality impacts, which SEZAD will need to monitor over time. Therefore, the overall impact from cumulative impacts upon air quality is predicted to be of a **Low** magnitude for the operational phase.

Future Cumulative Baseline

Emissions to air arising from construction activities and operations at other project sites within the Duqm area are likely to have a detrimental impact upon the future air quality baseline. The magnitude of pollutant emissions from these projects has not been quantified due to the lack of information presented within the available EIAs.

The generation and emission of dust during the construction phase of other projects within the Duqm area, is a certainty, and due to the character of the soils and landscape surrounding Duqm, cumulative emissions of dust during the early construction phases of each of the projects are likely to be high. Therefore baseline dust concentrations used within the assessment of construction dust for the Duqm Refinery were assumed to be high. However, dust has a 'drop-out' rate sufficient to effectively remove it from ambient air within 200m of its source (Holman et al., 2014). As the allocated areas for residential development are at a considerable distance (greater than 5km) of the construction sites, exposure of sensitive receptors to dust associated with construction will be remote.

The generation and emission of both NO₂ and SO₂ during the construction phase of other projects within the Duqm area, has been identified, though specific NO₂ and SO₂ emission data was not available for all of the assessed project assessments. Emissions of NO₂ are likely to increase, and possibly SO₂, across the study area as industrial development increases within of the Duqm SEZ and its associated increase in residential population. However, due to the low density of industrial development, distances between other known projects and the Duqm Refinery Project sites, there is a significant opportunity for both NO₂ and SO₂ emissions to disperse. In addition, areas in Duqm allocated for residential development are removed from the principal industrial zones, therefore exposure of sensitive receptors to pollutants associated with industrial emissions will be limited. Therefore, project contributions of NO₂ and SO₂ to the future baseline have been assumed to be negligible for both the construction and operation phases of other projects within the Duqm area.

NOISE – COMMUNITY

Construction Phase

Noise in Oman is governed by two regulations, MD 79/94 and MD 80/94. MD 79/94 provides noise limits from industrial noise and traffic noise for which the criteria for the boundary of an industrial site is no greater than 70dBA. MD 80/94 provides noise limits for workers exposed to noise and stipulates that where noise levels are 85dB and higher, workers must be provided with adequate hearing protection.

There is minimal information available for the third party projects mentioned in Appendix B-2, but it is assumed that, based on the EIA information available, the boundary noise level will be maintained at less than 70dBA, and workers are provided with adequate hearing protection where there is exposure to noise levels of 85dBA and higher. Also every effort should be made to reduce noise levels to below 85dBA and locate noisy equipment away from the site boundary.

Assuming the above is implemented in these projects, it is anticipated that there would be no cumulative impact for workers within the sites as they will already be exposed to machines generating high noise levels. Therefore, contributions from other distant sites will have no significant effect on overall noise exposure. However, it has been identified that on-site activities could lead to exposure of maximum levels exceeding 110 dB L_{AFmax} .

Article 2 of MD 79/94 does not refer to noise from temporary construction activities; it is therefore assumed the limits do not apply to such sources, and the IFC Guidelines are instead applicable. For the DRPIC projects, noise levels at identified high sensitivity receptors are expected to be below the IFC Guideline day and night-time noise limits during all peak activity periods. However, in areas where projects have an overlapping ZOI, the combined effect of multiple boundary noise levels at 70dB can be enhanced through the cumulative action of onsite and long range audible activities such as rock drilling, breaking, crushing, foundation piling and blasting activities.

Even when considering the worst case scenario, the construction noise impacts identified would only act locally and in the short-term. However, the construction noise impacts would still be negative and are considered to have a low to medium severity. Therefore, the impact from ambient noise is predicted to be of **Low** magnitude for the construction phase.

Operation Phase

The assessment of operational noise levels from the Refinery and off-site facilities at identified receptors are predicted to meet the industrial noise limits set out in MD 79/94 for all periods. Further consideration has been given to the ability of the Refinery and off-site facilities noise impacts to act cumulatively with the AFs. All of the cumulative impacts associated with the AFs are considered to be negligible, which is detailed below.

An increase in road traffic as a result of the solids export route operational phase is anticipated. Existing local receptors may be affected by noise from the increased traffic flows. When considering the export routes cumulative influence, the following assumptions have been made in the noise level predictions:

- Worst-case: all 19 anticipated export lorries move within a single day / evening / night period (in practice it's likely to be spread out); and
- Lorries travelling at approx. average 60 kph.

The cumulative influence of the solids export route is deemed to be insignificant, except for receptors at the north end of Saay village, as displayed in Table 6-8.

Table 6-8: Noise Predictions for the Solids Export Link Route

RECEPTOR ID	RECEPTOR LOCATION	LIMIT CRITERIA, dB L _{Aeq,T} DAY / EVE / NIGHT & HOLIDAYS	PREDICTED SOLIDS EXPORT ROUTE NOISE LEVEL, dB L _{Aeq,T} DAY / EVE / NIGHT & HOLIDAYS	IMPACT SEVERITY
R01	Saay village - north	55 / 50 / 45	33 / 38 / 35	Negligible
R02	Saay village - south	55 / 50 / 45	21 / 26 / 23	Negligible
R03	Saay village - west	55 / 50 / 45	25 / 30 / 27	Negligible
R04	Nafun village - west	45 / 40 / 35	14 / 19 / 16	Negligible
R05	Nafun village - east	45 / 40 / 35	15 / 20 / 17	Negligible
R06	Frontier town	55 / 50 / 45	17 / 22 / 19	Negligible
R07	Frontier town - hotels	55 / 50 / 45	11 / 16 / 13	Negligible
R08	Renaissance workcamp	55 / 50 / 45	25 / 29 / 26	Negligible
R09	150 Villas	55 / 50 / 45	18 / 23 / 20	Negligible
R10	Shuwayr village	45 / 40 / 35	9 / 14 / 11	Negligible
R11	Proposed residential area	55 / 50 / 45	20 / 25 / 22	Negligible
R12	Royal Oman Police	55 / 50 / 45	17 / 21 / 18	Negligible
R13	Dhahr village - northwest	45 / 40 / 35	0 / 5 / 2	Negligible
R14	Dhahr village - northeast	45 / 40 / 35	1 / 5 / 2	Negligible
R15	Dhahr village - east	45 / 40 / 35	1 / 6 / 3	Negligible
R16	Dhahr village - south	45 / 40 / 35	< 0 / 4 / 1	Negligible

For the receptors at the north end of Saay village, the combined predicted noise levels of the solids export route and Project components or other AFs would still be below IFC and Omani limits and would therefore present a negligible impact.

Within their respective EIAs, the Ras Markaz Import Terminal and Export Terminal suggests the noise level at the project line will be 70 dB. These values have already been considered as radiating sources within the noise modelling parameters. Therefore, calculations and noise level predictions already incorporate the cumulative impact from the Ras Markaz Crude Oil Park and Export Terminal area. As displayed in the Consolidated Impact and Mitigation Report (DRPIC Report No.: 70029220-*12*/CESIA/Tech), these levels are shown to be below IFC/Omani limits and thus considered to have a negligible impact.

Similarly, the DIPWP ESIA states that an 85 dB on-site limit will be upheld. If this level is maintained, the cumulative impact will be negligible at the Saay and Nafun village (closest receptors).

The AF pipeline developments (Natural gas spur line and Export pipeline corridor) are anticipated to generate no significant noise levels, other than periodic maintenance works. This is considered to be negligible.

Therefore, the AFs are expected to result in no significant cumulative impact.

Little information is available for the third party projects but it is assumed that, based on experience, all new projects will be required to meet the Omani limits. These are generally more stringent than the IFC guidelines and it may be reasonable to assume these will be achieved. Another important mitigating factor to consider is that with more third party development, there will be more physical obstacles between the refinery components and sensitive areas. Such a scenario is not accounted for within the noise modelling as such features do not yet exist, so the noise levels reaching receptors from the Project components are likely to be lower than originally estimated.

In consideration of the baseline noise environment, the predicted levels are expected to be imperceptible at all locations with the exception of the area around the north of Saay Village and the Renaissance Workcamp. At all receptors the predicted levels are below the applicable guideline criteria, and the impact severity is therefore considered very low. Therefore, the impact from ambient noise is predicted to be of a **Negligible** magnitude for the operational phase.

VISUAL AMENITY

See Physical Environment (Landscape) section above for the considered visual amenity magnitude.

6.2.7 Cultural Heritage

The cumulative impacts that have been assessed for the Cultural Heritage VECs identified in **Appendix A-1** (and refined) are:

- Archaeological sites; and
- Cultural

ARCHAEOLOGICAL SITES

Construction Phase

There are several projects within the area of SEZAD which are in various stages of their lifecycle and within 20km of the Duqm Refinery. Studies in the region show that the character of the archaeological remains within the vicinity can be divided into up-standing visible remains, surface remains and graves. Cumulative impacts (e.g. damage) to archaeological remains during the construction phase are most likely during intrusive temporary works such as the construction of haul roads and compounds or permanent works such as underground pipes and foundations. In addition, the setting of up-standing remains may be affected during the construction phase although this is considered to be of low magnitude. In order to protect the heritage assets, included all those on the updated Gazetteer (as a result of the baseline survey carried out in the Consolidated ESIA), appropriate mitigation strategies shall be put in place by DRPIC during all construction works within the area once full details of temporary and permanent construction are available. Measures to implement these are integrated into the ESMP. Some examples of mitigation measures that are reflected in DRPIC's ESMP for Cultural Heritage are shown below and it is expected that SEZAD will adopt similar, if not the same measures. The following generic recommendations should be adhered to:

- Clear marking of all listed significant cultural heritage assets in the area of works (including temporary) with marked with bunting/flags and inclusion of an adequate (i.e. 40m) buffer zone;
- Cultural heritage assets should be avoided, by design, either during the construction or operational phase of the development;
- 'Safe routes' for vehicles to be included in the Contractors' ESMP;
- Consultation on any foreseeable and unavoidable impact on a cultural heritage asset to be held with the Ministry of Heritage and Culture (MHC) and SEZAD;
- All necessary archaeological works to be carried out by a suitably qualified archaeologist in consultation with the MHC and SEZAD.

The mitigation ranking system in the updated Gazetteer produced by Five Oceans also made recommendations, for instance, Mitigation Rank #3 – measures for any graves impacted should be conducted in agreement with Ministry of Heritage and Culture, in accordance with Omani legislation and by a qualified archaeologist. Lithic scatters (Rank #2 items), on the other hand, should be marked by flags for mitigation, as they are difficult to see; the contractors can then avoid these areas. Such measures should be adapted by SEZAD for third party developments.

All the measures committed to by DRPIC, in combination with assurances from SEZAD that strategic protection of identified (i.e. known) and non-identified (unknown) cultural heritage assets will be part of their ongoing monitoring and management of the entire Duqm SEZ, will go a long way to ensure the Duqm region does not suffer damage of archaeological resources.

The construction phase will see an increase in noise, air pollution and lighting due to a rise in traffic and human presence. If these proposed developments are completed the Duqm SEZ and surrounding area will be in a construction phase for a long period of time. It would be recommended that following the mapping of all heritage assets affected by this Project, a generic mitigation strategy for the entire area – to which third party developments could adhere - is completed by SEZAD. It is understood that SEZAD holds information on GIS and uses this during their assessment of submitted EIA/ESIA reports, so there is a ready made system to allow this update to happen. The aim of this strategy would be to reduce the impacts on heritage assets and possibly enhance some to be incorporated in the development proposal for recreation. Mitigation should aim to reduce impacts on the heritage assets by avoidance this can only be achieved if the full details of the development are understood.

It is thought that the general impacts during the construction phase will be short term and are estimated to be of a moderate severity. Even in the event of the surrounding SEZ undergoing permanent works, it is predicted that the level of impact severity is unlikely to change.

All works should be subjected to a mitigation strategy which would be agreed by the Ministry for Heritage and Culture. Any cumulative impact is anticipated to be of a **Medium** magnitude.

Operation Phase

The operational phase of the considered developments will be long term, increasing human activity in the area and therefore noise, lighting and pollution. Increases in noise and light will alter the setting of up-standing heritage assets and these may also be impacted by increased local activity and public visitation. The Environmental Baseline Cultural Heritage assessment (DRPIC Report No. 06-C-Base/Cul) described how certain sites are regularly visited by local inhabitants and in instances, offerings have been made at heritage assets. This activity could increase causing possible impacts to the asset's surroundings and (if applicable) structural integrity.

In order to limit damage to the heritage assets, a mitigation strategy should also be implemented during the operational phase of these developments. This strategy would highlight opportunities to enhance heritage assets for recreational purposes (recreational tourism) and indicate negative impacts associated with new developments. If significant heritage assets could be incorporated into the masterplan of proposed developments within the area, their value as recreational tourism assets could provide a positive impact.

The impacts during the operational phase will be long term and are likely to be of minor severity. The impacts are likely to be localised and it is therefore considered that these impacts will be of **Low** magnitude.

CULTURAL

The Socio-economic and Health section above provided details and the magnitude of cultural (safety and security) aspects.

DRPIC is putting measures in place to manage the potential clash of cultural values between local communities and migrant workers. These include:

- At Construction Camps – located away from local communities and self-sufficient (e.g. provision of food, recreation/entertainment) to minimise interaction with the community and to be secure; this is the case at the recently established Renaissance Camp which has integrated facilities in modern accommodation buildings;
- Camp rules, protocols and regulations (e.g. zero tolerance of alcohol and drugs) and shared with the nearest residents in a relevant language and media;
- Provision of a Grievance Mechanism for workers;
- Ongoing monitoring (including meetings and discussions with stakeholders such as local authorities and the Governate) of in-migration levels to better understand patterns and trends, so that action can be taken;
- Contractors to have Communications' Plan for effective stakeholder engagement;
- Robust recruitment policy and ongoing management to prioritise employment of those considered local, and formal application procedures to avoid the presence of those to site seeking work on a casual basis;
- During operations, the recruitment and training-up of locals (i.e. Omani nationals) will clearly assist in developing enhanced communications and relationships between the workers from different cultures and between employees and local communities.

When and where possible, DRPIC shall encourage SEZAD – in the context of the wider development – to adopt the same style and types of mitigation for third party projects. The effectiveness of these measures and their management will determine the impacts associated with in-migration experienced in the Duqm area. Despite these measures and recommendations, the potential for breakouts of cultural conflict exists. The impact of such incidences might range from small to significant but the overall is considered to be low to medium.

6.3 STEP 5 - ASSESSMENT OF SIGNIFICANCE OF PREDICTED CUMULATIVE IMPACTS ON VECs

The tasks carried out at this stage were to:

- Identify the significance of the impact for all VECs (including relevant individual receptors); and
- Discuss the thresholds relating to 'significant' or 'insignificant' impacts.

When the magnitude of the effect for each VEC is known (Step 4), the sensitivity of the receptor (identified in Step 3) was considered and along with a determination of the probability of the effect occurring, the significance of the impact assessed.

To enable a transparent and repeatable assessment, we have used the generic criteria for levels of magnitude, sensitivity, and value (identified in the earlier steps) to determine the significance of the impact using a matrix (see Table 6-9). However, given the role of professional judgement in the assessment process, there may be some variation between subject areas in the significance rating process and the matrix in Table 6-10. In addition, the relevance of these criteria to a quantifiable threshold or level of acceptability of change has been clarified where necessary.

Table 6-9: Matrix for Assessing Impact Significance

RECEPTOR SENSITIVITY/VALUE	MAGNITUDE OF EFFECT				
	Very High	High	Medium	Low	Very Low
Very High	Major	Major	Moderate	Minor	Minor

RECEPTOR SENSITIVITY/VALUE	MAGNITUDE OF EFFECT				
	Very High	High	Medium	Low	Very Low
High	Major	Moderate	Minor	Minor	Negligible
Medium	Moderate	Minor	Minor	Negligible	Negligible
Low	Minor	Minor	Negligible	Negligible	Negligible
Very Low	Minor	Negligible	Negligible	Negligible	Negligible

The definition of the significance ratings for the impacts are provided in Table 6-10. These provide both the definition of impacts determined through the matrix approach above or that using professional judgement.

Table 6-10: Generic Description of Significance Ratings

SIGNIFICANCE	DESCRIPTION
Major	Very large or large change in environmental or socio-economic conditions. Effects, both negative and beneficial, which are likely to be important considerations at a national to regional level because they contribute to achieving national / regional objectives, or, which are likely to result in exceedance of statutory objectives and/or breaches of legislation.
Moderate	Intermediate change in environmental or socio-economic conditions. Effects that are likely to be important considerations at a regional and local level.
Minor	Small change in environmental or socio-economic conditions. These effects may be raised as local issues but are unlikely to be of importance in the decision making process.
Negligible	No discernible change in environmental or socio-economic conditions. An effect that is likely to have a negligible or neutral influence, irrespective of other effects.

Where impact significance could not be determined, this has been noted. The assessment of significance has also taken into account the significance determination in the Consolidated ESIA, and has been undertaken on the basis that the updated mitigation measures will be successfully implemented, and similar mitigation measures would be expected to be implemented for the other projects.

6.4 SIGNIFICANCE OF THE CUMULATIVE IMPACTS

The significance of the cumulative impacts is considered below on the basis of the assessment of the magnitude of the effects in **Section 6.2**, and in relation to the sensitivity/value of the likely VECs (as tabulated in **Appendix C**). The collated VEC cumulative impact significance is provided in Table 8-1.

6.4.1 Ecosystem Services/Natural Resources

NATURAL CAPITAL

Cumulative impacts on natural resources are assessed to be Very Low in magnitude during construction and operation. Receptor sensitivity is Low though of High value. Consequently, the

cumulative impact is considered to be of **Negligible** significance during construction and operation of the DRPIC project.

LAND USE

With the sensitivity of receptors judged to be medium, but the potential magnitude to be low to high (see Table 6-6), there is **Minor** negative cumulative impact predicted in relation to land use (see Section 6.2).

6.4.2 Physical Environment

AIR QUALITY

See Community and Health section below for cumulative air quality significance.

GREEN HOUSE GAS EMISSIONS

Cumulative impacts from the Project and its components' contribution of GHG emissions are assessed to be Very Low in magnitude during construction and operation with respect to the global challenge of climate change. Receptor sensitivity is High and of High value. Consequently, the cumulative impact is considered to be of **Negligible** significance during construction and operation. The overall contribution of GHG emissions from the development of the wider Duqm SEZ, once operational, will make a significant contribution to the carbon footprint of Oman and the Government will need to manage its balance of contributors in line with its international treaty and convention commitments.

NOISE

See Community and Health section below for cumulative noise significance.

GROUNDWATER

Cumulative impacts on groundwater are assessed to be Very Low in magnitude during construction and operation. Receptor sensitivity is Medium though of Low value. Consequently, the cumulative impact is considered to be of **Negligible** significance during construction and operation of the DRPIC project.

SOIL

There are no cumulative impacts predicted in relation to land use.

SURFACE WATER

Cumulative effects on surface water are assessed to be Very Low in magnitude during construction and operation. Receptor sensitivity is High though of Medium value. Consequently, the cumulative impact is considered to be of **Negligible** significance during construction and operation of the DRPIC project.

LANDSCAPE & VISUAL

Without mitigation and consistency (e.g. in the location, layout and screening/planting of plots) of mitigation within the Duqm SEZ, moderate negative impacts could occur in respect of the impact of new development adjacent to Project and AF development, notably at the Ras Markaz Crude Oil Tank Farm and Duqm Refinery sites where landscape 'LCA2 – Low lying alluvium plains' and 'LCA5 – Limestone/Dolomite coastal cliffs' are present.

If SEZAD is able to adopt similar measures to DRPIC on landscape and visual intrusion, cumulative impact can be minimised and opportunities taken to enhance the landscape – in what is a long-term and planned industrial /commercial zone.

There are no significant cumulative impacts predicted in relation to landscape.

6.4.3 Biodiversity

MARINE ECOLOGY

Appendix D-1 and D-2 state the significance of the potential construction and operation phase cumulative impacts for the marine VECs.

TERRESTRIAL ECOLOGY

Appendix D-1 and D-2 state the significance of the potential construction and operation phase cumulative impacts for the marine VECs.

6.4.4 Socio-economic

Construction Phase

Cumulative effects on local communities, local employment (including livelihood) and economy (including tourism and other potential economic impacts such as inflation of local commodities/services and wages) and local infrastructure are assessed to be of Medium magnitude during construction. Receptor sensitivity is considered to be High for the construction phase. Consequently, the cumulative impact of the construction phase on the local community, local employment and economy, as well as their health and local infrastructure is considered to be of **Minor** significance (negative). The cumulative impact of the construction phase on local employment and economy is considered to be also of **Minor** significance (positive).

Operation Phase

Cumulative effects on local communities, local employment (including livelihood) and economy (including tourism and other potential economic impacts such as inflation of local commodities/services and wages) and local infrastructure are assessed to be of medium magnitude during operation. Receptor sensitivity is considered to be High for the operation phase. Consequently, the cumulative impact of the operation phase on most social receptors is considered to be **Minor**. However, for the local economy and community health the magnitude was considered to be Medium and the receptor sensitivity High, resulting in **Minor** (positive) and **Minor** (negative) significance, respectively.

6.4.5 Community and Health

AIR QUALITY - COMMUNITY

Construction Phase

Cumulative effects on air quality are assessed to be Medium in magnitude during construction. Receptor sensitivity is considered to be High and the receptor value is considered to be Low. Consequently, the cumulative impact of the construction phase is considered to be of **Minor** significance.

Operation Phase

Cumulative effects on air quality are assessed to be Medium in magnitude during operation. Receptor sensitivity and value are considered to be High and Low respectively. Consequently, the cumulative impact of the operational phase is considered to be of **Minor** significance.

NOISE - COMMUNITY*Construction Phase*

Cumulative effects on noise are assessed to be Low in magnitude during construction. Receptor sensitivity and value are considered to be Medium and Low respectively. Consequently, the cumulative impact of the construction phase is deemed to be of **Negligible** significance.

Operation Phase

There are no cumulative impacts predicted in relation to noise during the operational phase; see section to 6.2 for reference.

VISUAL AMENITY

See Physical Environment section above for the considered visual amenity magnitude.

6.4.6 Cultural Heritage**ARCHAEOLOGICAL SITES***Construction Phase*

Cumulative effects on cultural heritage are assessed to be Medium in magnitude during construction. Receptor sensitivity is considered to be High and of High value. Therefore, the cumulative impact of the construction phase is considered to be of **Minor** significance in the context of successfully implementing the mitigation measures (outlined in Section 6.2.6, DRPIC's ESMP and the Contractors' ESMP and SEZAD adopting the same or a similarly effective approach.

Operation Phase

Cumulative effects on cultural heritage are assessed to be Low in magnitude during construction. Receptor sensitivity is considered to be High and of High value. Therefore, the cumulative impact of the operation phase is considered to be of **Minor** significance.

CULTURAL

See Socio-Economic section above for cumulative cultural significance.

6.5 THRESHOLDS OF SIGNIFICANCE

This section discusses the relevant thresholds of significant or potentially significant impacts on the relevant VEC/Receptor Group, particularly where thresholds may be encroached or where there is uncertainty.

6.5.1 Ecosystem Services/Natural Resources

NATURAL CAPITAL

Whilst any use of natural resources could be considered a threshold of significance, such a threshold is exceeded on a daily basis. The key threshold is whether the consumption of natural resources is exceeded to the point where the region can no longer support the requirements of the project. It is anticipated that this threshold will not be exceeded.

LAND USE

Minor negative cumulative impacts on land use and land ownership are anticipated based on the likely sensitivity of receptors (medium) and magnitude of effect (medium). Therefore, the VEC resilience to change is considered high and is expected to be able to cope with cumulative changes. Moreover, based on discussions with SEZAD, land acquisition will be limited to the currently ongoing resettlement process and no more households will be resettled.

6.5.2 Physical Environment

AIR QUALITY

See Community and Health Section (6.5.5) below for the threshold considered for air quality.

GREEN HOUSE GAS EMISSIONS

The threshold of significance on the atmosphere from GHGs emitted from the developments considered in the CIA is not likely to be exceeded, based on the low contribution compared to national and international GHG emissions emitted every year.

NOISE

The Section 6.5.5 on Community and Health also addresses the thresholds considered for noise.

GROUNDWATER

Any change to groundwater as a result of construction or operational activities could be considered a threshold of significance. Monitoring of the scheme and adoption of best practice principles will ensure any significant threshold is not likely to be exceeded.

SOIL

No cumulative impacts on soil are anticipated. Therefore, the VEC resilience to change is considered high and is expected to be able to cope with cumulative changes.

SURFACE WATER

The capacity of the surface water drainage network is used to determine the threshold of significance of the Duqm Refinery Project cumulatively with other projects which will be constructed more or less at the same time, or when operational. The threshold of significance considered for the surface water is not likely to be exceeded, based on the minimal cumulative influence identified.

LANDSCAPE

Any change of landscape could be deemed an exceedance of the threshold. The project is located in an area of development (SEZAD). As such, exceedance of significance is only applicable to

where the project operates outside these areas. Hence any significance threshold is not likely to be exceeded.

6.5.3 Biodiversity

TERRESTRIAL ECOLOGY AND MARINE ECOLOGY

Any damage to uncommon or rare terrestrial and marine habitats or species as a result of construction or operational activities could be considered a threshold of significance. Monitoring of the scheme and adoption of best practice principles will ensure any significant threshold is not likely to be exceeded.

6.5.4 Socio-economic

RESIDENTIAL POPULATION/COMMUNITY – GENERAL

Any negative significant and/or permanent impact on local communities as a result of construction or operational activities could be considered a threshold of significance. Monitoring of the social management plans implementation and continuous consultations and dialogue with local communities and SEZAD (as the main stakeholder in the area) will ensure any significant threshold is not likely to be exceeded.

LOCAL BUSINESS/ECONOMY

Some impacts on local employment and economy are predicted to be minor positive and some are minor negative, but both are not considered a threshold of significance.. In addition, DRPIC will be closely monitoring their EPC Contractors' In-Country Value strategy implementation which could present an opportunity to further optimise local employment in the area (thus optimising positive impacts).

LOCAL INFRASTRUCTURE

Any negative significant and/or permanent impact on local infrastructure as a result of construction or operational activities could be considered a threshold of significance. The preparation of a traffic management plan by EPC Contractors and further dialogue and consultation with local communities and third parties on traffic management (through SEZAD) will ensure any significant threshold is not likely to be exceeded.

6.5.5 Community and Health

COMMUNICABLE DISEASES – COMMUNITY

Any negative significant and/or permanent impact on local communities' health as a result of an outbreak or spread of communicable diseases caused by the influx of workers (particularly during the construction phase) constitutes a threshold of significance. The Workers' Influx Management Plan and Community Health and Safety Management Plan implementation by EPC Contractors as well as regular training and refresher courses for workers on communicable diseases will help to ensure that this significant threshold is not exceeded.

AIR QUALITY – COMMUNITY

The relevant thresholds of significance with regard to air quality (the air quality objectives) were considered in the determination of the significance of impacts detailed in Section 6.2.

NOISE – COMMUNITY

The relevant thresholds of significance with regard to noise (the Oman and IFC objectives) were considered in the determination of the significance of impacts detailed in Section 6.2.

VISUAL AMENITY

See Physical Environment (Landscape) section above for the threshold considered for visual amenity.

6.5.6 Cultural Heritage

ARCHAEOLOGICAL SITES

Cumulative impacts on archaeological sites are most likely to occur in the construction phase. Cultural heritage assets (i.e. the receptor in this case) has a resilience to damage or loss that is Low. Assets are not expected be able to cope with the cumulative risks of damage or loss, i.e., this physical change constitutes the thresholds for significance.

CULTURAL

See Residential Population/Community section above for the threshold considered for cultural.

7 MANAGEMENT OF CUMULATIVE IMPACTS

7.1 STEP 6 – MANAGEMENT OF CUMULATIVE IMPACTS

INTRODUCTION

As with the process of ESIA, the CIA approach to managing cumulative impacts revolves around the development of mitigation measures (either changes in design or construction/operational methods, or external measures (e.g. local outside the site boundary, regionally) such as offsets, creation, or compensation).

Where significant cumulative impacts or potentially significant impacts remain, additional mitigation measures may need to be developed. The principles of mitigation should follow the hierarchy of mitigation which comprises the following in order:

- **Prevention:** changes to projects design (or potential location/orientation) to avoid negative effects on a VEC;
- **Reduction:** where prevention is not possible, negative effects should be reduced through sensitive treatments/design;
- **Compensation:** where prevention or reduction measures are not available, it may be appropriate in some circumstances to provide compensatory measures. Such circumstances are generally limited to the compensatory provision of new or enhanced habitats/social assets to replace losses of particular significance. It should be noted that compensatory measures do not eliminate the original negative effect, they merely seek to offset it with a comparable positive one; and
- **Remediation:** where negative effects are unavoidable, management measures can be introduced to limit their influence.

Where potential impacts have been highlighted, recommendations have been made as to whether further detailed monitoring or additional mitigation measures should be considered.

7.2 RECOMMENDED MEASURES

The following additional recommendations are made in order to prevent, reduce, or offset the potential significance of significant negative cumulative impacts where that impact is certain. Where uncertainty arises monitoring is the appropriate approach to determining whether the impact is occurring and measures would need to be undertaken to ameliorate the scale of the impact to acceptable levels.

AIR QUALITY

In order to reduce the risk of adverse impacts from above threshold ozone, PM₁₀ and PM_{2.5} at sensitive receptors during the construction phase, measures should include abatement and suppression of particulate emissions and dust re-entrainment in areas close to boundaries of the DRPIC Project and AF sites. This will assist in containing excessive dust, curbing potential dust nuisance and reduce incidence of elevated PM₁₀ and PM_{2.5}. In addition, near real time fence line monitoring of both PM₁₀ and PM_{2.5} will provide early warning of any potential dust nuisance complaints, and allow site managers to be able to intervene in order to either relocate or cease dusty works.

LANDSCAPE

EPC Contractors on Project Facilities are responsible for landscape measures such as screening at Project sites. DRPIC should encourage SEZAD to adopt the same standards of landscape initiative throughout the Duqm SEZ so that there is consistency in the style of mitigation and consistency in species (e.g. planting flora) for new tenants. These measures would include standard mitigation, for instance:

- Encourage laydown and support areas, in construction, to take up the minimum physical footprint in order to avoid unnecessary disturbance of existing landform and vegetation;
- Minimise lighting levels, duration of use, eliminating unnecessary lighting etc;
- Minimise the use of reflective materials in construction, encourage the use of local stone and aggregate and muted colour schemes to avoid glare and maximising the best possible integration into the local environment; and
- Inclusion of native and xerophytic species in planting mixes.

These mitigation measures have been incorporated into DRPIC's ESMP.

BIODIVERSITY

Appendix D-1 and D-2 contain mitigation recommendations to address potentially significant cumulative impacts. These measures are taken from the mitigation measures presented in the biodiversity assessment (Consolidated Impact and Mitigation Report). The principles behind these recommendations are equally as applicable to all future development projects in Duqm SEZ.

SOCIO-ECONOMIC

The minor (negative) impacts on local communities, their health and infrastructure during the construction phase will be remedied through the implementation of the ESMP and ongoing engagement and consultation with local communities and SEZAD, as well as a robust Grievance Procedure developed by DRPIC and which will be implemented by all EPC Contractors and their management personnel. All other socio-economic impacts during both construction and operation phases are either positive, minor or negligible.

CULTURAL HERITAGE

The risks of cumulative impacts on archaeological sites during the construction and operational phase can be minimised through the application of the ESMP and ongoing engagement and consultation with local communities and SEZAD.

7.3 RESIDUAL CUMULATIVE IMPACTS

Where significant negative impacts were identified and mitigation measures recommended, the subsequent reduction in the magnitude and significance of the impact is discussed below.

AIR QUALITY

Elevated concentrations of Ozone, PM_{2.5} and PM₁₀ are likely to occur over both the construction phase and operational phase of the Duqm Refinery and AFs. In order to reduce the likely harm to health of construction site staff and Refinery site staff, specific occupational exposure mitigation measures need to be designed and put in place to limit site staff exposure to elevated particulate matter and ozone. In order to ensure occupational exposure mitigations are implemented during periods of elevated particulate matter and/or ambient ozone concentrations, it is recommended that

continuous ambient air monitoring is undertaken during both the construction and operational phases of the Duqm Refinery and AFs. This needs to be designed to provide information that can inform management decision on the working environment, treatment and measures to remain within legal limits, hours of exposure etc. Therefore occupational exposure mitigations can be put in place should elevated particulate matter and/or ambient ozone concentrations be detected on-site.

LANDSCAPE

For the Project, EPC Contractors will implement a variety of measures (e.g. planting) that will address landscape and visual impact. DRPIC is encouraged to liaise with SEZAD on the development of AF and third party plots to ensure that development occurring on adjacent/neighbouring plots and that taking place within the wider Duqm SEZ progresses on a consistent basis (e.g. third parties maintain continuous engagement with each other, local communities and SEZAD); then, all moderate negative impacts will be reduced to the minor level.

EPC Contractors on Project Facilities are responsible for landscape measures such as screening at Project sites. DRPIC should encourage SEZAD to adopt the same standards of landscape initiative throughout the Duqm SEZ so that there is consistency in the style of mitigation and consistency in species (e.g. landscape planting using native/endemic tree species). The same approaches need to be adopted during the operation phase because of the scale and extent of third party development. If these initiatives are successful, then cumulative impacts will be reduced to negligible/low.

BIODIVERSITY

Appendices D-1 and D-2 state the residual impacts for each VEC. Provided the mitigation measures are implemented, most adverse impacts are reduced to a minor level. A major impact would still remain in the event of a major oil spill on all marine VECs. However, the recommended mitigation actions would markedly reduce the risk of occurrence of such a catastrophic event and enhance the chances of successful clean-up.

SOCIO-ECONOMIC

Provided all social management plans are implemented and DRPIC and their EPC Contractors maintain continuous engagement with local communities and SEZAD, all moderate negative impacts will be reduced to the minor level.

CULTURAL HERITAGE

Provided the ESMP is implemented and DRPIC and their EPC Contractors maintain continuous engagement with local communities and SEZAD, all moderate negative impacts will be reduced to the minor level.

8

FINDINGS AND CONCLUSIONS

8.1

INTRODUCTION

The Duqm SEZ is a strategic development by the Government of Oman based on a plethora of technical, commercial and planning studies carried out over the last two decades. The key ambition is to stimulate economic growth in order to attract industry, create employment, and market growth. This is being targeted for urban development in a dedicated area of land with responsibility for managing this with SEZAD. There is therefore an opportunity to ensure that the growth of the SEZ takes place with robust principles of environmental, social and sustainability management in place.

By following the policies, sustainability framework, tenets, elements and principles of the suite of international environmental and social standards, DRPIC and the Duqm Refinery Project – as the first significant scale industrial development in the area – sets a good precedent for development. If other, consequent and subsequent third party development follows these standards, and indeed new requirements that will become more developed under SEZAD, the potential impacts of cumulative impact across the SEZ can be managed with control and oversight.

This assessment identified that whilst many negligible, negative and positive cumulative impacts could occur, only a small number of potentially significant cumulative impacts have been identified on the basis of the conservative assessment. A summary of all the assessed VEC cumulative impacts significance before mitigation is provided below in Table 8-.

Table 8-1: Summary of VEC Cumulative Impact Significance

VEC	VEC RECEPTOR	SENSITIVITY / VALUE	MAGNITUDE - CONSTRUCTION	MAGNITUDE - OPERATION	SIGNIFICANCE - CONSTRUCTION	SIGNIFICANCE - OPERATION
Ecosystems Services/Natural resources	Natural capital	Low / High	Very Low	Very Low	Negligible	Negligible
	Land use	Low / Low	N/A	N/A	Minor	Minor
Physical Environment	Air quality	High / Low	Medium	Medium	Minor	Minor
	GHGs	High / High	Very Low	Very Low	Negligible	Negligible
	Noise	Medium / Low	Low	N/A	Negligible	Negligible
	Groundwater	High / Low	Very Low	Very Low	Negligible	Negligible
	Soil	Very Low / Very Low	N/A	N/A	Negligible	Negligible
	Surface water quality (freshwater / marine)	High / Medium	Very Low	Very Low	Negligible	Negligible
	Topography / Landscape	Low / Medium	Low	Low to Medium	Negligible to Low	Negligible to Medium
Biodiversity	Marine habitats, flora and fauna	Appendix C-3	Appendix D-1	Appendix D-2	Appendix D-1	Appendix D-2
	Terrestrial habitats, flora and fauna	Appendix C-3	Appendix D-1	Appendix D-2	Appendix D-1	Appendix D-2
Socio-economics	Resident population	High / Medium	Medium	Medium	Minor	Minor
	Local business / economy	Low / High	Medium	Medium	Minor (Positive)	Minor (Positive)

VEC	VEC RECEPTOR	SENSITIVITY / VALUE	MAGNITUDE - CONSTRUCTION	MAGNITUDE - OPERATION	SIGNIFICANCE - CONSTRUCTION	SIGNIFICANCE - OPERATION
	Road traffic / transport	Low / Medium	Medium	Negligible	Minor	Minor
	Local infrastructure	Medium / Medium	Medium	Negligible	Minor	Minor
Community and Health	Air Quality – community	High / High	Medium	Medium	Minor	Minor
	Noise – community	Medium / Low	Low	N/A	Negligible	Negligible
	Traffic – community	Low / Medium	Medium	Medium	Minor	Minor
	Visual amenity	Low / Medium	N/A	N/A	Negligible	Negligible
Cultural Heritage	Archaeology and cultural heritage	High / High	Medium	Low	Minor	Minor
	Culture	High / Medium	Medium	Medium	Minor	Minor

8.2

RECOMMENDATIONS FOR FURTHER WORK/MONITORING

COLLECTION OF INFORMATION

There is limited reference to documentation and baseline data regarding planned and potential third party projects for the study area. This Report is a first stage assessment of cumulative impacts (and signposts of potential cumulative risk areas) that SEZAD can continue to build upon as plans for additional development are progressed. This assessment can help to inform standards, thresholds, targets and KPIs that could be adopted in a framework of future development within Dqum SEZ. These should follow the best practices adopted by the set of international standards, including IFC, WHO relevant to the Duqm Refinery Project.

MANAGEMENT OF CUMULATIVE IMPACTS

DRIPC will monitor their respective contribution to cumulative impacts as part of their Environmental and Social Management Systems and plans. The ESMP captures such commitments.

It is acknowledged that DRPIC will not be able to individually manage all the effects of cumulative impacts, in which Project and AF activities have the potential to contribute. DRPIC is committed to participating in regular and ongoing cooperation with SEZAD and any other relevant stakeholders (e.g. Government bodies) to ensure that management efforts at the strategic level are effective. In order to maximise the successful management of cumulative impacts deriving from AFs and third party developments, examples of the practical actions that DRPIC, SEZAD, relevant stakeholders and other developers can pursue, are given below:

- Make a reasonable endeavour to ensure that the design of any new AFs, or material change to any existing AFs and third party developments (that may interact with the Project) are consistent with international requirements;
- When there is an opportunity, attend meetings with the owners and/or operators of AFs/third party developments or their key contractors to encourage best practice performance;
- Where gaps in the management plans and systems of AFs/third party developments are identified, DRPIC (and Contractor, where applicable) shall, where possible, provide SEZAD and/or operators of those AFs/third party developments with relevant parts of the HSE Management System so that the developer has the opportunity to use reasonable endeavours to prepare similar plans, implement them and comply with them;
- When there is an opportunity, receive information (including data and reports) from the owners and/or operators of the AFs/third party developments;
- Measures should include abatement and suppression of particulate emissions and dust re-entrainment in areas close to boundaries of the DRPIC Project elements and AF sites; and
- The risks of cumulative impacts during the construction phase will be remedied through successful implementation of the wide range of Environmental and Social Management Plans and ongoing engagement and consultation with local communities and SEZAD.

ONGOING STAKEHOLDER CONSULTATION

Engagement with stakeholders in the study area is an important component of cumulative impact monitoring. EPC Contractors will implement the DRPIC's Stakeholder Engagement Plan (SEP) also, which includes the Grievance Management process. Feedback from local stakeholders will assist the contractors in ascertaining how effective their management measures are in mitigating cumulative impacts.

COOPERATION AND REGIONAL INVOLVEMENT

Cumulative impacts are those that result from the successive, incremental, and/or combined effects of an action, project, or activity when added to other existing, planned, and/or reasonably anticipated future ones. Hence, the Duqm Refinery Project will be unable to individually manage all the effects of cumulative impacts to which their activities contribute.

DRPIC is therefore encouraged to participate in regular and ongoing cooperation with SEZAD and other relevant stakeholders, new developers (as appropriate), and government institutions (See SEP for details) to ensure that management efforts at the strategic level are effective. This requires leadership from SEZAD on the topic of CIA, including future directions of study, monitoring and collation of information from their different areas, zones, projects and initiatives in Duqm SEZ. This will be especially important when managing impacts arising from air quality, in-migration of workers and also biodiversity impacts.

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Appendix A

SCOPING PHASE I

APPENDIX A-1

VEC COLLATION

VALUED ENVIRONMENTAL AND SOCIAL COMPONENTS (VEC)

VEC	IMPACT SOURCE	VEC RECEPTOR – SECONDARY RECEPTOR
Ecosystems Services/ Natural resources	Stress on water resources through consumption of potable water for construction / operation / decommissioning	Natural capital (freshwater and groundwater resources) – resident population / land use / local economy
	Consumption of fossil fuels for vehicles, equipment, as feedstock, and as pilot gas for combustion devices.	Natural capital (oil, diesel, petrol and natural gas) – resident population / land use / local economy
	Consumption of natural resources (mineral, wood and metal) for construction materials	Natural capital (wood, metal ores, rocks, geological deposits and aggregates) - resident population / land use / local economy
	Alteration of land use for installation of project facilities and storage of construction and waste materials	Natural capital (Land use) – land owners / resident population
Physical environment	Release of air pollutants from various emission sources during construction / operation / decommissioning activities	Air quality – health and nuisance - resident population / employees / Terrestrial habitats, flora and fauna
	Release of dust and PM ¹⁰ from construction / operation / decommissioning activities and road traffic	
	Lower atmosphere – climate (global population)	Temporary or constant greenhouse gas emissions (GHG) during construction / operation / decommissioning.
	Increase in ambient noise levels from construction / operation / decommissioning activities, plant equipment and vehicles	Noise – health and nuisance – resident population / employees / Terrestrial fauna
	Release of process and sanitary wastewater management (improper collection, storage, treatment and/or disposal)	Groundwater and Soil - resident population / employees / land use / local economy
		Surface water (freshwater / marine) - biodiversity (flora and fauna) / land use / local economy
	Release of non-hazardous (industrial and domestic) and hazardous substances during storage, handling and waste management	Groundwater and Soil - resident population / employees / land use / local economy
		Surface water (freshwater / marine) - biodiversity (flora and fauna) / land use / local economy
Accidental release of oil / effluent into the marine and terrestrial environment during transportation, handling and processing	Surface water (freshwater / marine) quality - biodiversity (flora and fauna) / land use / local economy	

VEC	IMPACT SOURCE	VEC RECEPTOR – SECONDARY RECEPTOR
	Dredging, reclamation and disposal activities at Export Terminal port basin, offshore borrow area and offshore dredge disposal area	Marine water quality - biodiversity (flora and fauna) / local economy.
	Land take for installation of project facilities and storage of construction and waste materials	Soil and Topography - resident population/ biodiversity (flora and fauna)
Biodiversity	Temporary or permanent alteration to physical environment during construction / operation / decommissioning (indirect impact from above)	Terrestrial / Marine habitats, flora and fauna
	Temporary or permanent disturbance during construction / operation / decommissioning	Terrestrial / Marine habitats, flora and fauna
	Increase in lighting / noise from Refinery operation	Terrestrial / Marine habitats, flora and fauna
	Accidental release of oil / effluent into the marine and terrestrial environment during transportation, handling and processing	Terrestrial / Marine habitats, flora and fauna
	Dredging, reclamation and disposal activities at \export Terminal port basin, offshore borrow area and offshore dredge disposal area	Marine habitats, flora and fauna.
	Land take for site preparation / installation of project facilities and storage of construction and disposal of waste materials	Terrestrial habitats, flora and fauna
	Release of air pollutants from various emission sources during construction / operation / decommissioning activities	Terrestrial habitats, flora and fauna
Socio-economic	Employment of local people and expatriates for Refinery construction / operation (direct and indirect employment) and in local markets (e.g. fisheries)	Employment – Resident population / Local economy
	Increased strain on road traffic from transportation of equipment, machinery, raw materials and wastes	Road traffic (congestion) - resident population / local economy
	Increased utilisation and strain on local infrastructure facilities	Local infrastructure - resident population / workers
	Temporary influx of a peak of 20,000 workers into the area during construction.	Community Safety & Security / relationship between local communities and workers

VEC	IMPACT SOURCE	VEC RECEPTOR – SECONDARY RECEPTOR
Community and health	Release of air pollutants from various emission sources at the Refinery	Air quality – health and nuisance - resident population / employees
	Release of dust and PM ₁₀ from construction / operation / decom. activities and road traffic	
	Increase in ambient noise levels from construction / operation / decommissioning activities, plant equipment and vehicles	Noise – health and nuisance – resident population / employees
	Employment of local people and expatriates for Refinery construction / operation (direct and indirect employment)	Relationship between workers and local communities/Local Economy
	Increased traffic from transportation of equipment, machinery, raw materials and wastes	Road traffic – resident population / workers
Cultural heritage	Temporary or permanent disturbance to archaeological resources during construction / operation / decommissioning.	Archaeological sites or sites of cultural and / or religious significance
	Restricted access to cultural heritage sites	
	Cultural conflict of employment of local people and expatriates for Refinery construction / operation	Resident population / employees

APPENDIX A-2

BIODIVERSITY VECS

BIODIVERSITY VEC	JUSTIFICATION
Designated Sites	
Duqm Important Bird Area (IBA)	IBA classified by Birdlife International that supports regionally important populations of seabirds, and contains the most important sections of intertidal habitat.
Jidat Al Harrasis IBA	IBA classified by Birdlife International that supports nationally important populations of regionally endemic birds.
Terrestrial - Natural Habitats	
Intertidal mudflats, sand and lagoon areas (in Duqm IBA)	Essential habitat for internationally important aggregations of migratory seabirds, nesting habitat for critically endangered Green and Loggerhead Turtles.
Endangered, endemic plant species (<i>Salsola omanensis</i> , <i>Ochradenus harsusiticus</i>)	Endangered species with limited distribution, Tier 2 (see Project Biodiversity Assessment - Technical Appendix C - CHA for further details)
Endangered carnivores (striped hyena, Arabian wolf, Ruppell's Sand Fox)	Nationally critically endangered (striped hyena), nationally endangered (wolf and Ruppell's Sand Fox) that require critical habitat assessment (pending)
Mountain areas	Essential habitat for species with limited distributions including ibex (nationally endangered), gazelle (regionally endemic)
Wadis	Essential habitat and migratory corridor for species with limited distributions including ibex (nationally endangered), gazelle (regionally endemic)
Ibex and Gazelle	Nationally endangered (ibex) and regionally endemic species that require critical habitat assessment (pending)
Marine – Natural Habitats	
Shallow coastal habitats (0-20m)	Essential habitat for other whales and dolphins as well as Tier 1 & 2 species (see above)
Marine – Species	
Arabian Sea Humpback Whale	Regionally endangered species with limited distribution, Tier 1 species (see Project Biodiversity Assessment - Technical Appendix C - CHA for further details).
Indian Ocean Humpback Dolphin	Regionally endangered species, Tier 2 species (see Project Biodiversity Assessment - Technical Appendix C - CHA for further details)
Turtles (Green, Loggerhead and Hawksbill).	Critically endangered species, Tier 2 species, with the Loggerhead Turtle potentially a Tier 1 species ((see Project Biodiversity Assessment - Technical Appendix C - CHA for further details). NB Olive Ridley Turtles are also present in the area but have not yet been subjected to a critical habitat assessment (pending)
Other whales and dolphins	Species include Sperm Whale (IUCN Vulnerable), Blue Whale (IUCN endangered) that may trigger the need for CHA.

APPENDIX A-3

SPATIAL BOUNDARIES / ZONE OF INFLUENCE

ZONE OF INFLUENCES (ZOI)

VEC	VEC RECEPTOR	ZOI
Ecosystems Services / Natural resources	Natural capital	National large scale projects.
	Land use	1km boundary around the DRPIC Project sites.
Physical environment	Air quality	5km boundary around the Duqm Refinery, Ras Markaz Crude Oil Storage Facility and the DLBB. 1km boundary around the Pipeline route. 500m boundary either side of the key transport routes.
	Noise	10km boundary around the Duqm Refinery, Ras Markaz Crude Oil Storage Facility and the DLBB. 1km boundary around the Pipeline route. 600m boundary either side of the key transport routes.
	Groundwater	10km boundary around the Duqm Refinery Project sites.
	Soil	1km boundary around the Duqm Refinery Project sites.
	Surface water quality (freshwater / marine)	10 km boundary around the Duqm Refinery Project sites. 1 km boundary around designated dredging areas and navigation routes.
	Topography / Landscape	1km boundary around the Duqm Refinery Project sites.
	Biodiversity	Marine habitats, flora and fauna
Terrestrial habitats, flora and fauna		10km boundary around the discharge location.
Socio-economic	Resident population	10km boundary around the Duqm Refinery Project components.
	Local Communities / Assets	5km boundary around the Pipeline.
	Road Traffic	10km boundary around the DRPIC Project sites.
	Transport networks	

VEC	VEC RECEPTOR	ZOI
	Local infrastructure	Regional / large scale projects.
Community and Health	Air Quality and Odour– community	5km boundary around the Duqm Refinery, Ras Markaz Crude Oil Storage Terminal and the DLBB. 1km boundary around the Pipeline route. 500m boundary either side of the key transport routes.
	Noise – community	500m boundary around the Duqm Refinery Project component sites. 200m boundary either side of the key transport routes.
	Traffic – community	10km boundary around the Duqm Refinery Project sites.
	Visual amenity	1km boundary around the Duqm Refinery Project sites.
Cultural heritage	Archaeology and cultural heritage sites	1km boundary around the Duqm Refinery Project sites.
	Culture	10km boundary around the Duqm Refinery Project component sites and Workers' Camp sites.

ZOI JUSTIFICATION

LAND USE AND TOPOGRAPHY

A **1km** ZOI has been used for land use and topography as it is the distance over which noise and deposition of gaseous emissions are likely to have reduced to levels that would not be discernible above background levels. These aspects would result in an indirect impact on land use and topography, whereas the direct disturbance impacts would only be attributed to the footprint of a project (including working area).

It is also noted that the changes in land use would impact upon visual amenity. However, this distance is deemed appropriate as the development is set in an area that has already been designated as an industrial zone.

AMBIENT AIR QUALITY AND ODOUR

A **5km** ZOI has been used for air quality impacts around the Duqm Refinery and the project component sites. Operational activities will release critical pollutants (NO_x, CO, SO₂, and PM₁₀) and Volatile Organic Compounds (VOCs) from a multitude of on-site sources that will potentially deteriorate local ambient air quality and odour conditions within a 5km radius.

A **1km** ZOI has been used for the air quality and odour impacts from the Crude Pipeline construction works. This boundary has been defined based on the construction dust and related localised exhaust emissions. Furthermore, anticipated future leaks during pipeline operation may result in negatively influencing local air quality and odour conditions.

A **500m** ZOI has been assigned to the effects on air quality from road traffic. Within this area, it is envisaged that the enhanced traffic exhaust emissions may have direct impacts up to 200m, but indirectly effect VEC receptors up to 500m, such as deposition on ecological receptors.

NOISE

Due to the complexity of the construction and operational phases it is difficult to define the noise levels during these activities. Such industrial activities tend to propagate low frequency noise levels that commence at high intensities. Since noise is attenuated by distance, a **10km** ZOI has been used for the impacts in relation to noise around the DRPIC Project sites during construction and operation.

A **1km** ZOI has been used for the noise impacts from the Crude Pipeline construction works. This boundary has been imposed due to the reduced scale of onsite construction activities and the predicted minimal operational noise levels.

An additional distance of **600m** ZOI has been assigned for noise, surrounding the proposed major road networks in order to account for the anticipated enhanced traffic levels.

SURFACE WATER AND GROUNDWATER RESOURCES

Accidental spills of non-hazardous and hazardous substances and releases of wastewater will cause contaminated run-off. Improper management of hazardous wastewater streams and wastes may potentially lead to the pollution of surrounding surface water and groundwater sources.

In addition, project works could potentially damage existing surface drainage channels and subsequently modify groundwater flow, providing alternative pathways for contamination. Such influences can have a much wider indirect impact upon the local surrounding environment.

Therefore, a **10km** ZOI has been designated, as beyond this area processes such as attenuation, dilution and degradation will reduce pollution levels to an indiscernible level.

SOIL

Direct impacts on soil from releases of non-hazardous (industrial and domestic) and hazardous substances would only take effect within the project footprint. However, in order to provide a conservative and robust assessment, a **1km** ZOI has been assigned. This is to account for the deposition of gaseous emissions that could influence and alter the surrounding soils composition. It is deemed at this distance, levels of the gaseous emissions output would no longer be noticeable above current background levels.

MARINE ECOLOGY

Marine Ecology has been allocated a **250km** ZOI. This is the maximum judged distance to which releases to the marine environment would no longer have a negative influence over the notably diverse surrounding marine flora and fauna (plankton, fish, benthos, marine mammals and turtles etc.). This distance has been developed for the absence of a fully developed impact scenario assessment and accounts for noise, wildlife strikes and spills from ships.

The direct impact of the marine construction works such as dredging and harbour construction would only be attributed to the footprint of the project.

TERRESTRIAL ECOLOGY

Although the direct impact of the Project works would only be attributed to the footprint of the project, in reality a ZOI is hard to define as it varies for different effects. In consultation with air quality and acoustic specialists, an area extending 0.25km from the Project footprint is likely to capture the majority of potentially significant impacts on ecological features. However, this distance does not account for local terrestrial mammal movements.

Therefore, a pragmatic approach has been adopted and a **10km** ZOI for terrestrial ecology has been allocated. This distance also represents when the deposition of gaseous emissions is likely to have reduced to levels that would not be discernible above background levels and would not impact on flora and habitats to any measurable degree.

Furthermore, this distance is judged to be suitable to which dust, artificial lighting, noise and vibration levels would be unlikely to be discernible to fauna.

LOCAL RESIDENTIAL, INFRASTRUCTURE, COMMUNITY, BUSINESS AND ECONOMY

The Duqm Refinery and its project components will carry a significant influence over the local community including existing infrastructure, employment, enhanced local business and intrusion on fishing regions. Due to the wide prominent effect the project is anticipated to have on the local residents and communities, a **10km** ZOI has been allocated for the impacts on related to socio-economic effects.

A separate **5km** ZOI has been used for the Ras Markaz Pipeline in order to represent a distance appropriate to the health and safety risks from oil and gas pipelines. The Pipeline will also influence the socio-economic VECs identified, but to a reduced degree and mainly during the construction phase.

TRAFFIC AND TRANSPORT

A **10km** ZOI has been used for the impacts on transport and traffic. Due to the large scale of the project and its requirements, effects on the access for local residents and communities are anticipated.

ARCHAEOLOGY

A **1km** ZOI has been used for impacts on archaeological sites to consider both the direct impact disturbance impacts within site areas, but also the appreciation of an archaeological site's setting which could be affected by increased noise or visual disturbance from construction or operational activities.

Appendix B

SCOPING PHASE II

APPENDIX B-1

PROJECTS FOR CONSIDERATION

LIST OF THIRD PARTY PROJECTS IN DUQM SEZ AND REGION

DEVELOPMENT	SOURCE	DEVELOPMENT STAGE (IF KNOWN)	EIA REPORT	ES / COMMENTS
Duqm Refinery Project				
Duqm Refinery	Project Information; SEZAD Masterplan and website Data Room	Platform constructed and site fenced off	Duqm Refinery EIA Report in Data Room. To be updated and consolidated with further project components	Includes Construction Camps
Crude Oil Storage at Ras Markaz (DRPIC Crude Oil Storage)	Data Room	Not started	Ras Markaz Crude Oil Park ESIA in Data Room	8 oil tanks only
Crude Oil Import Pipeline (Ras Markaz to Refinery)	Data Room	Not started	Ras Markaz Oil Pipeline Concept Study & FEED EIA in Data Room	
Export Terminal	Data Room	Topsides not started	Duqm Liquid Bulk Berths Project EIA (aka Export Terminal EIA)	
Associated Facilities				
Duqm Export Terminal (DLBB) jetty marine scope including dredging, reclamation / ground improvement and berth construction.	Ramboll Report, Export Terminal EIA	Marine scope (dredging and reclamation) started.	Data Room	
Natural gas spur line from gas supply station to Refinery	Ramboll Report	Tender awarded	Not available	
Export Pipeline Corridor	Ramboll Report, Service Corridor ESIA	Tender Awarded. Construction Imminent	Data Room	
Marafiq Duqm Integrated Power and Water Plant (DIPWP)	Ramboll Report; IDZ ESIA, DIPWP ESIA	Tendering	Data Room	
Seawater supply network	Ramboll Report, SWIP EIA	Project Cancelled	Data Room	Seawater Intake and Outfall Project (SWIP). Note that seawater and outfall for the Refinery is now under Marafiq's DIPWP scope and will be addressed as a Technical Addendum. Not available for this work.
Waste water discharge / common outfall	Ramboll Report, SWIP EIA	Not started	Data Room	Dedicated to Marafiq customers only
Ras Markaz Crude Oil	Ramboll Report,	Tendering	Data Room	

DEVELOPMENT	SOURCE	DEVELOPMENT STAGE (IF KNOWN)	EIA REPORT	ES / COMMENTS
Park (Phase 1.2 and 1.3 Marine Scope/Infrastructure)	Ras Markaz Crude Oil Park ESIA			
Haul road / lane for solid product from Refinery to Duqm Export Terminal	Ramboll Report	Road 1 and 5 being developed	Not available	Product will be transported via a dedicated lane on the Public Highway (N32) until reaching new Road 1 and 5. Alongside Road 1 and 5, there will be a service road.
Third Party Projects (Completed)				
150 Villas (Housing Units)	SEZAD Masterplan / Consultation notes / SEZAD Website	Under Construction (nearly finished)	Not available	Project completed and handed over to the Ministry of Housing
Renaissance Village Duqm	Observations on site	Complete. In operation	Not available	
RAECO Diesel Power Plant		In Operation	Not available	Possibly planning an expansion
Third Party Projects (Recently Progressed)				
Port of Duqm - Dock off-loading facility (i.e. Commercial quay)	Ramboll Report, SEZAD Website	In Operation and under expansion	Not available	
Port of Duqm		In Operation and under expansion	EIA on SEZAD Website	
Sebacic Acid production plant	Consultation notes / Web article	Construction started	Not available	
Fishery Harbour	SEZAD Masterplan / SEZAD Website	Tender Evaluation; Omani civil works contractor appointed. Road commenced (from visual observation in March)	Not available	
Fishery Industrial Complex	SEZAD Masterplan / SEZAD Website	As above	Not available	
Royal Oman Police services Complex	SEZAD Masterplan	Under Construction	Not available	
Sewage Treatment Plant (STP)	IDZ ESIA / SEZAD Website	Power supply is under construction	Not available	
Road Transportation Network	IDZ ESIA	Under Construction	Not available	Roads NR32, no others specifically referenced. Although 'Duqm Industrial

DEVELOPMENT	SOURCE	DEVELOPMENT STAGE (IF KNOWN)	EIA REPORT	ES / COMMENTS
				and Free Zone Masterplan' document generally refers to numerous roads that will support it.
Flood Protection Dams	SEZAD	Under Construction	Not available	
Wadi Sayy Channel	SEZAD	Under Construction	Not available	
Wadi Jurf Channel	SEZAD	Under Construction	Not available	
Natural Gas Pipeline to Duqm	Ramboll Report	Construction commenced	ESIA Requested from OGC	
Natural gas supply station (GSS) at Duqm	Ramboll Report	Not known	Not available	
Be'ah Integrated waste facility	Ramboll Report	Not known	Not available	Hazardous and Non-Hazardous Waste Facilities
Third Party Projects (Possible)				
Ras Markaz Future phases	Ramboll Report	Not known	Not available	
Construction of water network supply to Port of Duqm	SEZAD Website	Tender Evaluation	Not available	
Master Planning for the Development of Al Duqm Town	SEZAD Website	Tender Preparation	Not available	
Airport Substation (Construction of Airport Project Phase 3 – Buildings)	SEZAD Masterplan / SEZAD Website	Under Tendering	Not available	
Airport Air traffic Control Tower		Not known	Not available	
Design of residential water, waste, Communication and electricity network (residential / Industrial)	SEZAD Masterplan / SEZAD Website	Tender Preparation	Not available	
Telecommunications Infrastructure (estimated 87,000 wired lines)	SEZAD Masterplan	Not known	Not available	
Renewable Energy Park (Wind / Solar)	SEZAD Masterplan	Assume considered in SEZAD Masterplan above	Not available	
SEZAD staff Accommodation &	SEZAD Masterplan /	Under Tendering	Not available	

DEVELOPMENT	SOURCE	DEVELOPMENT STAGE (IF KNOWN)	EIA REPORT	ES / COMMENTS
Recreation	SEZAD Website			
Rail Corridor/High Speed Rail	IDZ ESIA	Not known	Not available	
WANFANG swathe	SEZAD website	Not known	Not available	
Malls	-	Not known	Not available	
Hotels	-	Not known	Not available	
Bird Nesting	-	Not known	Not available	
Marine Farm	-	Not known	Not available	
Duqm Petrochemical Complex	-	Feasibility Studies	Not available	

APPENDIX B-2

THIRD PARTY PROJECT INFORMATION

THIRD PARTY PROJECTS

150 VILLAS (HOUSING UNITS) - Completed. A resettlement process which started in late 2016, with the Government commissioning a new development of modern houses, located approximately 15km from the Duqm Airport. This development is called "150 Villas". Affected families will receive a new replacement house (villa) each containing six bedrooms some with ensuite bathrooms.

RENAISSANCE VILLAGE DUQM - Completed. This involves the expansion of the Duqm Renaissance Village to encompass an additional area of 71,805 m. Through expanding its Village in Duqm, the Renaissance Services Company seeks to keep pace with growth in both the SEZAD population and the increased pace of its projects. The project includes the construction of various rooms, restaurants and many other services.

RAECO DIESEL POWER PLANT- In Operation. The system serving Duqm and the surrounding areas is supplied by the Duqm power station, a 66 MW diesel-fired power plant, which is owned and operated by RAECO.

PORT OF DUQM DOCK OFF-LOADING FACILITY (I.E. COMMERCIAL QUAY) - In Operation and under expansion. The Port of Duqm has officially commenced its commercial activities. The ports facilities (Storage Area, Commercial Berth Zone 1, 2, 3 and 4 and Government Berth) of the Port are due to undergo expansion and are currently going through various tendering stages.

SEBACIC ACID PRODUCTION PLANT - Construction started. Work on the facility, which represents the first overseas industrial investment in the Special Economic Zone. The 30,000 tonnes per annum capacity Sebacic Acid Plant represents the first phase of Sebacic Oman's long-term vision to establish a world-scale bio-refinery integrated with a biopolymer refinery at Duqm.

FISHERY HARBOUR- Tender Evaluation; Omani civil works contractor appointed. Road commenced (from visual observation in March). The Fishing Harbour will be able to accommodate small and medium size fishing boats. Dredging will likely be required.

FISHERY INDUSTRIAL COMPLEX- Tender Evaluation; Omani civil works contractor appointed. Road commenced (from visual observation in March). This development, together with the Fishery Harbour, will form the fish industry area in Duqm. The complex will include a retail, wholesale and export markets; designated areas 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.

ROYAL OMAN POLICE SERVICES COMPLEX - Under Construction. Royal Oman police is constructing a police station and complex at Al Duqm in the Al Wusta Governorate. This will consist of numerous accompanying facilities and will include up to 30 buildings.

SEWAGE TREATMENT PLANT (STP)- Power supply is under construction. Galfar has been awarded a contract by Duqm Special Economic Zone Authority, for the operation and maintenance of a 2,000 m³/day sewage treatment plant. The contract value is OMR 365,170 (\$950,000).

ROAD TRANSPORTATION NETWORK- Under Construction. 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. Construction has already begun on two main roads within Duqm; the first is a 17 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 22.5 km, 4-lane road beltway around the city that will connect the residential areas within the city with the beach. In addition, another 37km. 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.

FLOOD PROTECTION DAMS- Under Construction. Flood protection dams will be built upstream of the Jurf and Saay wadis to stave off potential flood events that could imperil industrial schemes, most notably the Duqm Refinery Project, which will be located downstream of these wadis.

WADI SAI CHANNEL- Under Construction. The project, tendered out in separate contracts, entails the construction of an elaborate network of flood channels that will drain runoff from the Jurf and Saay wadis currently crisscrossing the SEZ, safely into the Arabian Sea. The Wadi Sai channel will be up to 90-320 m wide and 10 km long up to the meeting point with Wadi Jarf Channel.

WADI JURF CHANNEL- Under Construction. The Wadi Jurf Channel will act as one of the two drainage networks. The Wadi Jurf Channel will be about 12 km long and 340-650 m wide at the discharge point at the sea.

NATURAL GAS PIPELINE TO DUQM - ESIA approved, EPC Awarded and construction started. The 221km long pipeline will carry natural gas from central Oman to the new Duqm Special Economic Zone (SEZ) on the Wusta coast. A corridor for the construction of the pipeline, linking the Saih Nihayda gas field with Duqm, has been delineated.

NATURAL GAS SUPPLY STATION (GSS) AT DUQM- EPC awarded. Oman Gas Company will supply Duqm with clean natural gas from gas fields in the Al Wusta region. The GSS will initially have a capacity of 15MMSCMD, expandable to a capacity of 25MMSCMD. The company has selected the optimal gas route and gas supply stations. Natural gas is a clean-burning energy source; it will power the economy of Duqm while maintaining a healthy quality of life for its residents.

BE'AH INTEGRATED WASTE FACILITY - Nearing completion/completed. The joint venture of well-known Omani contracting firm Hasan Juma Backer Trading & Contracting Co LLC (HJB) and India's Tatva Global Environment, one of the largest providers of waste management services in the subcontinent, has been awarded a contract valued at around \$20 million for the design and construction of an Integrated Waste Treatment Storage and Disposal Facility in Duqm Special Economic Zone (SEZ) on the Sultanate's Wusta coast. An integral component of this infrastructure is a modern landfill that will receive for treatment and disposal the massive amounts of waste streams expected to be generated by industries operating within the hub.

RAS MARKAZ FUTURE PHASES - Development stage unknown. Ras Markaz terminal is being developed in five phases. Phase one will have a capacity of 26 million barrels and is expected to be commissioned by the end of 2018. The second phase of development is to be carried out with a total investment of roughly \$925m, including construction of the terminal tanks with an investment of \$700m, and \$225m for the construction of basic infrastructure facilities. The tanks for the remaining three phases of the terminal development will be built with an investment of approximately \$700m, while basic infrastructure facilities will be completed at an estimated cost of \$381m per phase.

CONSTRUCTION OF WATER NETWORK SUPPLY TO PORT OF DUQM - Tender Evaluation. A major water supply network project is being undertaken to serve the fast-developing Duqm Wilayat in central Oman is nearing completion. The water supply network will cater to the needs of various projects which are currently underway in Duqm, such as the Duqm Port.

MASTER PLANNING FOR THE DEVELOPMENT OF DUQM TOWN- Tender Preparation. An area of 23km² 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.

AIRPORT SUBSTATION (AIRPORT PROJECT PHASE 3 – BUILDINGS) - Under Tendering. This third package phase includes the passenger terminal spread over 5,600sq m with an annual capacity

of half a million passengers. The ground floor of the terminal will have passenger facilities like retail outlets, restaurants and utilities. The passenger terminal will also have four aerobridges. The statement by the ministry also pointed out that the project includes construction of an air navigation complex. This complex will include a 38m air traffic control tower, buildings for navigation and meteorology, services, maintenance, firefighting and gate-keeping.

AIRPORT AIR TRAFFIC CONTROL TOWER - Development stage unknown. Phase 3 of the airport project includes an air traffic control tower. The development is anticipated to be completed by the year-end.

DESIGN OF RESIDENTIAL WATER, WASTE, COMMUNICATION AND ELECTRICITY NETWORK (RESIDENTIAL / INDUSTRIAL) - Tender Preparation. No information available.

TELECOMMUNICATIONS INFRASTRUCTURE - Development stage unknown. The development of the IDZ area will require a new telecommunications infrastructure to serve the needs of the area. Based on the proposed land use and projected population, an estimated 87,000 wired lines will be required.

RENEWABLE ENERGY PARK (SOLAR) - Development stage unknown. Ningxia Zhongke Jiaye New Energy and Technology Management Co. have signed an agreement with the Oman-based investment firm for the development of a large-scale solar power project in Duqm. The project shall be developed in two phases, with the first one having a capacity of 400 megawatts. The first phase will eventually be expanded to 1,000 megawatts capacity. The intention of the project is to set Oman's economy and energy mix on the road to diversification and create a new and sustainable model for economic growth.

SEZAD STAFF ACCOMMODATION & RECREATION - Under Tendering. No Information available.

RAIL CORRIDOR/HIGH SPEED RAIL - Development stage unknown. A single alignment has been considered for a rail link from a main line that is proposed to the west of the IDZ to the port area. This rail alignment generally runs across the central part of the IDZ from west to east. There will be single rail route for both passenger and freight transport. Rail Station locations will have direct access to future locations for residential/commercial use.

WANFANG SWATHE - Development stage unknown. The WANFANG proposal is a \$10 billion investment consisting of numerous proposed developments including, a heavy industrial zone, light industrial zone and mixed-use areas including a tourism sector.

MALLS - Development stage unknown.

HOTELS - Development stage unknown.

BIRD NESTING - Development stage unknown.

MARINE FARM - Design Phase. The development would represent Oman's biggest marine farm project. The Marine Farm planning is in the design phase of coastal development.

DUQM PETROCHEMICAL COMPLEX – Feasibility Stage. The Petrochemical Complex represents the second phase in a two phase DRPIC project. This considers the Duqm Refinery Project as the first phase. Studies are being performed to integrate the petrochemical complex at the same site. The adjacent facility is expected to incorporate a mixed feedstock cracker, a polypropylene plant, an aromatics facility and a styrene plant.

APPENDIX B-3

DISTANCE OF PROJECTS

ASSOCIATED FACILITIES AND THIRD PARTY PROJECTS DISTANCES

DEVELOPMENT	DISTANCE					COMMENTS / ASSUMPTIONS
	Duqm Oil Refinery	Ras Markaz Crude Oil Park	Ras Markaz Oil Pipeline	DLBB	Construction Camps	
Associated Developments						
DLBB jetty marine scope	4.5 km	>59 km	4.5 km	0.0 km	6.0 km	
Natural Gas Spur Line	0 km	>61 km	0 km	6 km	1 km	
Export Pipeline Corridor	0 km	>59 km	0 km	0 km	6.5 km	
DIPWP	<1 km	>64 km	2.5 km	5 km	4.5 km	
Waste water Discharge / Common Outfall	1 km	65 km	4.5 km	7 km	6 km	Locations based on associated facilities report
Ras Markaz Crude Oil Park (Phase 1.2 and 1.3)	>64 km	0 km	0 km	>59 km	>64 km	
Haul road / lane for solid product	0 km	>55 km	0 km	0 km	1 km	Locations based on associated facilities report
Third Party Projects (Completed)						
150 Villas (Housing Units)	18.5 km	>45 km	>9 km	16 km	18.5 km	
Renaissance Village Duqm	13.5 km	>45 km	>11 km	9.5 km	13 km	
RAECO Diesel Power Plant	<1 km	>64 km	2.5 km	5 km	4.5 km	
Third Party Projects (Recently Progressed)						
Port of Duqm - Dock off-loading facility (i.e. Commercial quay)	8 km	> 57 km	8 km	3 km	9.5 km	
Port of Duqm	8 km	> 57 km	8 km	3 km	9.5 km	
Sebacic Acid production plant	1 km	> 61 km	2 km	3.5 km	4 km	

DEVELOPMENT	DISTANCE					COMMENTS / ASSUMPTIONS
Fishery Harbour	> 27 km	> 34 km	> 15 km	> 23 km	> 27 km	
Fishery Industrial Complex	> 27 km	> 34 km	> 13 km	> 23 km	> 27 km	
Royal Oman Police services Complex	20 km	> 43 km	> 6.5 km	17 km	19 km	
Sewage Treatment Plant (STP)	4.5 km	>68 km	8 km	12 km	5 km	
Road Transportation Network	<1 km	34 km	< 1km	<1 km	<1 km	Approx. locations given in DSEZ EIA. Existing roads not considered. Boundary for new roads considered to stop at Fishery Industrial Complex.
Flood Protection Dams	4.5 km	57 km	2 km	4.5 km	3 km	Location estimate has been taken at a mid-point up stream of the proposed Sai and Jarf drainage channel.
Wadi Sai Channel	4.5 km	50 km	4 km	4 km	4.5 km	Locations based on associated facilities report and masterplan
Wadi Jarf Channel	3 km	60 km	0 km	1 km	<1 km	Locations based on associated facilities report and masterplan
Natural Gas Pipeline to Duqm	-	-	-	-	-	Location unknown
Natural gas supply station (GSS) at Duqm	5 km	69 km	8.5 km	12 km	6.5 km	
Be'ah Integrated waste facility	-	-	-	-	-	Location unknown
Third Party Projects (Possible)						
Ras Markaz Future phases	63 km	0 km	0 km	>59 km	62 km	
Construction of water network supply to Port of Duqm	-	-	-	-	-	Location unknown
Master Planning for the Development of Al Duqm Town	-	-	-	-	-	Location unknown
Airport Substation	21.5 km	37.5 km	3 km	17.5 km	21 km	

DEVELOPMENT	DISTANCE					COMMENTS / ASSUMPTIONS
(Construction of Airport Project Phase 3 – Buildings)						
Airport Air traffic Control Tower	21.5 km	37.5 km	3 km	17.5 km	21 km	
Design of residential water, waste, Communication and electricity network (residential / Industrial)	-	-	-	-	-	Location unknown
Telecommunications Infrastructure (estimated 87,000 wired lines)	-	-	-	-	-	Location unknown
Renewable Energy Park (Solar)	13.5 km	>45 km	<1 km	>11 km	>12 km	Measurements based on the designated 'renewable energy' area on map from data room.
SEZAD staff Accommodation & Recreation	20 km	>43 km	>6.5 km	17 km	19 km	
Rail Corridor/High Speed Rail	>6.5 km	>38 km	0 km	>3 km	>6 km	
WANFANG swathe (\$10 billion investment)	>6.5 km	>56 km	>3.5 km	>6 km	>6.5 km	Measurements based on the multiple locations displayed on the masterplan from data room.
Malls	-	-	-	-	-	Location unknown
Hotels	-	-	-	-	-	Location unknown
Bird Nesting	-	-	-	-	-	Location unknown
Marine Farm	22 km	18.5 km	18.5 km	17.5 km	22 km	

APPENDIX B-4

THIRD PARTY QUALITATIVE ASSESSMENT

PROJECT	DISTANCE						Eco. SERVICES/ NATURAL RESOURCES		PHYSICAL ENVIRONMENT							BIODIVERSITY		SOCIO - ECONOMIC					COMMUNITY AND HEALTH					CULTURAL HERITAGE	
	Duqm Refinery	RM - OP	RM - Pipeline	DLBB	CC	EIA	Natural Capital	Land Use	Air Quality	Greenhouse Gas Emissions	Noise	Groundwater	Surface-Water	Soil	Topography	Terrestrial ecology	Marine ecology	Resident population / community	Road Traffic	Local business / economy	Local Infrastructure	Air Quality - Community	Noise - Community	Access - Community	Traffic - Community	Visual Amenity	Archaeology	Culture	
Associated Facilities																													
DLBB jetty marine scope	4.5 km	>59 km	4.5 km	0.0 km	6.0 km	Y	N	N	CO	N	CO	N	N	N	N	N	CO	CO	CO	CO	CO	CO	CO	CO	CO	N	?	?	
Natural Gas Spur Line	0 km	0 km	0 km	2.5 km	1 km	Y	N	N	CO	N	CO	N	N	N	N	C	N	CO	C	C	C	CO	CO	CO	C	N	?	?	
Export Pipeline Corridor	0 km	> 59 km	0 km	0 km	6.5 km	Y	N	N	C	N	C	N	N	N	N	C	N	CO	C	C	C	C	C	CO	CO	N	?	?	
DIPWP	<1 km	>64 km	2.5 km	5 km	4.5 km	Y	N	N	CO	N	CO	N	CO	N	N	CO	N	CO	CO	CO	CO	CO	CO	CO	CO	N	?	?	
Waste water Discharge / Common Outfall	2 km	66 km	5.75 km	8 km	6 km	Y	N	N	CO	N	C	N	CO	N	N	N	CO	CO	C	C	C	O	C	N	C	N	?	?	
Ras Markaz Crude Oil Park (Phase 1.2 and 1.3)	>64 km	0 km	0 km	>59 km	>64 km	Y	N	N	CO	N	CO	N	CO	N	N	C	CO	CO	CO	CO	CO	CO	CO	N	CO	N	?	?	
Haul road / lane for solid product	0 km	>55 km	0 km	0 km	1 km	N	N	N	CO	N	CO	N	CO	N	N	CO	N	CO	CO	C	C	CO	CO	CO	C	N	?	?	
Third Party Projects (Completed)																													
150 Villas (Housing Units)	18.5 km	>45 km	>9 km	16 km	18.5 km	N	N	N	N	N	N	?	N	O	O	N	N	O	O	N	O	N	N	N	O	N	N	?	
Renaissance Village Duqm	13.5 km	>45 km	>11 km	9.5 km	13 km	N	O	N	O	O	O	?	N	O	O	O	N	O	O	O	O	O	O	N	O	N	N	?	
RAECO Diesel Power Plant	-	-	-	-	-	N	O	N	O	O	O	?	N	O	O	O	N	O	O	O	O	O	O	N	O	N	N	?	
Third Party Projects (Recently Progressed)																													
Port of Duqm - Dock off-loading facility	8 km	> 57 km	8 km	3 km	9.5 km	N	C	N	CO	?	CO	?	N	?	O	O	CO	CO	CO	CO	CO	CO	CO	CO	CO	N	?	?	
Port of Duqm	8 km	> 57 km	8 km	3 km	9.5 km	N	C	N	CO	?	CO	?	N	?	O	O	CO	CO	CO	CO	CO	CO	CO	CO	CO	N	?	?	
Sebacic Acid production plant	1 km	> 61 km	2 km	3.5 km	4 km	N	CO	N	CO	?	CO	?	N	?	O	CO	N	CO	CO	CO	CO	CO	CO	CO	CO	N	?	?	
Fishery Harbour	> 27 km	> 34 km	> 15 km	> 23 km	> 27 km	N	C	N	CO	?	CO	?	N	?	O	CO	CO	CO	CO	CO	CO	CO	CO	N	CO	N	?	?	
Royal Oman Police services Complex	20 km	> 43 km	> 6.5 km	17 km	19 km	N	C	N	CO	?	C	?	N	?	O	CO	N	C	CO	CO	CO	CO	C	CO	CO	N	?	?	
Sewage Treatment Plant (STP)	4.5 km	>68 km	8 km	12 km	5 km	N	CO	N	CO	?	CO	?	N	?	O	CO	N	CO	CO	CO	O	CO	CO	CO	CO	N	?	?	
Road Transportation Network	<1 km	34 km	< 1km	<1 km	<1 km	N	C	N	CO	?	CO	?	CO	?	O	CO	N	CO	C	O	C	C	O	O	CO	CO	C	O	?
Flood Protection Dams	4.5 km	57 km	2 km	4.5 km	3 km	N	C	N	C	?	C	CO	CO	?	O	C	N	C	C	C	C	C	C	CO	C	N	?	?	
Wadi Sayy Channel	4.5 km	50 km	4 km	4 km	4.5 km	N	C	N	C	?	C	CO	CO	?	O	C	N	CO	C	C	C	C	C	CO	C	N	?	?	
Wadi Jurf Channel	3 km	60 km	0 km	1 km	<1 km	N	C	N	C	?	C	CO	CO	?	O	C	N	CO	C	C	C	C	C	CO	C	N	?	?	
Natural gas supply station (GSS)	5 km	69 km	8.5 km	12 km	6.5 km	N	CO	N	CO	?	CO	?	N	?	O	CO	N	CO	CO	CO	CO	CO	CO	CO	N	?	?		

Third Party Projects (Possible)																													
Natural Gas Pipeline to Duqm	-	-	-	-	-	N	C	N	C	?	C	?	C	?	O	C	N	CO	C	C	C	C	C	CO	C	N	?	?	
Be'ah Integrated waste facility	-	-	-	-	-	N	CO	N	CO	?	CO	?	N	?	O	CO	N	CO	CO	CO	CO	CO	CO	CO	CO	N	?	?	
Ras Markaz Future phases	63 km	0 km	0 km	>59 km	62 km	N	CO	N	CO	?	CO	?	N	?	O	CO	CO	CO	CO	CO	CO	CO	CO	CO	CO	N	?	?	
Construction of water network supply to Port of Duqm	-	-	-	-	-	N	C	N	C	?	C	?	CO	?	O	CO	N	CO	C	CO	O	C	C	CO	C	N	?	?	
Master Planning for the Development of Al Duqm Town	-	-	-	-	-	N	C	N	CO	?	CO	?	CO	?	O	CO	N	C	O	CO	C	CO	CO	CO	CO	N	?	?	
Airport Substation (Construction of Airport Project Phase 3 – Buildings)	21.5 km	37.5 km	3 km	17.5 km	21 km	N	C	N	CO	?	CO	?	N	?	O	O	N	C	CO	CO	CO	CO	CO	N	CO	N	?	?	
Airport Air traffic Control Tower	21.5 km	37.5 km	3 km	17.5 km	21 km	N	C	N	C	?	C	?	N	?	O	O	N	C	C	CO	CO	C	C	N	N	N	?	?	
Design of water, waste, Communication and electricity network (residential / Industrial)	-	-	-	-	-	N	C	N	CO	?	C	?	CO	?	O	CO	N	C	O	C	CO	O	CO	C	C	C	N	?	?
Telecommunications Infrastructure (estimated 87,000 wired lines)	-	-	-	-	-	N	C	N	C	?	C	?	N	?	O	CO	N	C	O	C	C	O	C	C	C	C	N	?	?
Renewable Energy Park (Solar)	13.5 km	>45 km	<1 km	>11 km	>12 km	N	C	N	C	?	C	?	N	?	O	CO	N	CO	C	C	CO	C	C	CO	C	N	?	?	
SEZAD staff Accommodation & Recreation	20 km	>43 km	>6.5 km	17 km	19 km	N	C	N	CO	?	CO	?	N	?	O	CO	N	CO	CO	CO	CO	CO	CO	CO	CO	N	?	?	
Rail Corridor/High Speed Rail	>6.5 km	>38 km	0 km	>3 km	>6 km	N	CO	N	CO	?	CO	?	CO	?	O	CO	N	CO	O	C	CO	CO	CO	O	O	N	?	?	
WANFANG swathe	>6.5 km	>56 km	>3.5 km	>6 km	>6.5 km	N	CO	N	CO	?	CO	?	N	?	O	CO	N	CO	CO	CO	CO	CO	CO	CO	CO	N	?	?	
Malls	-	-	-	-	-	N	C	N	CO	?	CO	?	N	?	O	C	N	C	O	CO	CO	CO	CO	CO	CO	N	?	?	
Hotels	-	-	-	-	-	N	C	N	CO	?	CO	?	N	?	O	C	N	CO	CO	CO	CO	CO	CO	CO	CO	N	?	?	
Bird Nesting	-	-	-	-	-	N	N	N	N	N	N	N	N	N	N	O	N	N	N	N	N	N	N	N	N	N	N	N	N
Marine Farm	22 km	18.5 km	18.5 km	17.5 km	22 km	N	C	N	C	?	C	N	N	N	N	N	C	O	C	O	C	CO	N	C	C	N	C	N	?
Duqm Petrochemical Complex	<1 km	> 66 km	4 km	8 km	4 km	N	CO	N	CO	?	CO	?	N	?	O	CO	N	CO	CO	CO	CO	CO	CO	CO	CO	N	?	?	

Key	
C	Construction phase only
O	Operation phase only
CO	Construction and Operation Phase
N	Negligible / Managed impact
?	Uncertain / unknown
	Large scale negative impact
	Small scale negative impact
	Positive impact

Appendix C

STEP 3 – VEC BASELINE INFORMATION, SENSITIVITY AND VALUE

APPENDIX C-1

VEC BASELINE

RECEPTOR	ESIA BASELINE				
	Duqm Refinery and Construction Camps	RM - OP	RM - Pipeline	Export Terminal	WSP Baseline For Consolidated ESIA
Materials / natural resources	Materials and natural resources are purchased from third party suppliers, and location of resources can vary from local, regional and national.				Not part of the WSP ESIA Consolidation Scope.
Land Use					Not part of the WSP ESIA Consolidation Scope.
Topograpghy	<p>The topography of the Refinery site is generally classified as low-lying coastal plain (to the east) that is enclosed to the north, west and south by sandstone and limestone hills.</p> <p>The site lies between two wadis, Wadi Jurf on the southern side and a small wadi on northern side along with numerous braided natural drainage channels.</p> <p>The DRPIC site has an elevation varying between 2 - 20m above mean sea level.</p> <p>The project site also consists of flat sandy strips parallel to the coastline and also includes coastal dunes, belts of scrubs and sparse trees.</p> <p>The area has no prior established land use pattern.</p>	<p>The proposed Project site in Ras Al-Markaz is located within Wilayat Al-Duqm in Al Wusta region of Oman, approximately 500 km south of Muscat and 55km south of Duqm. The site covers an area of approximately 13 km².</p>	<p>The pipeline ROW traverses through two major topographic regions which are the Northern Interior Plains and the Al Huqf region. The northern interior plain is a type of accumulation plain found in Oman and is mostly a broad slope of alluvial material at the foot of an escarpment and is mostly in the form of gravel plains with a few small gravel mounds. The Huqf region is mostly composed of sabkha dune outcrop complex with hills of rock outcrop alternating with saline basins and sand dunes. Tidal flats are extensive along the coast.</p>	<p>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.</p> <p>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. North of the LBW are a series of non-tidal lagoons ('khawrs'), whereby the water has seeped underground to produce highly saline lagoons. The lagoons are 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 sea level.</p>	<p>The landscape character is typical of mature marine fringe environments in the Al Wusta region, which is generally organised by an open coastline backed by sand and alluvium plains and hills. The DSEZ has been given descriptions labelled LCA1-5 and was used in order to characterise the different areas occupied by the Duqm Refinery projects. The descriptions used to characterise the area are given below:</p> <p>LCA1 - Beach and Dunes LCA2 - Low Lying Alluvium Plains LCA3 - Urban Landscape LCA4 - Limestone and Sandstone Hills LCA5 - Limstone/Dolomite Coastal Cliffs</p> <p>More details and further information is provided in the Landscape & Visual Context report (Report N^o 70029220-102-BS01).</p>
Air Quality and Odour	<p>The ambient air quality was found to be compliant with the Omani (Provisional) Ambient Air Quality Standards.</p> <p>An on site monitoring location recorded the following 24-hr minimum and maximum pollutant concentrations in October 2013 and June - July 2014:</p> <p>CO (175 to 229 ug/m³), NO (5.7 to 13.3 ug/m³), NO₂ (37.2 to 68.4 ug/m³), NOx (56.8 to 72.8 ug/m³), O₃ (54 to 129 ug/m³), SO₂ (15.3 to 25.0 ug/m³), PM₁₀ (63 to 80 ug/m³).</p> <p>The Duqm area has inherently high dust levels due to the windy conditions which prevail in the region and its openness to the sea.</p> <p>Measured odour baseline sampling results shows the air quality in the concerned area has no odorous compounds.</p>	<p>Continuous ambient air quality monitoring was undertaken at three locations, which were selected on the basis of proximity to sensitive receptors and future land use for the SEZAD. Anthropogenic sources of air pollution in the area are fishing boats, generators used by the fishermen, and road traffic as a result of fishermen travelling in the area. The air quality monitoring program was undertaken in March and November 2013, with the maximum concentrations given below:</p> <p>March - CO 1hr/8hr/24hr (897/532/393 ug/m³), NO₂ 1hr/8hr/24hr (152.1/29.7/22.5 ug/m³), O₃ 1hr/8hr/24hr (123/106/100 ug/m³), SO₂ 1hr/8hr/24hr (35.2/31.6/23.1 ug/m³), H₂S 1hr/8hr/24hr (2.5/2.2/2.1 ug/m³), PM₁₀ 1hr/8hr/24hr (590/380/244 ug/m³).</p> <p>November - CO 1hr/8hr/24hr (448/386/328 ug/m³), NO₂ 1hr/8hr/24hr (57/18/12 ug/m³), NO_x 1hr/8hr/24hr (66/22/15 ug/m³), O₃ 1hr/8hr/24hr (80/112/70 ug/m³), SO₂ 1hr/8hr/24hr (23/22/22 ug/m³), PM₁₀ 1hr/8hr/24hr (396/158/93 ug/m³).</p> <p>The higher values can be attributed to increased vehicular movement due to increase in port activity, when the commercial quay was inaugurated for operations. The concentrations of SO₂ could be due to the nearby power plant emissions and the use of diesel for construction purposes.</p>	<p>SEZAD undertook continuous ambient air quality studies at 3 locations within the DSEZ area. The monitoring was undertaken for select months between November 2012 and November 2013. The monitoring recorded the following minimum and maximum concentrations:</p> <p>CO 8hr (262 to 1709 ug/m³), NO₂ 1 hr / 24 hr (32 / 16.9 to 81.7 / 68.4 ug/m³), O₃ 8 hr (64 to 177 ug/m³), SO₂ 1 hr / 24 hr (10.7 / 9.7 to 211 / 91 ug/m³), PM₁₀ 24 hr (79 to 244 ug/m³).</p> <p>In addition, ambient dust levels were measured at 70 locations along the pipeline ROW. Particulate Matter (PM_{2.5} and PM₁₀) and Total Suspended Particulates (TSP) levels in the ambient air were monitored. The monitoring recorded the following minimum and maximum concentrations:</p> <p>PM₁₀ 24 hr (10 to 344 ug/m³), PM_{2.5} 24 hr (2 to 91 ug/m³) and TSP (6 to 484 ug/m³).</p> <p>As dust is expected to be a significant emission from project operation emphasis must be placed on the management of dust during the construction phase.</p>	<p>In 2015 a diffusion tube monitoring method was used to record the air quality conditions around the DLBB project site. The following minimum and maximum pollutant concentrations were recorded:</p> <p>NO (3.26 to 4.57 ug/m³), NO₂ (1.18 to 2.18 ug/m³), NOx (4.44 to 6.65 ug/m³), O₃ (59 to 78 ug/m³), SO₂ (0.57 to 3.02 ug/m³), PM_{2.5} (2 to 20 ug/m³), PM₁₀ (4 to 80 ug/m³).</p> <p>The air quality parameters are within the USEPA National Ambient Air Quality Standards (NAAQS), excluding O₃ at one location, where the ozone level is marginally above the USEPA NAAQS limit.</p>	<p>Ambient air quality results from the air quality monitoring equipment, located at the Sebacic Acid plant, have been reported for the first month of monitoring between 3rd May until 6th August 2017.</p> <p>The monitoring results indicate that both NO₂ (Period mean - 3.32 ug/m³) and SO₂ (Period mean - 6.26 ug/m³) were both low in concentration during the sampling period, implying that there are no significant industrial emissions sources.</p> <p>However, O₃, PM₁₀ and PM_{2.5} all exceeded short-term concentrations limits. In the case of PM₁₀, the period mean (151.53 ug/m³) exceeded the 24hr air quality standards. For O₃ (Max concentration - 172.69 ug/m³) and PM_{2.5} (Max concentration - 158.92 ug/m³) the maximum concentration exceeded the 24hr air quality standards for both pollutants.</p> <p>More details and further information is provided in the Air Quality Baseline report (Report N^o 70029220-101).</p>
Noise	<p>The site is within a dedicated special economic zone and will have commercial developments in the future. As this is not a dedicated industrial estate, noise</p>	<p>The proposed site currently has no significant noise sources located within several kilometres. Given the isolated location of the site, vehicular traffic noise is restricted. Current anthropogenic</p>	<p>The noise survey was undertaken at about 70 locations. The Ministerial Decisions defines the allowable daytime noise level as a result of industrial plants and public</p>	<p>A noise survey was undertaken at nine monitoring locations and at Say village (near the main road) to measure the equivalent continuous (L A-eq)</p>	<p>An updated survey was undertaken to provide supplementary and updated baseline information. Noise levels were monitored at none different sites and across four areas, including the Wadi Saay, Nafun, Antoot Fishing</p>

RECEPTOR	ESIA BASELINE				
	<p>levels have been compared with those stipulated for suburban residential area in MD 79/94. The measurements indicate that noise levels at certain locations exceed the limits (highlighted bold) specified for different time intervals:</p> <p>Workdays daytime (57.0 to 73.2dB Leq), Workdays evening (48.8 to 62.0dB Leq), and Holidays and nights (51.0 to 62.6dB Leq).</p> <p>High noise levels have been attributed to nearby dirt tracks, Road 32, the nearby power and desalination unit and environmental disturbances.</p> <p>In comparison with the previous survey work, the measurements taken indicate that during periods of low winds (ie < 5m⁻¹), noise levels at comparable locations around Duqm are generally somewhat lower than reported during higher wind conditions.</p>	<p>noise sources in the area include fishing boats, movement of fishermen's vehicles and the fish unloading area.</p> <p>Noise monitoring was carried out at 13 locations around the proposed site location. The noise was measured during the day and evening: Daytime (32.3 to 58.0dB Leq) and Evening (63.8 to 93.6dB Leq)</p> <p>As this is dedicated industrial estate, noise levels have been compared with those stipulated for industrial area in MD 79/94. The measurements indicate that noise levels at certain locations exceed the limits specified for evening time intervals. The area is currently devoid of any industrial activities. The inherently higher noise levels can be attributed to that from the strong winds, which is a common feature in the region considering the open nature of the entire site and also from the surfing noise of the waves for locations in close proximity to the coast.</p>	<p>works in rural recreational area as 45 dB(A). This standard was exceeded at a number of locations, however there was no specific sources and represents the natural ambient condition.</p> <p>The minimum and maximum recorded measurements are given below: Ambient noise levels (35.3 to 71.2dB LA-eq). It should be noted that the high wind speed was the primary cause for exceedance.</p>	<p>sound levels in the Export Terminal project area. The minimum and maximum recorded measurements are given below: Monitoring locations (38.37 to 62.0 LA-eq) and Say village (56.75 to 62.4 LA-eq).</p> <p>The ambient LA-eq levels measured around the site and near the main road in Say village during January as well as August are below applicable standard limits.</p> <p>However, the LA-eq levels measured in August are mostly higher than the LA-eq levels measured in January. This is because of the increased number of construction vehicles plying the road connecting LBW to the Highway 32 in August. Further, the wind speed during measurements in August were higher than the wind speed during measurements in January.</p>	<p>Area and Dhahr.</p> <p>The noise levels are summarised in terms of the range of the measured LAeq (ambient) and LA90 (background) noise levels.</p> <p>The minimum and maximum recorded measurements are given below (LA-eq/LA90):</p> <p>Wadi Saay (44 to 53 LA-eq / 39 to 46 LA90), Nafun (41 to 54 LA-eq / 38 to 53 LA90), Antoot Fishing Area (42 to 44 LA-eq / 35 to 36 LA90) and Dhahr (42 to 48 LA-eq / 35 to 41 LA90).</p> <p>The most prevalent noise source around the area was wind interaction with buildings, surfaces and vegetation. Measured average wind speeds were below 5 ms⁻¹ during all measurements with the exception of a daytime measurement (7ms⁻¹) at Dhahr.</p> <p>The full details of the monitoring results are presented in the environmental baseline noise report (Report N^o 70029220-102-BS01).</p>
Surface Water	<p>More than 20 wadis with catchments greater than 4 km² within Duqm with visible and known widths and depths as they reach the sea. The shallow nature of the area results in an increased possibility for the wadis flow to change direction especially if the wadi channels become subject to construction.</p>	<p>The study area consists of many channels that flow water from the western hilly region towards the sea. Due to elevated ridges in the study area the local flow direction varies on the stream however regionally the flow is from northwest to east and south east.</p> <p>The rainwater from an important part of the project area is running towards a main stream and flowing over the edge of the cliff at one location, eroding the cliff. The construction of the tank terminal will affect the natural run off of storm water.</p>	<p>The wadis are mostly dry with water present only during a storm or rain event. After storm events runoff from steep bare hills runs into wadis and surface water flow for a few hours or days. On occasions floods may occur in low lying area. Wadis are located on the gently sloping, nearly flat parts of deserts; commonly they begin on the spread portions of fans and extend to inland sabkha. Permanent channels do not typically exist, due to lack of continual water flow.</p> <p>The Ras Markaz Oil Pipeline crosses a number of wadis, and among them 189 (59 wadis and 130 wadi plains) have been categorised as major wadis.</p>	<p>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.</p> <p>The marine water quality around the Project Area had elevated turbidity levels 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.</p>	<p>Additional baseline studies not part of the WSP ESIA Consolidation Scope.</p>
Groundwater Hydrogeology	<p>The site is underlain mainly by Tertiary sediments of the Hadhramaut group. The main aquifer is the Umm er Radhuma (UER) formation. Recharge occurs through regional aquifer system and it is approximately 200 m below ground level. It constitutes the main regional aquifer in the Najd (Southern Oman), with groundwater becoming gradually more saline in down-flow direction, from fresh in the area of the Dhofar Mountains to saline in the Al Wusta that is our project region.</p> <p>Therefore, in this study area the groundwater is not suitable for drinking. Further, parameters such as Sulphate, Sulphide, Nitrite and Fluoride are above Omani drinking water standard.</p>	<p>Groundwater samples were collected from the Crude Oil Park site as part of the baseline studies for the ESIA. The Crude Oil Park is located in the Eastern Padi plain, which is a nearly level monotonous rock plain, made of hard carbonate rocks that resist erosion.</p> <p>It is evident from above results are within limits except boron and manganese which exceed the Omani Standards, the latter of which shows ground water is hard in nature. Chlorides are also within limits that mean the groundwater has no seawater intrusion effects.</p>	<p>Groundwater along the Crude Pipeline route is expected to be brackish and in the form of narrow lenses. In the sabkha area the groundwater is expected to be shallow and brackish. Rainfall is the primary source of groundwater recharge as the infiltration through coarse alluvium and fissured rock is high.</p> <p>The groundwater in the study area is generally saline. The highest salinity is near the centre of the project Right of Way (ROW) and is comparatively better towards Nahadha and Ras Markaz. Further it is expected that the Nahadha area has better groundwater quality than other areas along the ROW.</p> <p>The number of wells monitoring wells and boreholes decrease in number and density from Nahadha to Ras Markaz. There are no Afalaj in the vicinity of the pipeline.</p>	<p>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.</p> <p>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.</p>	<p>Additional baseline studies not part of the WSP ESIA Consolidation Scope.</p>

RECEPTOR	ESIA BASELINE				
			<p>Broadly the ground water in the sampled area is poor and unsuitable for human consumption.</p> <p>The groundwater samples also showed Barium and Zinc levels in higher than the Dutch Intervention standard. However, these elevated levels are attributed to natural variations.</p>		
Soil	<p>The study area consists of the coastal alluvium and patches of calcium carbonate (Marl) or lime-rich mud/mudstone which contain variable amounts of clays and silt. The sediment grains consist of fragments of fossils, limestones and dolomites, and other carbonate grains, or some combination of these known as Calcirudite.</p> <p>Soil samples were collected from the site and analysed and the values were found to be within the limits except for natural leaching of certain metals</p>	<p>In order to analyse the quality of soil within the Crude Oil Park site, twelve composite soil samples were collected from the site. On comparison of the parameters in the soil samples from the project site with the corresponding standard limits, it is seen that all parameter levels are below the specified limits. The soil at the site is alkaline. There is no evidence of any hydrocarbon contamination of the soil samples.</p>	<p>Oman rainfall is very limited and soils are very dry most of the time. Hence, soil formation is 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 soil in the project area as poor and unsuitable for agriculture.</p> <p>The soil is high in calcium (between 122 and 276 g/kg) and magnesium (between 5.5 and 37.2 g/kg). The sample collected at BVS 3 showed levels of chromium and nickel in excess of the Dutch Intervention Standard. However, these elevated levels are attributed to natural variations.</p>	<p>The surface geology of the study area is characterised by sabkha. 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.</p> <p>The high salt concentration in sabkha soil is a challenge for construction as it would cause damage to concrete and steel.</p> <p>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.</p>	<p>Additional baseline studies not part of the WSP ESIA Consolidation Scope.</p>
Marine Ecology	<p>The offshore region does not have any significant marine species which could be affected as a result of the project.</p> <p>The project site is located near to the long crenulated bay (Ghubbat Quwayrat bay) in the northern area of the Duqm port.</p> <p>The sandy intertidal shoreline is inhabited by a number of animals includes many burrowing polychaetes, crustaceans, gastropods, bivalves and amphipods.</p> <p>Large shoals of pelagic and demersal fish were sighted in almost all the areas of the bay, which indicates high productivity of the water column in the study area.</p> <p>A number of humpback whales (population endangered by IUCN) and dolphins were reported from the offshore region. Marine green turtles (IUCN Red Listed) were observed at the survey areas of the project site.</p> <p>Sensitive habitats like seagrass and corals were not observed in the subtidal area.</p>	<p>The proposed offshore project area is a part of Arabian Sea, one of the most highly diverse and productive ecosystem in this region, due to the coastal upwelling of nutrient rich cold water that occurs along the coast of the Arabian Peninsula (which takes in Southern Oman).</p> <p>SEZAD environmental baseline survey revealed presence of invertebrates (sea anemones, crabs and crustaceans), macroalgae, coral, numerous pelagic fish and marine turtles (Green, Loggerhead, Olive Ridley and Hawksbill).</p> <p>The turtles are listed in the IUCN Red List of Threatened Species. The Ras Madrakah area was reported as supporting green, loggerhead and hawksbill turtle nesting, with over 500 green turtle nests and 107 loggerhead turtle nests recorded immediately south of proposed project site (preliminary marine survey at Ras Markaz 2012).</p> <p>About 21 species of whales and dolphins are known to occur in Oman waters and 12 have been reported from the Gulf of Masirah region. These species include the baleen whales, deep water sperm whales, odontocete whales, False killer whales, indo-pacific humpback dolphins, spinner dolphins, long-beaked common dolphin</p>	<p>No information.</p>	<p>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. There is evidence that turtles feed and nest on beaches along the coast immediately surrounding the Duqm area, such as green and loggerhead turtles. The area around Duqm is considered a critical feeding and breeding habitat for certain turtle species, as well as being on a migratory pathway.</p> <p>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.</p> <p>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.</p>	<p>The benthos in the immediate marine area adjacent to project activities appears to be composed of fine sand and clayey substrates with little or no hard substrates present. Historic baselines all confirm that no significant areas of coral, seagrass or substantial areas of macroalgae were identified during baseline surveys.</p> <p>According to the results of the marine baseline surveys reported in HMR (2015) two species of baleen whales, the Bryde's whale and humpback whales (endangered by IUCN). The most commonly encountered species in the Duqm area are humpback whales and common dolphins.</p> <p>Marine turtles (the endangered green turtle) were observed at the survey areas of the Refinery Project site usually near the coastline, bay and seaweed beds, and go on to indicate that each year the large numbers of Green turtles nest on the beaches of Ras Madrakah area, 70km south of the Port of Duqm. Baseline surveys conducted showed active nesting beaches used by two species of turtle, green turtles and loggerhead turtles.</p> <p>For more details on the marine ecology findings, please refer to the biodiversity assessment report (REPORT N^o 70029220-04-CL-TECH/BIO) and the associated Appendices A-F.</p>

RECEPTOR	ESIA BASELINE				
		and bottlenose dolphins.			
Terrestrial Ecology	<p>To the south of the Refinery site is a sabkah area which is also an important birding area and a sensitive ecosystem. The area just near the Lee breakwater of Duqm Port is an ecologically sensitive zone and is classified as an Important Birding Area by BirdLife International. This is yet to be declared as an official site for conservation under the Ramsar Convention. This area lies in the project influence area, and the proposed coastal pipeline corridor passes through it. None of the plant species recorded in the site is listed in the 2011 Red List of the International Union for Conservation of Nature and Natural Resources (IUCN).</p> <p>The Oryx sanctuary (2,828 km²) has a breeding population of about 430 Arabian Oryx, and an estimated number of 200 Arabian Gazelle. These populations are located in a confined area within the reserve and is approximately 60 km north-west of the project location. The fauna in the area of influence of the refinery project within the Oryx reserve comprises of lizard <i>Pristurus robustus</i>, camels, goats and sheep. The coastal habitat is important migratory ground for wintering birds.</p>	The study area is an arid desert environment and a survey revealed that the overall abundance and diversity is low.	<p>Vegetation is typically found along wadis and minor runlets, where moisture may be present as a result of shallow groundwater lenses. The greatest diversity of communities is among the under-shrubs.</p> <p>The Arabian Oryx Sanctuary is an area within the Central Desert and Coastal Hills biogeographical regions of Oman. The sanctuary is protected by RD 4/2000, RD 11/2011, MD 111/2000, and MD 131/2000. The only wild breeding sites in Arabia of the endangered houbara bustard, a species of wader, Nubian ibex, Arabian wolves, honey badgers, caracals and the largest wild population of Arabian gazelle. At the closest in the DSEZ area the Crude Pipeline is about 2.5 km from the sanctuary.</p> <p>The IUCN Red List of Threatened Species identifies 75 mammal species in Oman, amongst which 52 are terrestrial species, with about 29 with range along the project ROW. Amongst the 29 species, 2 species are identified as Near Threatened (Sand Cat and Striped Hyaena), 4 species as Vulnerable (Nubian Ibex, Mountain Gazelle, Goitered Gazelle and Arabian Oryx) and 23 Species as Least Concern. The Regional Red List Status suggests that the Striped Hyaena is not present in the study area, while the Wild Cat is present.</p> <p>The IUCN Red List of Threatened Species identifies 325 species of Avifauna native to Oman. Among these 13 species are considered to be Critically Endangered, Endangered, or Vulnerable, with eight of these Critically Endangered, Endangered, or Vulnerable species present in the project area (Great Knot, Asian Houbara, Greater Spotted Eagle, Egyptian Vulture, Socotra Cormorant, Lappet-faced Vulture and Sociable Lapwing).</p>	<p>The flora in the study area is dominated by halophyte plant community. The plant species identified during the survey includes <i>Suaeda moschata</i>, <i>Suaeda vermiculata</i>, <i>Zygophyllum qatarense</i>, <i>Arthrocnemum macrostachyum</i>, <i>Halopeplis perfoliata</i>, <i>Limonium stockcii</i> and grasses such as <i>Halopyrum macrostachyum</i>. Most of the study area is barren and the flora in the study area is not rare or endemic to the region.</p> <p>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.</p> <p>The Eurasian Curlew is listed as Near Threatened, which means that this bird species is likely to become endangered in the near future. Flamingos were also noted 2 kmsouthwest of the LBW.</p> <p>The animals that were identified from indirect evidence are all listed as Least Concern by IUCN (Red Fox, Cheesman's Gerbil, Camel and Domestic Dog).</p> <p>A total of 39 species of herpetofauna are available in the region, including 8 species with doubtful occurrence. The rarest group representation in this region are 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.</p>	<p>Multiple designated sites were identified and include the Duqm Important Bird and Biodiversity Area (Duqm IBA), Jiddat Al Harasis IBA, DSEZ Nature Reserve and the Al Wusta Wildlife Reserve.</p> <p>Natural habitats are estimated to cover 47.0km² (79%) of the current Project area. The terrestrial habitats present within the Project area are not considered to be rare in Oman and exist elsewhere in the Gulf region. Four species were included in the terrestrial critical habitat assessment: Egyptian Vulture (<i>Neophron percnopterus</i>) and three endemic plants that are listed globally vulnerable namely <i>Salsola omanensis</i>, <i>Ochradenus harsusiticus</i> and <i>Pulicaria omanensis</i> subsp <i>milleri</i>. 27 mammal species may inhabit the area, including six feral/domestic mammal species.</p> <p>40 species of terrestrial reptiles and amphibians possibly occur in the area recorded, 12 are snakes, 27 are lizards, and one is an amphibian.</p> <p>There is some discrepancy in the number of birds that are reported to occur in the wider Duqm area. The available Project ESIA's indicate that approximately 168 species are known to occur there (including 22 breeding species), whereas as a list of 120 species appear in 5OES 2011 (based on official records supplied by the Oman Bird Records Committee, OBRC, in 2010). In addition, the 5OES 2011 report states that between 180 – 250 bird species (including waterbirds and non-waterbirds) have been recorded, the majority of which pass through the area during migration. Some 23 species of birds are suspected or confirmed to breed in the SEZAD area. A number of species of birds recorded at Duqm are considered endangered, vulnerable or near threatened by IUCN (2017). Two endangered species have been recorded at Duqm, the Egyptian Vulture and the Steppe Eagle but neither is found regularly here, and Duqm is not an important site for them.</p> <p>For more details on the terrestrial ecology findings, please refer to the biodiversity assessment report (REPORT N^o 70029220-04-CL-TECH/BIO) and the associated Appendices A-F.</p>
Local Infrastructure	Main sources of water supply in Al Wusta Governorate include a number of desalination plants that produced 1.48 million m ³ potable water during 2012. There are total 23 wells in the Governorate supplying water for domestic uses. The network system for water distribution is very limited and is mostly supplied by tankers.	No Information.	The initial route reconnaissance exercises identified several existing graded/blacktop roads and Over Head Line/buried power/utility cables. These include: 23 crossings with Route 31 (Muscat - Salalah) and 32 (Muscat – Al Mahout – Duqm – Ras Markaz), 52 graded roads at various concession areas and 16 overhead electric	At present, there is no engineered landfill operating in Duqm. Non-hazardous waste generated in Duqm is disposed at a dumpsite, which is approximately 15 ha and about 12 km NW from the DLBB Project. 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	Additional information not part of the WSP ESIA Consolidation Scope.

RECEPTOR	ESIA BASELINE				
	<p>solid non-hazardous waste for the study area are inadequate and waste is being stored and treated inappropriately. The only waste management facilities are unmanaged landfills and scattered tipping areas. There are no long standing facilities for the management of hazardous waste at Duqm. However, new facilities have been constructed for the storage of solid hazardous waste for the Dry Dock facility.</p> <p>Rural Areas Electricity Company SAOC (RAECO) which is a closed Omani Joint Stock Company incorporated under the Commercial Companies Law No. 4/74 of Oman, is the main power provider to Al Wusta Governorate. RAECO is primarily undertaking electricity generation, water desalination and electricity distribution activities in its authorized areas. As per Census 2010, there are around 6,387 housing units with 63.1% occupancy in Al Wusta, of which only 678 housing units were part of the project influence area. Housing units are typically classified as villas, apartments, Arabic houses, rural houses or other type.</p> <p>Duqm and Mahout wilayats have four health institutions catering to the needs of the local residents. There are currently 22 basic education and 1 general education schools in Al-Wusta.</p>		<p>lines.</p> <p>The proposed Ras Markaz Oil Pipeline crosses 5 Oil and Gas concessions, which are:</p> <p>Block 62 operated by Occidental Oman, Block 6 operated by PDO, Block 64 open block, Block 4 operated by CC energy, Block 54 open block and Block 55 Petrogas.</p>	<p>facility will be located in an area adjoining the existing dumpsite.</p> <p>A new Sewage Treatment Plant (STP) has been constructed in Duqm. The STP is located close to the existing landfill and has a capacity of 2,000 m³/day. Additionally, two 5,000 m³/d wastewater treatment facilities have been proposed by SEZAD.</p> <p>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. 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.</p> <p>Power is generated in Duqm 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.</p> <p>At present a reverse osmosis (RO) water desalination plant, with an initial daily capacity of 6,000 m³, provides water in Duqm. Further expansion of the RO plant along with the water distribution network is underway to meet the expected rise in demand.</p> <p>The villages have varied type of housing units, depicting the economic and social status of each individual. An area of 23 km² 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.</p> <p>There is a 12-bed local hospital in Say village, with health centres at Heytam and Ra's al Madrasah. The hospital is currently being expanded to include a dental clinic.</p> <p>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.</p>	

RECEPTOR	ESIA BASELINE				
Local business / economy	<p>The economy of the Al Wusta Governorate is characterised by its oil and fisheries resources, which constitute the two major export commodities of the Sultanate. Fishing and animal husbandry are the main occupation of the Al Wusta population.</p> <p>The Al Wusta communities are slowly adjusting to the new reality and emerging livelihood strategies which present new challenges and opportunities as a result of the on-going development of SEZAD and the corresponding changes from a traditional to faster-paced contemporary way of life associated with industrial and infrastructure development.</p>	<p>Apart from fishing and livestock rearing the local population are also benefits from outside employment. In Ad Duqm Wilayat - Duqm port, dry-dock and other construction companies are major recruiters of the local population in the form of low grade jobs such as drivers.</p> <p>Moreover, some service industry growth is also apparent in the region. General stores and coffee houses, water transportation and other small businesses are evident within the region providing income opportunities.</p>	No information.	<p>The port and shipyard is expected to enhance the Omani economy in terms of diversification and creation of job opportunities for Omani citizens.</p> <p>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.</p>	<p>Despite Duqm's distance from other strongholds of national economy, the region has seen significant recent growth; the population of the Al Wusta region increased from 25,499 in 2006 to 40,936 in 2014 (National Statistics, 2015), an increase of 60.5% compared to the population increase of Oman which was 54.9%.</p> <p>In addition, the development of the Duqm Port required moving fishermen from port area to the beach area known as Antoot. From there, they are to be moved to the New Fishing Harbour south of Port Duqm. This will affect fishermen who regularly fish and store their boats and equipment on the beach close to Antoot. Based on the site observations in March 2017, it is estimated that around 20 individual fishermen (but not households) will be affected by the move to the Fishing Harbour.</p> <p>For more details on the the local economy please refer to the scoio-economic and health baseline report (REPORT NO 70029220-05-C-BASE/SOC).</p>
Local Residential / Community	<p>The Project Influence Area covers 11 settlements that are part of Ad Duqm wilayat. The majority of the settlements are located along or near the shoreline, of which 6 are unpopulated as per 2010 Census. The total population of the 5 populated settlements is 7,051.</p>	<p>The Al Wusta Governorate, situated in between Al Dhahirah and Ad Dakhliyah Governorates (North) and Dhofar Governorate (South) with mainly four Wilayats (Ad Duqm, Hayma Mahout and Al Jazer) accounting together an area of about 77,853km² had a population of 22,983 as of 2003 census.</p>	<p>The Crude Pipeline route will cross Adh Dakhiliyah and Al Wusta Governorate which makes up 25.8 % of the land area of I Oman, however only represents about 1 % of the population in the Sultanate (i.e. about 40,151 persons) and hence has a low population density of 0.5 persons per km².</p> <p>Adh 'Dakhiliyah Governorate on the other hand has a population of 387,111 making up 10.3% of the land area and hence a much higher population density of 12.1 persons per km². Out of the 19 villages identified within 5km of the Pipeline ROW only 8 are populated.</p>	<p>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.</p> <p>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.</p>	<p>The total population in the Al Wusta Governorate is split: 54% Omanis and 46% foreign workers or expats. This illustrates a slightly higher presence of foreign workers in the Governorate compared with the average national level (NCSI, 2015). The population of the Ad Duqm area shows the same trend, where the total population of 8,559 people (or 0.2% of the total population) is split: 52% Omani and 48% foreign citizens.</p> <p>At the national level, in 2015 over 28% of the total population in Oman was represented by the youth demographic and children who, under the national statistics, fall into the 1-19 years' old age range. Importantly, over 57% of the total population are 20-44 year olds, where there are two foreign workers/expats for every Omani in the same age category. In Oman, only 2.4% of the total population falls within the above 65 years of age category.</p> <p>Desktop research on literacy levels in the region showed that although Al-Wusta has 23 basic education schools in the region (NCSI, 2015), the level of literacy is generally quite poor, when compared to the national figures.</p> <p>For more details on the residential and community findings including, education, unemployment, asset ownership, income and health please refer to the scoio-economic and health baseline report (REPORT N^o 70029220-05-C-BASE/SOC).</p>
Traffic and Transport	<p>Public Highway 32 acts as the DSEZ main arterial road. This road, with additional current informal access trcaks have been developed across the central part of the DSEZ area to provide access to the port and dry dock, which are currently under construction. Construction of Road 5 has already commenced.</p>	No Information	No Information	No Information	Additional information not part of the WSP ESIA Consolidation Scope..

RECEPTOR	ESIA BASELINE				
Cultural Heritage	<p>Amongst the numerous studies, Duqm was observed to be extremely rich in archaeology sites and a number of discoveries were made in area adjacent to the location of the proposed master plan for Duqm.</p> <p>The Rock Garden is a 3 km² area of limestone and sandstone rocks which formed in an underground freshwater aquifer over 46 million years ago. With time it has been shaped by wind, water, frost and other natural forces. This has been earmarked for formal protection as a dedicated tourist site and to integrate it with the tourism master plan.</p> <p>Moreover, despite extensive exposure to weathering and erosion, these sites have been well preserved on their own accord as erosion at many sites was observed to be extremely slow.</p>	<p>The Crude Oil Park site is a Greenfield site with very limited existing information available in relation to artefacts and archaeological remains. Archaeological sites in region exhibit the historic remains of the earlier locations and systems of settlements. These include archaeological sites as well as other exposed or underground sites comprising historic caves, remains of castle, graves, fragments of structures etc.</p>	<p>The Crude Pipeline route passes through the Huqf region and this area is of particular interest as it contains rocks from almost all of Oman's geological history. Using mineral isotopes the oldest rocks in the area are dated at about 730 million years.</p>	<p>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.</p>	<p>Updated surveys were carried out around the geographic area of the Duqm Refinery Project. These were carried out along the Crude Pipeline right of way and DRPIC Ras Markaz site as these areas were previously unsurveyed. Results revealed a total of 24 new archaeological sites. Most archaeological sites mapped during the survey were found in association with naturally occurring conchoidal stone outcrops of chert, flint, quartz, and quartzite. These lithic (stone tool) raw material sources were mainly found in the northwestern part of the survey area. Other new archaeological and architectural discoveries included Lower Palaeolithic remains, circular stone cairns, stone fireplaces, circular stone houses, large anchor stones and a trilith feature.</p> <p>There are also four locations considered to be of potential geological interest, the fossil outcrops, active hyperalkaline spring heads north of Duqm, and artesian springs on the edge of the escarpment. These loci are unique geological features on the landscapes around Duqm. For more details on the survey findings including their individual descriptions and locations, please refer to the cultural heritage baseline report (REPORT N^o 70029220-102-BS01).</p>

APPENDIX C-2

DUQM SEZ VEC BASELINE

RECEPTOR	ESIA BASELINE The Duqm SEZ (DSEZ) Area ("Site")
Materials / natural resources	Materials and natural resources are purchased from third party suppliers, and location of resources can vary from local, regional and national.
Land Use	Parts of the extensive DSEZ are traversed by a network of vehicle, goat and camel tracks. This allows small sections of the DSEZ to be used as an open thoroughfare for the local population, to access the beach at the eastern edge of the SEZ. Fish landing sites and fish drying shacks that are sporadically spread across the area in the west of the port area. However, most of the expansive Duqm SEZ is undeveloped and desert.
Topography	<p>A land use of note in the Duqm area is the Arabian Oryx Sanctuary that lies outside of the DSEZ project area, adjacent to the western boundary. This area has been designated to preserve undisturbed habitat for the benefit of the future of the species.</p> <p>The wide range of contrasting landscapes that characterise the site represent a valuable natural heritage. Over centuries, the people of Oman have developed a culture inextricably linked to the landscape and natural environment of their country. In general, the site can be classified by low-lying coastal and alluvium plains that are enclosed to the north, west and south by sandstone and limestone hills that lie at the foot of the Huqf escarpment. To the east the site meets the Gulf of Oman, with sandy beaches backed by dunes and non-tidal lagoons (khawrs). The area is incised by wadis that flow from the escarpment to the sea. This landscape arrangement is typical of the landscape along the eastern coast of Oman. The DRPIC site has an elevation varying between 2 - 20m above mean sea level , although the greater surrounding topography is very variable and ranges up to 190 m above sea level. Even in areas of similar topography land levels are very variable and undulating, mainly resulting from fluvial flash flood erosion and deposition processes.</p> <p>It is observed that some areas consist of extreme gravely, sandy, deep soils. Dunes and rock outcropping with shallow crusted, sandy soils are also present in the DSEZ. The landform of the area, with its predominantly flat plains surrounded by high escarpments, would make a development the size and type of Duqm DSEZ visible from all areas whose aspect faces the project site, including the coastal zones and marine environment.</p> <p>The landscape character of the overall DSEZ is typical of mature marine fringe environments in the Al Wusta region, which is generally characterised by an open coastline backed by sand and alluvium plains and hills.</p>
Air Quality and Odour	The previous data collected for the DSEZ baseline Air Quality was identified to be deficient. More recent and updated information regarding the DSEZ areas Air Quality baseline is given in Appendix C-1.
Noise	<p>A noise survey was undertaken to inform the understanding of baseline conditions within the DSEZ. A distribution of sampling locations was to obtain a general overview of existing baseline conditions throughout the DSEZ, as related to different geographic areas and the position of existing and future sensitive receivers.</p> <p>The results show that, at the time of the baseline sampling, the equivalent noise levels determined exceeded the MD79-94 threshold for rural residential areas during all samples but one. Similarly, more than half of the samples recorded indicate that the threshold for noise originating from an industrial source would have been exceeded despite the absence of any significant anthropogenic sources of noise within the Duqm development site at the time of sampling. The primary source of noise was invariably noted as coming from strong wind, a phenomenon affecting the Duqm development site as a whole; given the open nature of the site it is subject to the vagaries of the coastal weather systems that operate there. Low surf noise was detectable at some of the sample sites more proximate to the coast. It must be noted that the DSEZ masterplan wide baseline surveys were reported in 2011 and more recently, further surveys have been undertaken with greater relevance to the the Duqm Refinery Project, with the results summarised in Appendix C-1.</p>
Surface Water	<p>There is no permanent surface water on land as is typical for this region. Although wadis will flow during storms, water will only be present for a short time until it percolates to groundwater, drains to the sea or evaporates. In addition, any pools will evaporate quickly, which is supported by the development of sabkha in extensive areas across the DSEZ. The key long term surface water resources are associated with the marine zone, which lies immediately adjacent to the DSEZ and is connected via wadi flows that discharge to sea.</p> <p>Marine baseline water quality surveys have been completed as part of monitoring studies to support the port. These surveys have comprised of nearshore surveys in the port area and offshore surveys for the disposal area and borrow area. It must also be noted that these surveys were completed prior to any development occurring in this area and it is likely that conditions may have changed following construction. The survey was also undertaken in relatively nearshore areas within and adjacent to the port area. However, the information gathered in 2008 does provide information on natural baseline conditions and are of some relevance to the waters that front the wider DSEZ.</p> <p>The results of surveys show that the waters off Duqm are naturally rich in nutrients that support abundant wildlife. Water quality is generally very good. However, very high levels of nutrients were recorded that are linked to the movement of deeper colder waters flowing to the coast. The recorded ranges for temperature (26.6 – 27.8°C), salinity (34.9 – 36.9 ppt), dissolved oxygen (4.4 – 9.4 mg/l) and pH (8.1 – 8.5) were recorded, which are consistent with conditions expected at the time of survey. Higher dissolved oxygen levels are noted in nearshore surf zones as would be expected. Turbidity values varied from 0.3 to 6.3 NTU with the lower values noted in surface layers.</p>

RECEPTOR	ESIA BASELINE
Groundwater Hydrogeology	<p>In general, regional groundwater flows slowly inland from higher rainfall and recharge zones in north Oman Mountains in the Al Bhatina region and southern mountain areas in Dhofar. As the rain water penetrates the soil to the north and the south of Oman, it reaches deep soil horizons beneath the central part of Oman (including the Al Wusta region), commonly over 100 m below the ground surface. This ground water is transported to the west (towards Saudi Arabia) and east (towards the coast). This groundwater is highly saline.</p> <p>In the Duqm area, fresh groundwater lenses will likely occur after periods of strong rainfall which lead to run-off and infiltration to recharge lenses. The freshwater will therefore only be periodically available, although no fresh groundwater lenses were identified in the 2017 surveys of the area. Due to the erratic rainfall and its short duration, this localised rainfall is not expected to recharge deep groundwater wells.</p> <p>A number of wadi channels traverse the IDZ, Wadis generally run from higher ground to the rear of the DSEZ and flow downhill across the DSEZ area where they finally discharge to sea. Runoff is channelled via smaller tributaries that feed the larger wadis. However, in some instances smaller channels do not converge and they discharge directly to the sea. All wadis are generally deeply incised until they reach very flat areas and have wide discharge areas, particularly the larger wadis; this is representative of the extreme nature of flows and their erosional capacity due to the sediment type and geology of the area and the bed load or suspended load in wadis following erosion across the catchment area.</p>
Soil	<p>The genesis of soils in the DSEZ largely comes from the surrounding limestone geology. Most of the soil is classified as loamy to sandy soils and some of them are skeletal. The soil in the DSEZ can range from moderately to strongly saline soil. Some gypsum pans are present in the DSEZ which can be found in strongly dissected high alluvial terraces and fans. It is noted that some areas consist of extremely gravelly, sandy, deep soils. Dunes and rock outcrops with shallow crusted sandy soils are also present in the DSEZ.</p> <p>It is clear that soils of the DSEZ are largely derived from historic and recent natural alluvium deposition. The periodic flash floods lead to flooding across the DSEZ. When rainfall events occur, surface runoff water moves according to the elevation gradient across the DSEZ. This surface water transports rock and sediment, which is deposited in low lying areas and depressions to form the alluvium plains that are spread across the DSEZ. As would be expected, these deposits lie on the flat plains of the DSEZ and intersect hilly outcrops running alongside existing and historic wadis. In depressions water also accumulates, forming ponds that are exposed to high evaporation processes that leave salt behind. In addition to alluvium deposits, marine deposits are located along the coast, which consist of mudflats in low lying areas and coastal dunes.</p>
Marine Ecology	<p>Due to the high level of productivity in the water column, the marine environment at Duqm is subject to highly turbid conditions, which limit the development of any significant expanses of coral in the area. Certain macroalgae occur in unusually large quantities for the Arabian region in terms of relative biomass. In particular, dense beds of the brown algae grow in specific areas within the shallow sublittoral to a depth of about 9 m, contributing substantially to overall productivity and supporting a range of marine life, although no substantial areas of macroalgae were identified during historic baseline surveys.</p> <p>Overall, infauna communities were noted as being of moderate diversity and abundance in the port area and low diversity and abundance at the disposal and borrow areas. There is clear correlation that infauna species abundance and diversity decreases significantly further offshore.</p> <p>Due to the highly productive waters and, until recently, a history of relatively low fishing pressure, coastal areas of Al Wusta have supported an active fishery. Fish landings include large pelagics such as yellowfin tuna, longtail tuna, kingfish, queenfish; small pelagics such as sardines, mackerel; demersal fish like emperor, sea bream, grouper, crocker, catfish; crustaceans include lobster, shrimp, cuttlefish, abalone; and sharks and rays. This gives some indication as to which species of fish can be found offshore from Duqm. However, it must be noted that the precise location of fishing for landed fish is not known and this therefore only provides an indication of fish that may be present in the area.</p> <p>Cetaceans and turtles are distributed across nearshore and offshore habitats according to their needs for feeding, breeding, migration, and related behaviour at different times of the year. Among the habitats that they use, some are more critical than others. Marine mammals in Oman include about 21 species of whales and dolphins, which are top predators feeding in both deep and shallow waters on a wide range of prey. More common species include spinner dolphins, Arabian long-beaked common dolphins, false killer whales, bottlenose dolphins and Risso's dolphins. Less commonly occurring species include the spotted dolphin, killer whale, pygmy killer whale and Cuvier's beaked whale. The majority of species are known to be breeding residents of Oman. Of the larger whales, the Bryde's whale and humpback whales are the most frequently recorded in the area, both of which are known to feed and breed here. Little is known about the rare blue whales, but there appears to be some seasonality to the sighting records, which suggests a migratory route through the area in winter months.</p> <p>More recent and updated information regarding the DSEZ areas Marine Ecology baseline is given in the biodiversity assessment report (REPORT N^o 70029220-04-CL-TECH/BIO) and the associated Appendices A-F.</p>
Terrestrial Ecology	<p>The central section of Oman falls within the Arabian regional subzone phytochorion. In general, the vegetation of the central desert is sparse with low species richness. Indeed, despite covering nearly three quarters of Oman's land mass, it is estimated that only about 200 floral species, approximately 20% of the total species in Oman, occur within the central desert. Despite this, the limestone plateau of the central region is classified as a centre of local endemism with twelve endemic species and five threatened species occurring there. An increase in vegetation cover and richness occurs from the western to the eastern sections of the central desert as a result of the increasing effect of the heavy fogs and dews in the east. This moisture is crucial to sustaining perennial vegetation species and other wildlife during periods of drought in the hyperarid areas.</p> <p>The central region of Oman is dominated by a limestone plateau and gravel plains and includes the Arabian Oryx Sanctuary (AOS). The sanctuary was formerly listed as an UNESCO world heritage site, but it has since lost this status. The area is noted for its various plant and animal species such as the Arabian Oryx, Nubian Ibex, Caracal, Arabian Gazelle, Houbara Bustard and other animals. The site is also noted for its desert ecosystem biodiversity, including the Jiddat al Harasees; Huqf escarpment and depression; pools of Wadi Ash Shinan and the surrounding sabkha, woodlands and pastures.</p> <p>The DSEZ comprises a mosaic of seven main habitat types consisting of: a coastal zone (comprised of khawrs, intertidal mudflats and beaches); sabkha; wadi courses; gravel and sand plains; low rocky outcrops and gravel hills; Piedmont and foothills and finally rocky mountains and escarpments. The coastal zone habitat type is the smallest within the DSEZ, covering approximately 0.24% of the site. In the wider Duqm area it can be subdivided into three sub-categories: beach and back beach, khawrs and intertidal mudflats. Mudflats are present elsewhere in the Duqm area (e.g. near the port), but were not recorded within the DSEZ site.</p> <p>The sabkha in the DSEZ stretches from the coastal zone further inland, principally between areas of gravel and sand plains habitats. Tracks have been graded through the sabkha which has caused some fragmentation and litter has accumulated in areas close to the road. Sabkha only constitutes a relatively small proportion (7.46 %) of the DSEZ.</p> <p>The Duqm area was categorised as an IBA principally because of the importance of the shallow, sandy bay of the Ghubbat Quwayrat, which includes intertidal mudflats and a few small coastal khawrs (lagoons). This area lies to the east of the DSEZ in the area designated for Port Development in the overall Duqm Masterplan. southern end of the IBA has already been lost due to the development of the port.</p>

RECEPTOR	ESIA BASELINE
	<p>This area is a significant 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. A total of 120 bird species are recorded for the Duqm area by the OBRC and 115 in the IBA list, due to five species recorded by OBRC since the publication of the IBA document. The great majority of these species are marine or shoreline species (62%) and/or migratory (54%). Some species can be included in both categories. The species in greatest numbers (several thousand each winter) are the gulls and terns, that depend upon fish as a food source and are undoubtedly attracted by the fishing activities and associated waste.</p> <p>As is the case with most areas in Oman with low productivity and prey base, the mammalian fauna of the study area is likely to be constrained, particularly in terms of the larger species.</p> <p>At least 15 species of mammal have been recorded in the AOS (MECA, 2008), although it is unlikely that all of those will occur in the study area due to their habitat preferences, and in some cases low population numbers. Examples of species present in the AOS but unlikely to inhabit the site include the Arabian Oryx (<i>Oryx leucoryx</i> - regionally endemic and endangered), which are almost exclusively restricted to fenced enclosures in the Sanctuary and will not be released until the AOS boundary is fenced. Other species unlikely to venture into the DSEZ site include Sand Gazelle (<i>Gazella subgutturosa</i> - Vulnerable), which are scarce and are reported to favour the northern and western sections of the Sanctuary, and the Ruppell's fox (<i>Vulpes ruppellii</i>) and sand cat (<i>Felis margarita</i>), both of which prefer low-lying sandy areas and dunes. Species such as Striped Hyaena (<i>Hyaena hyaena</i> - Critically Endangered in Oman), Caracal (<i>Felis caracal</i> - Endangered in Oman), and Arabian Wolf (<i>Canis lupus</i> - Endangered in Oman) which used to occur along the Huqf escarpment have not been formally recorded there for many years and may no longer occur in the AOS. It is therefore unlikely that they inhabit the DSEZ.</p> <p>Of the total 39 species recorded, 12 are snakes, 26 are lizards, and one is an amphibian. Thirty one of the species have been confirmed as occurring in the area, and a further eight are considered likely to be present. A diverse reptile fauna exists in the Duqm area, apparently concentrated in sandy and gravel habitats supporting reasonable vegetation cover. The foothill areas exhibited the greatest diversity, due undoubtedly, to a great variety of niches in the form of shelter, along with scattered areas of reasonable vegetation cover. This would provide the richest food resources, as well as shade and suitable cover for nocturnal species during the day. Habitats with limited vegetation cover had seemingly limited reptile niche availability – the sabkha and mountain areas of almost bare rock.</p>
Local Infrastructure	<p>No baseline information available in the Duqm Industrial Zone EIA.</p>
Local business / economy	<p>There was an active fishing industry in Duqm and a associated fish processing and packaging plant located to the north of the main area of Duqm town. This plant has been decommissioned (when the Port of Duqm was built) and current facilities are temporary and informal along discrete areas of coast. New facilities are to be located at the New Fishing Harbour south of the Port of Duqm.</p> <p>The Al-Wusta region, including the northern part of Dhofar, is said to account for about 70% of all the artisan fish landings as identified by the Ministry of Fisheries Wealth statistics. The fishery is mixed (i.e. targets different stocks including pelagics, demersal, sharks and rays, crustaceans, cuttlefish and squid) and is governed to a great extent by seasonality. Although fisheries represent the major source of income to most households, some supplemental income is also generated through livestock farming (goats, camels). Meat, milk, oil and cheese, as well as some handicraft products, are all important in the communities. Camels, goats and donkeys are grazed in areas surrounding the villages, including those within the DSEZ.</p>
Local Residential / Community	<p>Some high level socio-economic details included in certain local EIAs prepared earlier for various project components, (i.e. EIA Study for Duqm Industrial Free Zone Masterplan, 2011) do not include sufficient socio-economic baseline data. In addition, national social statistics are being regularly updated and as a consequence the earlier high level socio-economic details can be considered outdated.</p> <p>Despite Duqm's distance from other strongholds of national economy, the region has seen significant recent growth; the population of the Al Wusta region increased from 25,499 in 2006 to 40,936 in 2014, an increase of 60.5% compared to the population increase of Oman which was 54.9%.</p> <p>The Al Wusta Governorate is spread over 79,700 km² and consists of four Wilayats: Hayma, Muhut, Ad Duqm and Al Jazir, with the total population in the Governorate of 40,936 people (or 1% of the total population) and a population density of only 0.5 ppl/km². The total population in the Al Wusta Governorate is split: 54% Omanis and 46% foreign workers or expats. The population of the Ad Duqm area shows the same trend, where the total population of 8,559 people (or 0.2% of the total population) is split: 52% Omani and 48% foreign citizens.</p> <p>Al Tayari, Nafun and Antoot are located within the study area. Within these areas, camel and goat rearing is an essential livelihood activity which can have a large influence over local households' incomes.</p>
Traffic and Transport	<p>Parts of the DSEZ are traversed by a network of vehicle, goat and camel tracks. This allows sections of the DSEZ to be used as an open thoroughfare for the local population, to access the beach at the eastern edge of the DSEZ.</p> <p>A public highway (Public Highway 32) acts as the DSEZ main arterial road. This road, with additional current informal access tracks have been developed across the central part of the DSEZ area to provide access to the port and dry dock, which are currently under expansion. Additions to the current road network are already under construction, including Road 5.</p> <p>Furthermore, the Duqm regional Airport has been established and is designed to accommodate all types of aircraft, including those handling large passenger numbers and air cargo loads with in-flight catering facilities. It is comprised of a passenger terminal with a capacity of 500,000 travelers per year, a 4 km runway, a cargo terminal with an initial 50,000 ton capacity and duty-free shops. Additional expansion and modifications to the airport are currently in development (e.g. Airport Project Phase 3 and Air Traffic Control Tower).</p>

RECEPTOR	ESIA BASELINE
Cultural Heritage	<p>A number of archaeological studies have been carried out in the proximity of the masterplan area. Preliminary evaluation of archaeological sites in the Duqm area suggested that very little other than graves date from the Islamic era, but there is a wide spectrum of evidence of human occupation from late pre-Islamic times back to the Early Stone Age. In Oman, generally, burial sites of all eras are found on higher ground, normally where there is rocky material to place over the grave. This, as elsewhere in Arabia, is to prevent scavenging by hyaenas. Burial on higher ground also helps to ensure that graves are not disturbed by flood. It has also been suggested that burial on high ground may have had religious significance in the past. Islamic burial sites, identifiable from the presence of one or two vertical stones, are especially sensitive and any development that might disturb them has to be referred to the Ministry of Awqaf and Islamic Affairs.</p> <p>Previous archaeological walk-over surveys recorded 174 archaeological sites in the Duqm SEZ. In addition, one geological site and seven archaeological sites were identified outside of the DSEZ. Of these sites in the SEZ, 12 had previously been recorded. In addition, available data from the Reto Jagher survey has identified a further four sites that were not investigated as part of our survey. This therefore means that there are 178 archaeological sites in the Duqm SEZ. Archaeological features found mainly consist of triliths, burial sites and flints.</p> <p>Towards the mouth of Wadi Sidrah there is a cluster of important archaeology, which as a group is considered to be worthy of protection. The archaeology in this area comprises graves, cemeteries and shell middens. The trilith site on the Sidrah road (archaeological site 146 just outside the IDZ boundary) where new buyut sha"abiyah are being built has been damaged by the movement of heavy machinery. This site is a visible feature adjacent to the main access to Sidrah from the northwest, so is relevant to the amenity resources of the DSEZ.</p> <p>The central area of the site has a swathe of archaeological locations along the southern edge of the foothills. The features are generally limited to burial grounds, with the majority being single graves. There is also a well-known traditional sacrificial site, known as Ayn Maqfaad", near the road in this area. The area around in the south of the site includes a variety of archaeological sites, including triliths, burial mounds and flint scatters. The site is also of geological value. This area also forms a connective band of archaeology with sites outside of the DSEZ that</p> <p>Shinan Pools sites sit outside of the DSEZ to the west it is a major natural feature with potential for use by visitors in sustainable numbers. As a source of drinking water for the Nubian Ibex, it must be managed to ensure that they remain protected with minimum disturbance. Nearby is a group of trilith sites, some woodland and a further smaller trilith site, within the IDZ boundary, where there are also Islamic graves and a current bedui settlement.</p> <p>More recent and updated information regarding the DSEZ areas Cultural Heritage baseline is given in the Culutral Heritage Baseline Report (Report N° 70029220-102-BS01).</p>

APPENDIX C-3

VEC SENSITIVITY AND VALUE

SENSITIVITY AND VALUE OF THE VECS

RECEPTOR GROUP	SENSITIVITY	JUSTIFICATION (EXAMPLES)	VALUE	JUSTIFICATION (EXAMPLES)
Natural capital	Low	Resources can be obtained from national and extra-national sources	High	Envisaged that resources will be sourced locally. Where there is poor availability or insufficient quantity and/or quality, procurement of such resources will extend to wider Oman.
Land Use	Low	The land throughout the Duqm SEZ is typical of the Al Wusta region and consider to be of low significance.	Low	Extent of land affected is expected to remain localised to the Duqm SEZ.
Air Quality and Odour	High	Air pollutants may affect human health and there could be permanent or irreplaceable change.	Low	The contribution from the Project's emissions will impact baseline pollutant concentrations in the Duqm SEZ.
GHGs	High	GHG emissions released to the atmosphere would be difficult to reverse and amend.	High	The Project contributions of GHG emissions will add to national contributions and Oman's annual GHG emission output.
Noise	Medium	Noise can cause nuisance to individuals, but the effects are considered less severe and potentially act over a shorter period in comparison to other VECs influencing human health (air quality).	Low	The contribution from the Project noise emissions will impact baseline concentrations in the Duqm SEZ.
Groundwater / Hydrogeology	High	Any major spillages or incidents, which is considered to be unlikely, would affect the quality of groundwater systems, and contribute to a contaminated resource, including soil.	Low	The impact (if any) is predicted to be limited to the Duqm SEZ.
Soil	Medium	The soil is situated on either purpose-built land (i.e. prepared) or of low quality to sustain other uses such as grazing or agriculture.	Very Low	Impacts on soil quality are likely to be localised (i.e. in the immediate footprint of the Project) and of short duration.
Surface water quality (freshwater / marine)	High	Valued surface water courses are susceptible to changes in water chemistry through run-off or spill.	Medium	Although impacts are likely to be more evident in the Duqm SEZ, surface water quality and associated flow/run off could have an impact on a wider and regional geographical scale.
Topography / Landscape	Low	The areas landscape arrangement is not highly valued (i.e. not protected), due to it being typical of the landscape along the eastern coast of	Medium	The area of development will be concentrated in the Duqm SEZ. However, it is possible that the Project will change the landscape of a part of the Al

RECEPTOR GROUP	SENSITIVITY	JUSTIFICATION (EXAMPLES)	VALUE	JUSTIFICATION (EXAMPLES)
		Oman.		Wusta region.
Marine habitats, flora and fauna	Appendix C.3	Appendix C.3	Appendix C.3	Appendix C.3
Terrestrial habitats, flora and fauna	Appendix C.3	Appendix C.3	Appendix C.3	Appendix C.3
Resident population	High	The impact to human health could be permanent or have a irreplaceable change.	Medium	Although direct health impacts are likely to be more evident in the Duqm area (air quality), there could be impacts that act on a wider regional geographical scale (contamination).
Local business / economy	Low	Current business in the area is only on a small and local scale. However, there is a large potential to accommodate change.	High	The Project has the potential to enhance economic value on a national scale in Oman.
Local Communities / Assets	High	Alterations to the local communities in and around the Duqm area will alter due to a spike in population and influx of foreign workers.	Medium	Impact on the Duqm SEZ is inevitable. However, population increase and community alterations through national and international migration may occur in the wider Al Wusta region.
Road Traffic / Transport	Low	The current transport network mostly consists of dirt tracks. The area is used as an open thoroughfare for the local population and there is a large capacity to accommodate change.	Medium	Improvement of roads and enhanced traffic will occur in the Duqm area. Enhanced road traffic is also likely to occur within the Al Wusta region via connecting link roads.
Local infrastructure	Medium	There is currently a little amount of local infrastructure, but it has been recently enhanced by an international port. There is still capacity for further infrastructure development in the DSEZ.	Medium	Although infrastructure will be being built directly in the Duqm area, it can provide a catalyst and base to support future growth in the Al Wusta region.
Culture Heritage	High	Risk of accidental damage to archaeological sites is considered to be significant and potentially irreversible, although very unlikely.	High	Cultural heritage and archeological sites will hold significant Omani value and will be of national importance.

APPENDIX C-4

BIODIVERSITY VEC SENSITIVITY

BIODIVERSITY VEC	SENSITIVITY
Designated Sites	
Duqm Important Bird Area (IBA)	Very High
Jidat Al Harrasis IBA	Very High
Terrestrial - Natural Habitats	
Intertidal mudflats, sand and lagoon areas (in Duqm IBA)	High
Endangered, endemic plant species (<i>Salsola omanensis</i> , <i>Ochradenus harsusiticus</i>)	High
Endangered carnivores (striped hyena, Arabian wolf, Ruppell's Sand Fox)	High
Mountain areas	Medium
Wadis	Medium
Ibex and Gazelle	Medium
Marine – Natural Habitats	
Shallow coastal habitats (0-20m)	Medium
Marine – Species	
Arabian Sea Humpback Whale	Very High
Indian Ocean Humpback Dolphin	High
Turtles (Green, Loggerhead and Hawksbill).	High
Other whales and dolphins	Medium

Appendix D

**BIODIVERSITY VEC MAGNITUDE, SIGNIFICANCE AND
RECOMMENDATIONS**

APPENDIX D-1

BIODIVERSITY CONSTRUCTION MAGNITUDE, SIGNIFICANCE AND RECOMMENDATIONS

VEC (SENSITIVITY)	CUMULATIVE IMPACT ASSESSMENT	SIGNIFICANCE OF CUMULATIVE IMPACTS	RECOMMENDATIONS	RESIDUAL IMPACT
Duqm Important Bird Area (IBA) (Very High)	<p>12 ha (approximately 1%) of the IBA comprising shallow, sandy bay, intertidal mudflats and small coastal khawrs (lagoons) was permanently removed to construct the Export Terminal which is an AF and Port Road Number 5 which is a separate development. The Port of Duqm Authority aims to expand Duqm Port in the future; further permanent loss of coastal habitats in the IBA will occur in the future – area yet to be defined. Construction of the Project topsides will result in disturbance of birds in the IBA possibly preventing them from foraging and roosting in habitats within close proximity to the Export Terminal. Construction disturbance will be temporary (for approximately a year).</p> <p>The IBA is unlikely to be able to support the numbers of wetland bird species for which it was designated as a consequence of habitat loss and disturbance. It may also be the case that certain micro-habitats have been removed by construction and thus the suitability of the IBA for certain bird species may be reduced (the species affected cannot be predicted without detailed topographic survey data and bird habitat suitability modelling). This effect has been predicted to be of very high magnitude in the construction phase.</p>	Major significant.	<p>The following measures should be secured via Strategic Initiative Approach.</p> <p>i) Enhancement of the remaining area of the IBA (construction of channels, clean-up of litter, provision of visitor facilities); ii) Onsite creation of constructed wetland using dredging spoil; iii) Offsite creation of constructed wetland using dredging spoil.</p>	Minor non-significant.
Jidat al Harrasis IBA (Very High)	No significant adverse construction phase impact was predicted for the Project and there is little potential for an adverse cumulative construction phase impact.	Not applicable.	None required.	Not applicable.
DSEZ Nature Reserve (High)	A slight adverse impact resulting from minor habitat loss caused by construction of the DRPIC Crude Oil Pipeline was predicted. No detailed plans for further encroachment in the DSEZ Nature Reserve are known and thus cumulative construction phase impacts are unlikely.	Not applicable.	None required.	Not applicable.
Al Wusta Wildlife Reserve (Very High)	No significant adverse construction phase impact was predicted for the Project and there is little potential for an adverse cumulative construction phase impact.	Not applicable.	None required.	Not applicable.
Wadis in close association with mountains & Wadis in open terrain (High)	Up to 5.3 km ² of this habitat could be directly removed/disturbed to facilitate Refinery, DRPIC Crude Oil Pipeline construction and construction of the Crude storage facility at the RM Crude Oil Terminal. Further areas (area unknown at this stage) of this habitat will be removed when the wider RM Crude Oil Terminal is built, when the construction camps are built and when further development is progressed in the SEZAD Heavy Industry Zone. In the Duqm region, this habitat type is relatively abundant. However, wadis are the key habitat type supporting trees which are relatively rare or survive as minor components outside wadi systems. Because they support more vegetation which is otherwise scarce on the desert plain and, in some cases also springs or other permanent water, they are of high value for species such as ibex and gazelle. Cumulative impacts of high magnitude are predicted resulting from habitat loss.	Moderate significant.	<p>Mitigation proposed in the biodiversity chapter relating to the Project alone is as follows:</p> <p>i) Minimise footprint a wadi crossings. ii) Reinstate wadi crossings to ensure natural passage of seasonal flood flows. iii) Compensatory landscape planting using native/endemic tree species.</p> <p>In addition to the above measures which will occur in the Project Footprint - recommendations in the biodiversity offsetting framework (Biodiversity Assessment - Technical Appendix E) to comply with the IFC PS 6 requirement to achieve no net loss of natural habitat associated with the Project should be progressed.</p> <p>Cumulative habitat loss impacts should be addressed by application of Performance Standard 6 offsetting targets to other projects and Associated Facilities. This will require SEZAD policy support to ensure inter-project application of no net loss principles relating to natural habitat.</p>	Minor significant.
Rocky mountain & escarpment (High)	No significant adverse construction phase impact was predicted for the Project and there is little potential for an adverse cumulative construction phase impact.	Not applicable.	None required.	Not applicable.
Shallow coastal habitats 0-20 m - (Medium)	No significant adverse construction phase impact was predicted. Although habitat loss will be caused by dredging associated with Export Terminal – this is an AF and the impact will be directly attributable to the AF and not the Project.	Not applicable.	None required.	Not applicable.
Endangered, endemic plant species (<i>Salsola omanensis</i> , <i>Ochradenus harsusiticus</i>) (High)	There are multiple locations (over 100 locations listed in the Biodiversity Assessment Technical Appendix C : Critical Habitat Assessment) where the Project Footprint overlaps an area which may constitute critical habitat for two endemic plant species. AF development, further development in the SEZAD Heavy Industry Zone and road and infrastructure construction may further remove habitat for the two endemic plant species. On the basis that habitat which may support these species will remain widespread in the Duqm region but with the knowledge that the population distribution and statuses of these species is poorly known (as little academic research has been undertaken), on a precautionary basis the cumulative impact of habitat loss is predicted to be of medium magnitude.	Moderate significant	<p>i) Preconstruction survey of instances where critical habitat intersects the Project Footprint (see Technical Appendix C: CHA for an inventory). ii) Translocate affected populations of endemic plant species for propagation and eventual use in introduction schemes in the SEZAD area. iii) Contribution toward native plant propagation and introduction scheme.</p> <p>In addition to the above measures which will occur in the Project Footprint - recommendations in the biodiversity offsetting framework (Biodiversity Assessment - Technical Appendix E) to comply with the International Financial Corporation PS 6 requirement to achieve a net gain of critical habitat associated with the Project should be progressed.</p> <p>Cumulative habitat loss impacts should be addressed by application of PS6 offsetting targets to other projects and Associated Facilities. This will require SEZAD policy support to ensure inter-project application of net gain principles relating to critical habitat.</p>	Minor non-significant.
Green,	A slight adverse impact resulting from construction lighting and disturbance from personnel and	Not applicable.	None required.	Not applicable.

VEC (SENSITIVITY)	CUMULATIVE IMPACT ASSESSMENT	SIGNIFICANCE OF CUMULATIVE IMPACTS	RECOMMENDATIONS	RESIDUAL IMPACT
Loggerhead and Hawksbill Turtles (High)	vehicles was predicted. Further development in the Aol is unlikely to threaten key turtle nesting beaches. Biodiversity Assessment - Technical Appendix C: Critical Habitat Assessment provides information on the distribution of key nesting sites. No adverse cumulative construction phase impact is predicted.			
Arabian Sea Humpback Whale (ASHW) (Very High)	There is little construction in close proximity to the marine environment proposed as part of the Project (the Export Terminal Topsides being the exception) and on this basis a significant adverse impact on ASHW associated with the Project alone is unlikely. However, construction of the Single Point Mooring at the Ras Markaz Oil Terminal and construction of the Export Terminal will both introduce a risk of ship strike mortality or injury, underwater noise and changes in prey distribution and abundance arising from disturbance and dispersion of sediments during dredging. Cumulatively, with the low magnitude effects attributable directly to the Project, these effects are likely to result in a Very High impact given the rarity of ASHW (mortality of a single individual may compromise its population status – see Biodiversity Assessment : Technical Appendix C – Critical Habitat Assessment).	Major significant.	<p>Measures to be secured via Strategic Initiative Approach (see Biodiversity Assessment – Technical Appendix C – Critical Habitat Assessment for further detail on the Strategic Initiative Approach).</p> <p>Formation of an 'advisory panel' that guides mitigation and monitoring through linking industry together government, conservation and research interests.</p> <p>DRPIC should request assurance of mitigation strategies implemented by OTTO, PDC and supply chain shipping to address potential indirect disturbance and shipping collisions associated with marine facilities in relation to the Ras Markaz Single Point Mooring facility; and the Product Export Terminal. This should include seeking assurance that available technologies are fitted to ships to minimise acoustic disturbance (e.g. low noise vessel technology engine mountings and low cavitation props).</p> <p>DRPIC should work within the Strategic Initiative to implement a code of conduct for avoidance of marine mammal and turtle collisions and minimum safety standards relating to pollution for all vessels importing and exporting oil products to/from the Refinery.</p> <p>Through a Strategic Initiative DRPIC should consider contributing to the cost of appointing competent cetacean observers on vessels to alert pilots to the presence of cetaceans. A real-time alert monitoring system could also be developed to alert shipping operators to cetacean presence in shipping lanes to enable reactive avoidance measures to be taken.</p> <p>DRPIC should consider contributing to primary research and management of cetacean distribution and ecology; monitoring of marine pollution; and assessment of marine acoustic disturbance to inform dynamic management of cetacean populations.</p> <p>The Strategic Initiative including SEZAD, Omani Government bodies and industrial bodies should produce and publish an oil spill response plan identifying the most sensitive biodiversity areas.</p> <p>The Strategic Initiative including SEZAD, Omani Government bodies and industrial bodies should produce and publish an oil spill response plan identifying the most sensitive biodiversity areas.</p> <p>The Strategic Initiative, SEZAD and Omani Government bodies should work towards implementation of an offsetting approach to address cumulative impacts on marine species (see Technical Appendix E: Biodiversity Offsetting Framework). Such an approach could be linked to a government lead region-wide/Gulf of Masirah wide zoning strategy with designated zones where different activities are prohibited or permitted (see Technical Appendix E – for further information). Implementation of an offsetting strategy may also offer a potential source of funding for conservation measures and would also provide a strategic framework to provide assurance to potential project funders (particularly those requiring compliance with IFC PS6) as implementation of the Duqm Special Economic Zone masterplan is progressed.</p>	Until Strategic Initiative Approach formulated and enacted it is not possible to conclude.
Indian Ocean humpback dolphin (High)	Similar impacts as were reported for ASHW are likely also for the Indian Ocean humpback dolphin. However, this species is more timid and therefore more likely to avoid construction areas, thus no significant adverse construction phase impact was predicted for the Project. As a result there is no potential for an adverse cumulative construction phase impact.	Not applicable	Mitigation for ASHW will be equally effective at mitigating impacts on Indian Ocean Humpback Dolphin as potential impacts for both species are caused by the same factors (acoustic disturbance, pollution and ship strike). It is noted that no mitigation is required for Indian Ocean humpback dolphin owing to the absence of likely significant impacts on this species.	As per ASHW.

APPENDIX D-2

BIODIVERSITY OPERATIONS MAGNITUDE, SIGNIFICANCE AND RECOMMENDATIONS

VEC (SENSITIVITY)	IMPACT SUMMARY	SIGNIFICANCE OF CUMULATIVE IMPACTS	RECOMMENDATIONS	RESIDUAL IMPACT
Duqm IBA (Very High)	A significant adverse impact was predicted for the construction phase associated with sporadic disturbance arising from vehicles, personnel and maintenance operations at the Export Terminal Topsides (Project related). Additional disturbance of birds may arise from the same sources operating in the Port of Duqm. This is predicted to result in an adverse impact of medium magnitude.	Major significant.	<p>Within land owned/operated by DRPIC the following measures should be applied:</p> <p>DRPIC implement a mandatory code of conduct applying to all topside operations in the Export Terminal. This should include suitable controls to limit bird disturbance such as:</p> <ul style="list-style-type: none"> i) Ensuring Export Terminal fencing prevents visual disturbance to birds using the IBA. ii) Using 'soft start' protocols for maintenance operations involving loud, percussive noise and vibration impacts. iii) Provision of designated staff recreation areas which birds are able to habituate to the presence of people in – evidence shows that birds are able to habituate to predictable/regular movements of people and vehicles but less so to sporadic and unpredictable events which caused disturbance of bird feeding and roosting. iv) Include bird conservation issues in the site induction delivered to all staff. <p>To address potential cumulative disturbance impacts DRPIC in collaboration with the Port Authority should implement a programme of bird monitoring (including different seasons to capture migrant bird populations). The aim of bird monitoring should be to assess the extent and severity of disturbance arising from topside and shipping operations. Similar measures to those recommended for DRPIC owned land may be appropriate for Port of Duqm owned land and will be confirmed when the results of bird monitoring are available.</p>	Minor non-significant.
Mountain areas and escarpment (High)	Changes in ozone concentrations resulting from air emissions from the Refinery in combination with other developments in the SEZAD Heavy Industrial Zone may result in polluted air affecting plant and lichen communities. Given lack of ambient air quality baseline information for areas of mountain escarpment potentially supporting notable lichen and plant communities, and the absence of air quality modelling for other potential sources in the SEZAD Heavy Industrial Zone, it is not possible to conclude on potential magnitude of such a cumulative impact. However, it is possible that it could be significantly adverse.	Not possible to conclude until dispersion modelling complete.	<p>Ambient air monitoring and wet/dry deposition monitoring close to sensitive habitat features (lichen and plant communities) to ascertain potential negative effects.</p> <p>Mitigation at source and compliance with air emissions standards. Monitoring of ambient air quality (if required / as informed by monitoring). SEZAD will need to impose appropriate mitigation on third party industrial operators to ensure cumulative air quality impacts are addressed.</p>	Not possible to conclude until dispersion modelling complete and mitigation approach defined (if required).
Shallow coastal waters (Medium)	The potential introduction of invasive species from Project supply chain shipping operations and impingement/entrainment of fish or marine macro invertebrates from water intake systems associated with DIPWP which is an AF may result in a high magnitude adverse impact.	Minor significant	<p>DRPIC should seek assurance from its supply chain and conduct regular audits to ensure environmentally benign anti-fouling technologies are being adopted at water intake/output points and that measures are in place to minimise entrainment/impingement of marine fauna.</p> <p>DRPIC should seek assurance from the Duqm Port Authority and within its own supply chain to verify that stringent environmental controls are in place to address invasive species introduction.</p>	Minor non-significant.
Wide ranging species such as large carnivores, gazelle and ibex	<p>Wide ranging species such as large carnivores, gazelle and ibex (all of which are high value IEFs) rely on a combination of resources that are also widespread such as food resources (prey, carrion, forage and grazing species, neighbouring populations). Because they rely on such a large proportion of the landscape they are sensitive to a range of 'urbanising effects' which may occur during the operational phase of the Project.</p> <p>Potential urbanising effects include: impediment to their movement, and ability to utilise the full landscape which may isolate animals from essential resources; increased mortality owing to road traffic collisions; areas of built development may interrupt commuting routes; increased human population may disturb or directly persecute large mammals.</p> <p>The magnitude of urbanising effects associated with the Project is likely to be low and not significant. This is because although the Project Footprint is large, the Refinery and Crude storage facility at the RM Crude Oil Terminal are relatively localised (in comparison to the extremely wide home ranges of large mammals); and the pipeline will be buried when operational and thus will not form a barrier.</p> <p>Considering the Project alongside its AFs, labour camps and wider infrastructure development in the Duqm SEZ, the cumulative impact magnitude may be increased to medium as the severity of urbanising effects is driven by the cumulative level of human use of the landscape.</p>	Minor significant	<p>Measures to be secured via Strategic Initiative Approach.</p> <p>DRPIC should contribute to an integrated Biodiversity Management Plan working collaboratively with SEZAD and other anchor tenants in the industrial area. An initial focus of the biodiversity management plan should be to obtain more accurate distribution, abundance and movement data for target species to inform mitigation planning.</p> <p>DRPIC should seek assurance from SEZAD that the integrated BMP incorporates measures to avoid development in wadis and flood prone areas; protection of movement routes of large mammals; and protection of suitable forage, browse and cover.</p>	Minor non-significant.
Green, Loggerhead and Hawksbill Turtles (High)	Non-significant slight adverse impacts resulting from operational lighting and disturbance from personnel and vehicles were predicted for the Project alone. Adverse effects related to collisions with ships or entrainment in water intake systems relate to AFs or shipping operations which are not part of the Project. These impacts are not cumulative impacts in the sense that there is no significant adverse impact arising from the Project in isolation so there cannot be a cumulative impact. However, it could be argued that they relate to the Project's supply chain (e.g. oil import	Moderate to minor significant.	As per ASHW – see Appendix D1	As per ASHW.

VEC (SENSITIVITY)	IMPACT SUMMARY	SIGNIFICANCE OF CUMULATIVE IMPACTS	RECOMMENDATIONS	RESIDUAL IMPACT
	and export shipping movements). On a precautionary basis it is predicted that combined adverse effects on ship collision and entrainment may result in a medium to high adverse magnitude impact.			
Cetaceans including ASHW (Very High) and Indian Ocean humpback dolphin (High)	The Project does not comprise marine operations aside from the Export Terminal which occupies a small part of the marine environment. However, adverse impacts may arise from noise and collision risk linked to ship movements caused by AFs, other developments in the area and Project supply chain ship movements (e.g. oil tanker and product vessel movements to and from Project and AFs). The sensitivity of the ASHW is very high to any incremental mortality rate, and the overall population size is currently critically small, so operational impacts are considered to range from low to very high magnitude. The sensitivity of the Indian Ocean humpback dolphin is also assumed to be very high because of the fragmented nature of its population distribution.	Major significant.	As per ASHW – see Appendix D1	As per ASHW.
All Marine IEFs (Up to Very High for ASHW)	Oil spill risk associated with the Export Terminal and the DRPIC Crude Pipeline is not a cumulative and is assessed as a possible Project impact in the biodiversity assessment (WSP, 2017). Oil spill risk associated with the Ras Markaz Tank Storage Facility and the Refinery shipping supply chain is a potential cumulative effect shared by the Project, AFs and shipping operators. A large oil spill event would result in a very high magnitude impact on all marine VECs.	Major significant.	<p>DRPIC should seek assurance and conduct regular audits throughout its supply chain to ensure that an adequate oil spill response plan is in place and that suitable and sufficient preventative measures are in place to prevent an oil spill.</p> <p>Other measures should be pursued by adopting a Strategic Initiative Approach:</p> <p>The Strategic Initiative including SEZAD, Omani Government bodies and industrial bodies should produce and publish an oil spill response plan identifying the most sensitive biodiversity areas.</p> <p>As part of a consortium of oil producers, transporters, refiners and Government sponsors, DRPIC should contribute to further research to and analyse potential oil spill scenarios to devise detailed oil response strategies.</p> <p>Industry wide support for further research into turtle and cetacean habitat use, movement pathways and distribution is also important to best design oil spill response planning.</p>	A major significant adverse impact would occur if a major oil spill happened. However, the recommended mitigation actions would markedly reduce the risk of occurrence and chances of successful clean up.

