

REPORT N° 70029220-*11*-CL-CESIA/NTS

NON-TECHNICAL SUMMARY

DUQM REFINERY PROJECT, OMAN

Part of Consolidated Environmental and Social Impact Assessment



FOR DRPIC ONLY: CONFIDENTIAL DECEMBER 2017

DUQM REFINERY, OMAN
ENVIRONMENTAL AND SOCIAL IMPACT
ASSESSMENT – NON-TECHNICAL
SUMMARY

Duqm Refinery & Petrochemical Industries Company

Confidential

Project no: 70029220
Date: December 2017

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LIST OF ABBREVIATIONS

Abbreviation	Description/Meaning
AF	Associated Facilities
ALARP	As Low as Reasonably Practicable
AQMS	Air Quality Monitoring System
ASHW	Arabian Sea Humpback Whale
BPD	Barrels per Day
CESMP	Construction Environmental and Social Management Plan
CIA	Cumulative Impact Assessment
CUC	Central Utilities Company
DGEA	Directorate General of Environmental Affairs
DIPWP	Duqm Integrated Power and Water Plant
DR	Duqm Refinery
DRPIC	Duqm Refinery and Petrochemical Industries Company LLC
Duqm SEZ	The Duqm Special Economic Zone
EIA	Environmental Impact Assessment
EPC	Engineering Procurement Construction
ESDD	Environmental and Social Due Diligence Report
ESIA	Environment and Social Impact Assessment
ESMP	Environment and Social Management Plan
GHGs	Greenhouse Gases
IBA	Important Bird Area
IEFs	Important Ecological Features
IESC	Independent Environmental and Social Consultant
Jet A-1	Kerosene Jet Fuel
km	Kilometre
LPG	Liquid Petroleum Gas
m	Metre

Abbreviation	Description/Meaning
M	Million
MECA	Ministry of Environment and Climate Affairs
NAEHS	National Archaeological and Environmental Heritage Sites
NCSI	National Centre for Statistics and Information
NTS	Non-Technical Summary
O ₃	Ozone
O&M	Operations and Maintenance
OGC	Oman Gas Company
OOC	Oman Oil Company
OTTCO	Oman Tank Terminal Company
PM ₁₀	Particulate Matter (10 micrometres or less in diameter)
PM _{2.5}	Particulate Matter (2.5 micrometres or less in diameter)
PS	Performance Standards
RAECO	Rural Area Electricity Company
RM	Ras Markaz
RoW	Right of Way
SEZAD	Special Economic Zone Authority at Duqm
UV	Ultraviolet
VECs	Valued Environmental and Social Components
WSP	WSP UK Ltd.
ZOI	Zone of Influence

1

INTRODUCTION

1.1

BACKGROUND TO THE PROJECT

Duqm Refinery and Petrochemical Industries Company LLC (DRPIC) is developing the Duqm Refinery Project (the “Project”) located within the Special Economic Zone at Duqm (Duqm SEZ). The Project is a joint venture between the Oman Oil Company (OOC) and Kuwait Petroleum (Europe) B.V. (KPE) to develop, build, own and operate an export refinery complex. A minority of the Project Company may be owned by one or more strategic or financial investors in the future.

The Project comprises:

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

The Project components, Associated Facilities (facilities that are being progressed by third parties and that would not have been constructed or expanded if the project did not exist and without which the project would not be viable) and alternatives are described in more detail in Section 3.

The Duqm area has been earmarked by Government as Oman’s next industrial and economic hub. Duqm Refinery is the first major industrial project to be planned and built in the Duqm SEZ and will serve as a springboard for other development. The Duqm SEZ is administered by the Special Economic Zone Authority at Duqm (SEZAD). 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.

A schematic showing the main activities earmarked in the Duqm SEZ, including the Refinery and Export Terminal, is shown in Figure 1-1; the overall Project and Associated Facilities are shown in Figure 1-2. All project components are located within the Duqm SEZ.

This Summary is part of the overall commission that WSP UK Limited (WSP) is carrying out for DRPIC, known as the Consolidated Environmental and Social Impact Assessment (ESIA) package of work. The scope of this overall work was to develop supplementary environmental, socio-economic and health assessment documentation that provides a holistic summary of the Project and consolidates its relevant aspects, impacts and mitigation measures, adding to the set of previous assessments, i.e., Environmental Impact Assessment (EIA) Reports (see Section 1.2 and list in References), where required.

A Consolidated Impact Assessment and Mitigation Report (DRPIC Report No.70029220-12*/CESIA/TECH) (‘Consolidated Report’) has been developed to further assess environmental and social aspects that have been screened and scoped as significant. It also serves as an overarching disclosure document to satisfy Lender Requirements. The Report’s content is summarised in this Non-technical Summary (NTS).

Figure 1-1: Schematic of Duqm SEZ showing Refinery Location (SEZAD, July 2017)

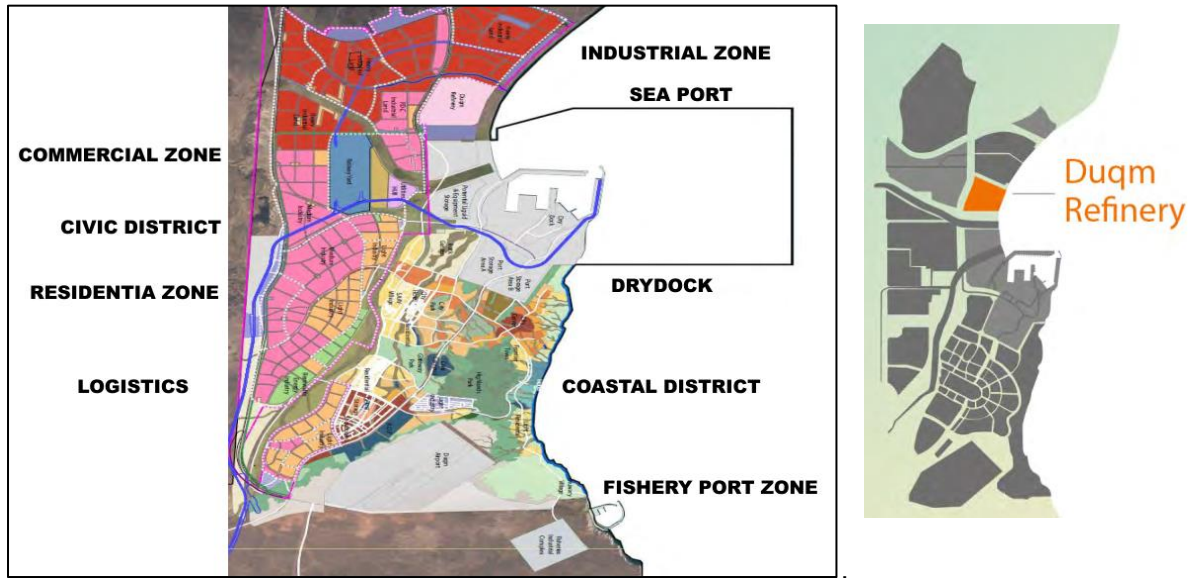
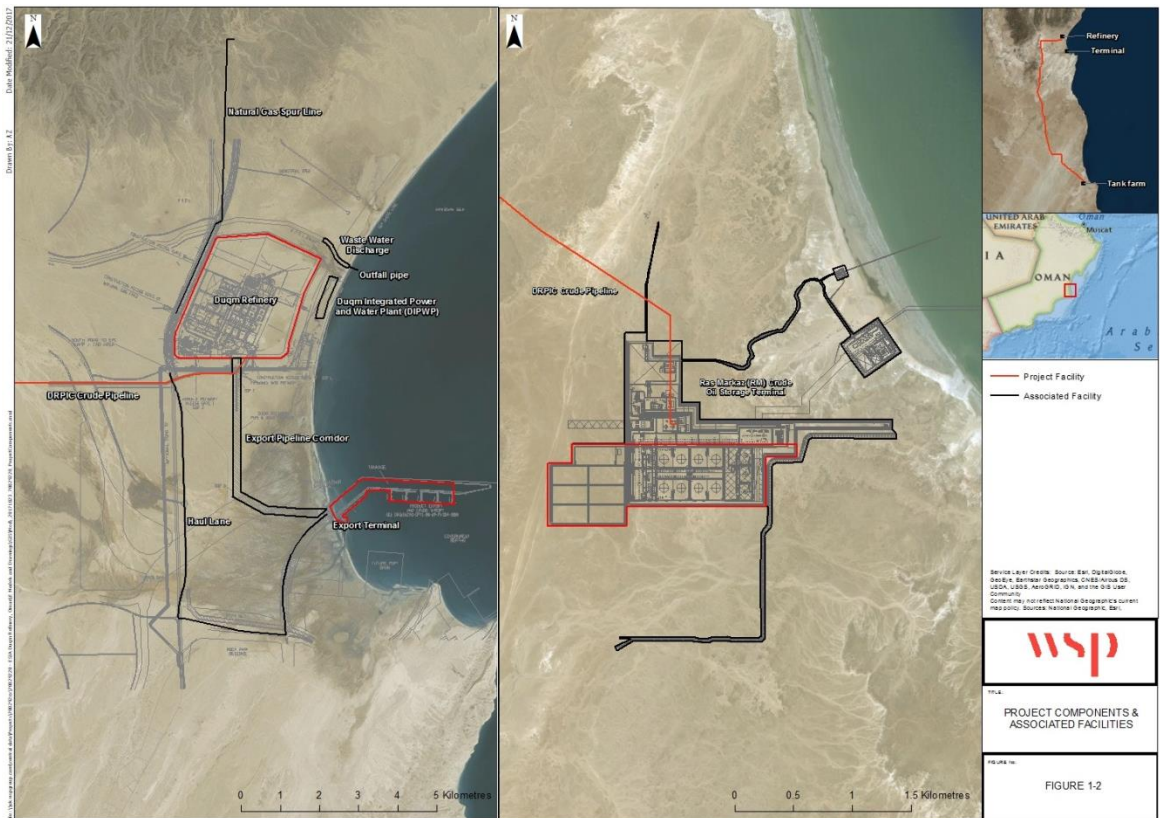


Figure 1-1 Project Components and Associated Facilities



1.2 REGULATORY CONTEXT AND STANDARDS

1.2.1 Omani Legislation and Guidance

While the SEZAD is the responsible authority for the Duqm SEZ, the Project is being implemented in compliance with the “Guidelines on Environmental Impact Assessment” issued by the Omani Directorate General of Environmental Affairs (DGEA) at the Ministry of Environment and Climate Affairs (MECA). For aspects for which Omani regulations are not available, applicable international regulations such as the IFC Performance Standards (PS) will be used – see below. Front End Engineering Design (FEED) was executed using the most stringent standard of the Omani regulation and IFC Guidelines. Thus the planning and development of the Project will be in compliance with Omani regulations on environmental protection and pollution prevention and the IFC PSs.

The Duqm Refinery Project will work within with the range of applicable legislation in Oman, for instance: Environmental Protection and Prevention of Pollution (RD 114/2001); Hazardous Wastes (MD 18/93); Noise Regulations (MD 79/94 and MD 80/94); and Ambient Air Guidelines (MD 41/2017).

1.2.2 Requirement to meet International Standards and Guidelines

In addition to the national legislation, the Project will follow the guidance in the IFC Sustainability Framework, Equator Principles and Organisation for Economic Co-operation and Development (OECD) recommendations on Common Approaches to the Environment and Officially Supported Credits. The following are applicable to the assessment of environmental and socio-economic and health impacts:

IFC Environmental and Social Performance Standards (2012), i.e:

- PS1: Assessment and Management of Environmental and Social Risks and Impacts;
 - PS2: Labour and Working Conditions;
 - PS3: Resource Efficiency and Pollution Prevention;
 - PS4: Community Health, Safety, and Security;
 - PS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources; and
 - PS8: Cultural Heritage.
- The Equator Principles (EPs) 2013; and
 - OECD recommendations on Common Approaches to the Environment and Officially Supported Credits (the “OECD Common Approaches”) (2012).

In addition, the IFC has published Sector Guidelines, of which the following have relevance for the Project including General Environment, Health, and Safety (EHS) Guidelines ; Petroleum Refining ; Ports, Harbours and Terminal, Crude Oil and Petroleum Products Terminals and Onshore Oil and Gas Development .

1.3 ENVIRONMENT AND SOCIAL CONTEXT

At the stage of preparing the previous EIA Reports, environmental mitigation measures had been proposed and incorporated into design (i.e. an ‘Environmental Basis of Design’) at the FEED stage. Requirements to deliver plant, process equipment and the buildings/facilities for the Project were incorporated into the procurement process for potential EPC Contractors to participate in tender.

During late 2016, an Environmental and Social Due Diligence (ESDD) Report was being prepared by the lenders’ Independent Environmental and Social Consultant (IESC) (Ramboll Environ, 2016) which identified omissions in key elements of the EIAs and limitations when compared to the IFC requirements. The due diligence concluded that baseline data on ecology, socio-economics and

health, air quality, noise and cultural heritage required updating and the assessment of potential impacts revisited.

In March 2017, WSP was appointed by DRPIC to carry out the Consolidated ESIA package of work and commenced by reviewing the previous EIA Reports and screening/scoping the Project, including a kick-off meeting in Muscat, a site visit to Duqm for orientation and observations. An Inception Report and Field Survey Plan followed (April 2017) preceding the deployment of specialists to the Duqm SEZ to carry out surveys on the ground to collect baseline data in May 2017. Field surveys included ambient air quality, cultural heritage, , noise and socio-economics and health. In-the-field walkover observations were made for biodiversity and landscape and visual aspects.

To obtain supplemental air quality baseline data, a Continuous Air Quality Monitoring Station (CAQMS) was deployed adjacent to the the Sebacic Acidification Plant gatehouse near the Duqm Refinery site for a period of three months from May. The WSP team was assisted by specialists from Omani company Five Oceans Environmental Services (5OES) for the household survey/engagement, biodiversity and cultural heritage activities. To that end, the combined team had the requisite local knowledge and experience of delivering surveys to international standards.

WSP produced Baseline Reports documenting the surveys (e.g. methodologies, equipment and results) in Summer 2017 and soon after, worked to assess any further potential impacts of the Project for collation into the Consolidated Report.

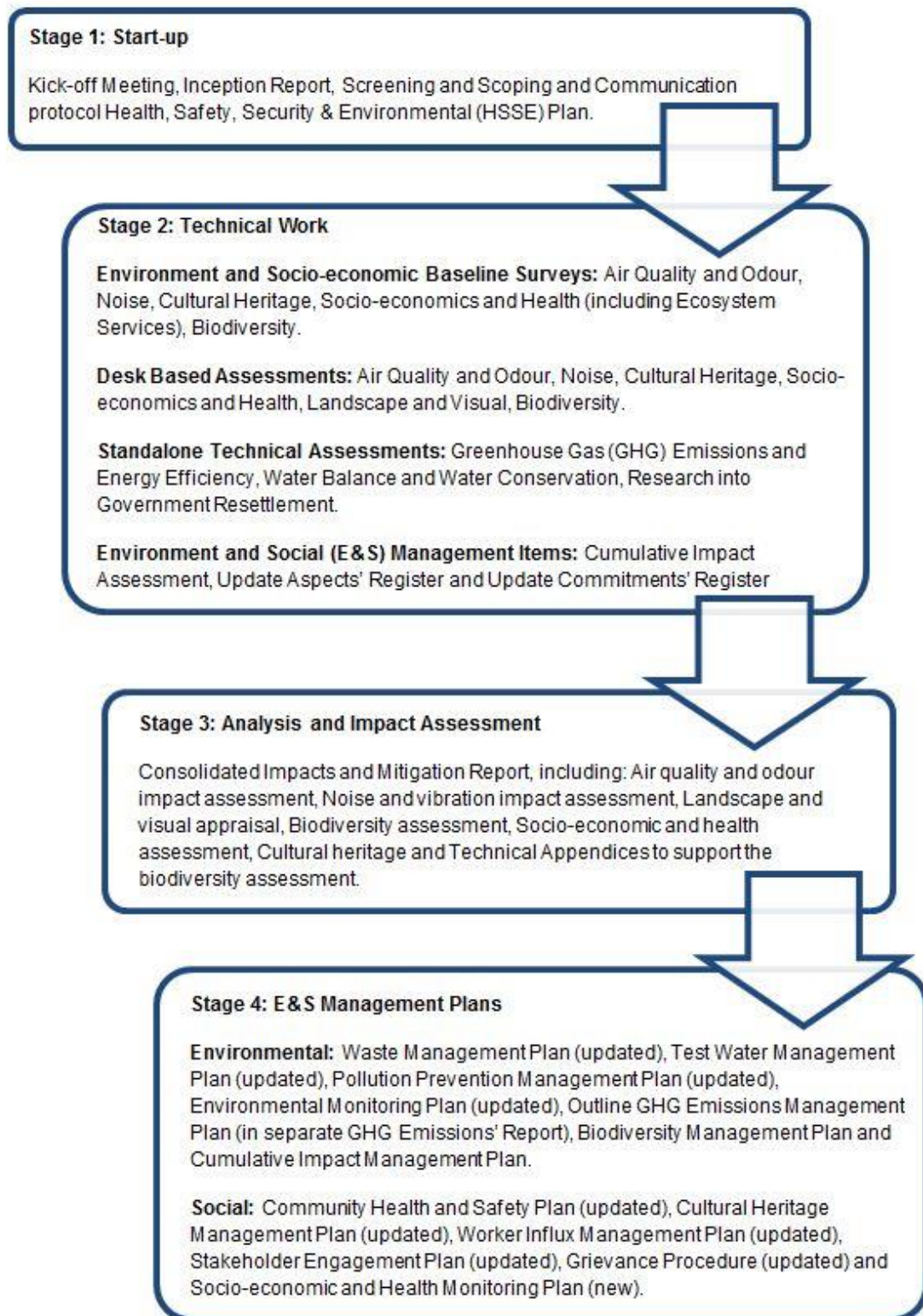
Mitigation measures from the original EIAs and enhancements/additions/clarifications to them were carried over into the Environmental and Social Management Plan (ESMP). DRPIC's appointed EPC Contractors will use the ESMP and set of sub-plans (see Stage 3 in Figure 1-3) to proactively manage environmental and social issues during construction. Their performance will be checked and audited by DRPIC, SEZAD and representatives of the lenders during construction, and in future operations.

1.4

METHODOLOGY TO CONSOLIDATED ESIA

The key activities to the approach in compiling this Consolidated Impact Assessment and Mitigation Report are shown in order in Figure 1-3.

Figure 1-3: Key Activities in Consolidated ESIA



1.4.1

ESIA to International Standards

For greenfield investment projects involving physical elements, aspects and proposed facilities likely to generate potentially significant adverse environmental and social risks and impacts, in the context of the project's 'area of influence', the IFC states that the proponent should carry out a comprehensive ESIA, as is the case for Duqm Refinery Project.

This area of influence (Aoi) encompasses the areas likely to be affected by the project, impacts from unplanned/predictable developments caused by the project, indirect impacts (e.g. on biodiversity), AFs and cumulative impacts.

These elements of ESIA are included in the Consolidated ESIA work and documented in the Consolidated Report.

The key processes involved in undertaking an ESIA to international standards are:

- Screening of the project and scoping of the assessment process;
- Consideration of alternatives;
- Stakeholder identification and engagement (focusing on those directly affected);
- Gathering of environmental and social baseline data;
- Impact identification, prediction, and analysis;
- Description of mitigation or management measures and actions;
- Assignment of significance to impacts and evaluation of residual impacts; and
- Documentation of the assessment process, i.e., an ESIA report.

The previous work carried out by DRPIC and the Consolidated ESIA package of work have, together, gathered all the information required to fulfil the stages of ESIA and its content, as required under international standards and guidance.

1.4.2

Overarching Technical Methodology

A summary of the key activities carried out as part of the Consolidated ESIA is presented below:

- **The Scoping Approach:** screening and scoping was developed by multiple parties through the analysis of previous EIA work commissioned by DRPIC. As well as DRPIC's own analysis, the content of the Consolidated ESIA was guided by the findings of the ongoing due diligence process. WSP carried out its own independent due diligence, reviewing Project documentation, and then identifying gaps between historical work and international standards and guidance. The work involved was the equivalent of a scoping exercise, determining appropriate spatial and temporal scopes for the subsequent assessment and outlining the approach to suitable surveys (e.g. for biodiversity, around the area of the Crude Oil Tank Farm at Ras Markaz and its interface into the Crude Pipeline), research methodologies and describing the technical assessments required.

As a result of scoping, the key focus of the Consolidated ESIA going forward, was to address the gaps and consolidate the impact assessment on the following parameters:

- Air quality and odour;
- Noise;
- Landscape and visual;
- Biodiversity;
- Socio-economics, social and health; and
- Cultural heritage.

Study and survey results (e.g. new primary data) were combined with relevant information collected in previous EIAs to form an enhanced baseline (see Section 2). Further

assessment of the potential impacts of the Project was then carried out (see Section 4 outlines for methodology).

- **Environmental and Social Management Plans:** based on the mitigation measures in previous Project EIAs and international lending requirements, DRPIC had developed an Environmental and Social Management Plan (ESMP) and sub-plans. This ESMP will be used by the appointed EPC Contractors. The plans contain a set of aims and outline the roles, responsibilities and standards to which performance on site, training and ongoing monitoring will be carried out.
- **Cumulative Impact Assessment:** in line with IFC guidelines, cumulative impacts of the Project were assessed separately and documented in a stand-alone CIA Report (see DRPIC Report Ref. 08-CL-CESIA/CIA), prepared with respect to the guidelines in the IFC Good Practice Handbook: Cumulative Impact Assessment and Management (April 2013), with a summary provided within this report. The CIA, *inter alia*: updated the AOI, addressed impacts in isolation and cumulatively from AFs and from third party facilities and future projects and considered a Valued Component-centric approach to identify all potential receptors from cumulative impacts.

The Consolidated Report therefore includes a summary of the previous EIA work and all new activities that together constitute a robust baseline before focussing on an assessment of the identified environmental and socio-economic/social impacts associated with the Project, as scoped-in at the Inception Report stage. The key impacts from the Consolidated Report are presented in this NTS.

1.5

THE PURPOSE AND CONTENT OF NTS

This NTS provides an overview, in layman's terms, of the main environmental and social findings from the ESIA of the Project. This current Section introduces the Project and the legal, environmental and social context. The following Section 2 outlines the findings of scoping and presents a summary of baseline conditions. The specifications of the Project are presented in more detail in Section 3 and the methodology for impact assessment, briefly in Section 4. Section 5 then summarises the impact assessment (and any associated mitigation) for the six technical parameters listed in Section 1.4.2 above. Section 6 summarizes the ESMPs that have been developed for the Project's construction phase, while Section 7 provides the findings and conclusions of the Consolidated ESIA.

It is important to note that this NTS does not, and is not intended to, convey all of the information relating to the aspects and impacts of the Project. Its intention is to present key information, describe the main findings and conclusions, enabling the reader to understand the significant environmental and social effects of the Project without needing to refer to the detailed assessments.

2

SCOPING RESULTS AND BASELINE

2.1

INTRODUCTION

A brief summary of the information on environmental and social topics from the previous studies used to inform scoping is listed in Table 2-1. This matrix shows topics and aspects – by Project Component – were sufficiently addressed in the existing EIA Reports (see References) and DRPIC E&S Management Plans (i.e. and therefore scoped out of this Consolidated ESIA). Similarly, those scoped in and the subject of subsequent Sections (5 to 10) in this Report are shown in the Table.

Table 2-1: Matrix of E&S Topics/Aspects and Project Components Summarising Results of Scoping

Document Reference →		PROJECT COMPONENTS					KEY ASSOCIATED FACILITIES		
		Refine ry EIA	Ras Markaz Crude Oil Storage Terminal	Crude Pipeline	Export Terminal	Const. Camp	Integrated Power and Water Plant	Sea Water for Industrial Zone Project	Service Corridor
Aspects ↓									
Biological	Terrestrial Flora & Fauna	✓	✓	✓	✓	✓	✓	✓	✓
	Marine Flora & Fauna	✓	✓	✗	✓	✗	✗	✓	✗
Physical	Air Quality	✓	✓	✓	✓	✓	✓	✓	✓
	Noise	✓	✓	✓	✓	✓	✓	✓	✓
	Climate Change	✓	✓	✓	✓	✓	✓	✓	✓
	Groundwater	✓	✓	✓	✓	✓	✓	✓	✓
	Soil	✓	✓	✓	✓	✓	✗	✓	✓
	Wastewater/Waste	✓	✓	✓	✓	✓	✓	✓	✓
	Accidental Releases	✓	✓	✓	✓	✓	✗	✓	✓
	Landscape	✓	✓	✓	✗	✓	✓	✓	✓
	Land Use	✓	✓	✓	✓	✓	✓	✓	✓
Natural Resources	✓	✓	✗	✗	✓	✓	✓	✓	
Social	Local Settlements	✓	✓	✗	✗	✓	✗	✓	✓
	Local Health and Safety	✓	✓	✗	✗	✓	✓	✓	✓
	Livelihood	✓	✓	✓	✓	✓	✓	✓	✓
	Infrastructure	✓	✓	✗	✗	✓	✗	✓	✓
	Traffic Density	✓	✓	✗	✓	✓	✓	✓	✓
	Economy	✓	✓	✗	✓	✓	✗	✓	✓

		PROJECT COMPONENTS					KEY ASSOCIATED FACILITIES		
Performance Standards	Labour & Working Conditions	x	x	x	x	x	✓	x	x
	Resource Efficiency & Pollution Prevention	✓	✓	x	✓	✓	✓	✓	✓
	Community health, Safety & Security	✓	✓	x	x	✓	✓	✓	✓
	Land Acquisition	✓	✓	✓	✓	✓	✓	✓	✓
	Biodiversity	✓	✓	✓	✓	✓	✓	✓	✓
	Cultural Heritage	✓	✓	✓	✓	✓	✓	✓	✓

2.2 BASELINE ASSESSMENT SUMMARIES

This Section provides a summary of baseline data on the following parameters; detailed environmental baseline reports comprising primary data collection were compiled and are available in separate reports, and presented as Appendices to the Consolidated Report:

- Air quality and odour (DRPIC Report Ref. 02-C-Base/AQ);
- Noise and vibration (02-C-Base/N);
- Visual and landscape (02-C-Base/VL);
- Social and health (05-C-Base/Soc);
- Cultural heritage (06-C-Base-Cul); and
- Biodiversity (multiple Appendices in Consolidated Report).

2.2.1 Air Quality

PREVIOUS BASELINE WORK

Previous baseline air quality and odour survey work has been documented in a wider range of reports such as Appendix A of the *EIA Study Report for Duqm Refinery* (HMR, 2015); and Sections 5 (ambient air quality) and 6 (impact assessment), and Appendix 3 of the *Raz Markaz Oil Pipeline Concept Study & FEED Environmental Impact Assessment Report* (WorleyParsons Oman Engineering, 2016). The previous baseline air quality studies and odour included measurements in and around Project components and relevant receptors.

The previous air quality surveys undertaken in the Duqm region detected exceedances of PM₁₀, O₃ and SO₂ concentrations against (the then provisional) Omani air quality standards. A continuous analyser was deployed for only three of the five air quality surveys and only for a maximum period of one month. In the studies which deployed diffusion tubes exposed over several weeks, the likelihood that a non-compliance against a 24hr air quality standard would have been detected is low. These previous studies, even though short in duration, and in two cases limited to a diffusion tube study, detected several non-compliances of ambient baseline pollutants, two of which (PM₁₀ and O₃) would be considered to be as result of natural processes, and not as a consequence of anthropogenic emissions. In a number of the other studies, PM₁₀ sampling was conducted over various short durations of between 15 mins to less than 24hrs. These sampling durations do not relate to existing air quality standards or limit values, and therefore cannot be used to adequately assess compliance or otherwise against existing standards or limit values. Air quality baseline data collected previously does provide a degree of historic context to the air quality baseline.

ENHANCED BASELINE BASED ON NEW SURVEYS

Continuous ambient air quality sampling of PM₁₀, PM_{2.5}, NO₂, SO₂, O₃, CO, H₂S, VOCs, BTEX and Methane was undertaken adjacent the Sebacic Acid plant compound gatehouse between 3rd May until 6th August 2017.

In addition to the CAQMS, passive samples were deployed at six locations across the study area for NO₂, SO₂, H₂S and BTEX. Sampling sites are shown below. Each sample was collected and a new sample deployed each month, providing a total of two months of passive sampling data. This diffusion tube sampling provides a spatial distribution of baseline ambient air concentrations.

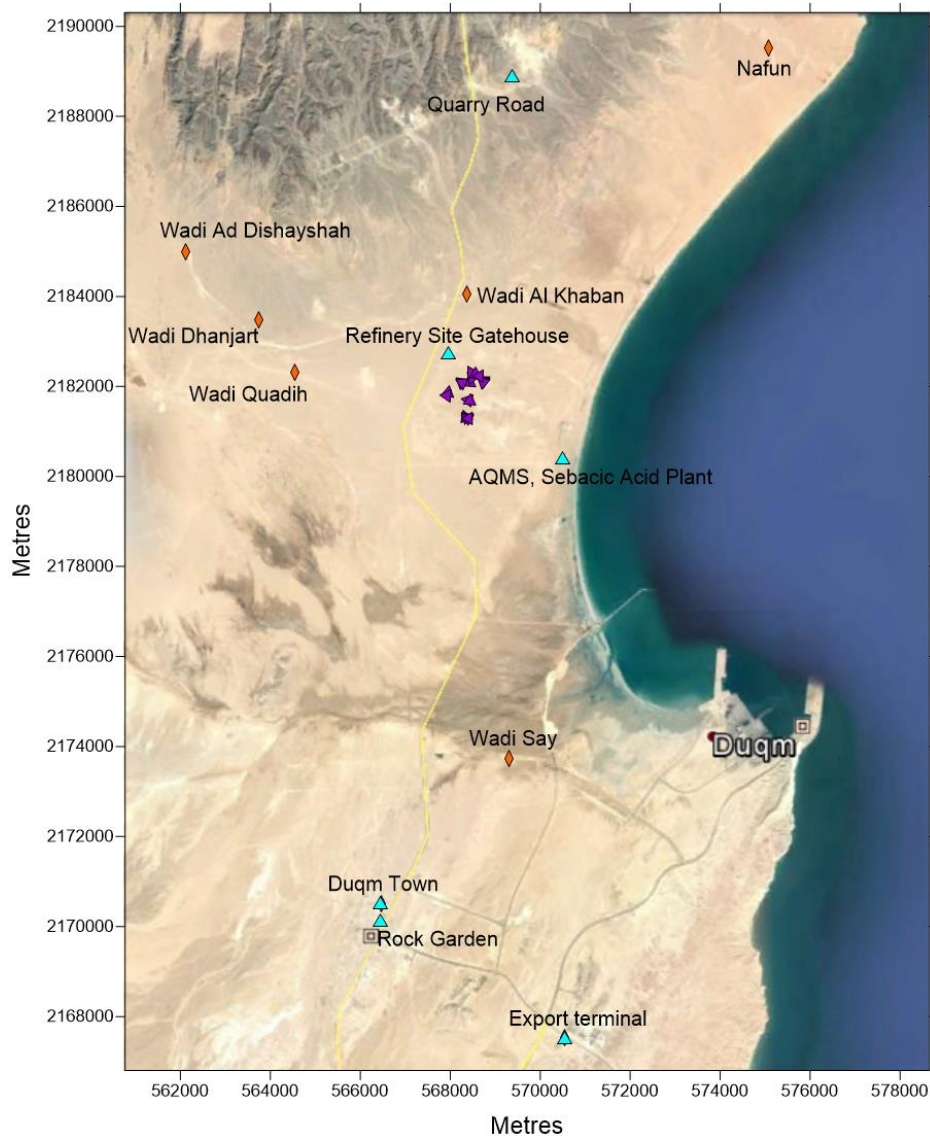


Figure 2-1 Map of study area showing monitoring locations (as blue triangles), sensitive receptor locations (as orange diamonds) and pollutant sources on site (as purple triangles)

This new air quality data provides a consistent medium term (three month) record of high quality air quality data for the Project. Sampling undertaken by WSP provided a secure continuous record of air quality measurable against current Omani national and comparison to international air quality standards and limits' values.

2.2.2

Ambient Air Quality and Odour Monitoring Results

Results from the AQMS are summarised in Table 2-33, as period average and compliances against 24 hourly, 8 hourly and 3 hourly standards, where relevant. Detail on the data recorded at the CAQMS is presented in the Appendices of the Consolidated Report.

Table 2-3: Ambient Air Quality Monitoring Station Results – Duqm, May to August 2017

POLLUTANT	PERIOD MEAN	MAX CONCENTRATION (AVERAGED TO STANDARD)	OMANI AQ STANDARD (MD 41/2017)	COMPLIANT BASELINE
O ₃ Conc µg/m ³	74.73	172.69 (8 hrs)	120 (8hrs)	No (Exceeds 8hr standard)
CO Conc mg/m ³	0.51	0.0088 (8 hrs)	10 (8 hrs)	Yes
		0.041 (1 hr)	30 (1 hr)	
NO µg/m ³	1.84			
NO ₂ µg/m ³	3.32	10.29 (24 hr)	130 (24 hr)	Yes
		58.48 (1 hr)	250 (1 hr)	
SO ₂ µg/m ³	6.26	14.46 (24 hr)	150 (24 hr)	Yes
		15.90 (1 hr)	350 (1 hr)	
H ₂ S µg/m ³	1.34	9.83(1hr)	30 (1 hr)	Yes
PM _{2.5} Conc ug/m ³	64.35	158.92 (24 hr)	65 (24 hr)	No
PM ₁₀ Conc ug/m ³	151.53	488.92 (24 hr)	150 (24 hr)	No
CH ₄ µg/m ³	770.72			-
NMHC µg/m ³	0.00	0.00	160 (3 hr)	Yes
TVOCs µg/m ³	4,174			-
Benzene µg/m ³	0.00	0.00		Yes
Toluene µg/m ³	0.38			-
EthylBenzene µg/m ³	0.00			-
M&P-Xylenes µg/m ³	0.00			-
O-Xylene µg/m ³	0.00			-

*Assuming NMHC = Butane

Air quality and odour monitored by the CAQMS was generally good during the sampling period 3rd May to 6th August 2017, though particulate matter and ozone were both elevated. Monitoring results indicate that both NO₂ and SO₂ were both low in concentration during the sampling period, implying that there are no significant industrial emissions sources within the proximity of the CAQMS. However, O₃, PM₁₀ and PM_{2.5} all exceeded short-term concentrations limits. In the case of both PM₁₀ and PM_{2.5}, the period mean exceeded the 24hr air quality standards for both pollutants. O₃ and PM are known to originate as a consequence of natural processes, such as strong sunlight and UV radiation in the case of O₃, and re-entrainment of dust and sand in the case of PM. Therefore, these pollutants are highly likely to originate from natural processes and not as a consequence of existing anthropogenic activity locally.

The periods of elevated particulate matter were extended and not attributable to localised sources. Therefore, though local construction activity would have contributed to the elevated PM

concentrations, it was not considered to be the primary source of particulates resulting in the exceedance of both the PM₁₀ and PM_{2.5} air quality standard.

Results from the diffusion tube survey are summarised in Table 2-4 below.

Table 2-4: Diffusion Tube Survey Results for Duqm Refinery Baseline Survey

Pollutant	NO ₂	SO ₂	H ₂ S	BENZENE	TOLUENE	ETHYL BENZENE	M,P-XYLENE	O-XYLENE
Duqm Town	8.33	0.32	-	-	-	-	-	-
Rock Garden	9.74	0.38	1.00	0.37	<0.21	<0.25	<0.25	<0.25
Dry Dock Camp	5.32	1.71	-	-	-	-	-	-
Quarry Road	5.16	0.16	0.22	0.25	<0.21	<0.25	<0.25	<0.25
Refinery Gate house	5.66	0.50	0.12	0.215	<0.21	<0.25	0.315	<0.25
CAQMS	6.56	1.29	-	-	-	-	-	-

Concentrations of pollutants monitored by diffusion tube across the study area were all very low, and indicate that none of the pollutants monitored by diffusion tube were likely to be at risk of exceeding any annual average limits (e.g. such as for Benzene or NO₂).

The spatial variation of pollutant concentrations observed by the diffusion tube results can be seen to vary with respect to the proximity to populated areas. Higher concentrations of NO₂ were detected at the Duqm Town site and the Rock Garden sample site (within 1km of Duqm Town); whereas the NO₂ concentrations elsewhere were all consistent, even at the CAQMS location (Sebacic Acid Plant). Therefore it can be implied that the current impact of vehicle emissions upon local air quality and NO₂ concentrations within the study low is currently low to negligible.

The concentrations of SO₂ monitored across the study area over the two month diffusion tube survey were low. As the Oman air quality limit value is assessed over a sample duration of 24 hours, no firm assessment of SO₂ limit value or standards compliance can be reached on the monthly diffusion tube samples. However, there is an implication that there is currently no dominating source of SO₂ within the study area, such as the Desalination plant power station, and that baseline concentrations at remote locations to the north of the proposed Refinery site (e.g. Quarry Road locations and Nafoon Village) are likely to remain very low.

2.2.3

Noise

PREVIOUS BASELINE WORK

Previous baseline noise survey work was documented in the historical EIAs for *Duqm Refinery* (HMR, 2015), *Duqm Refinery Construction Camp* (HMR, 2014), *Duqm Liquid Bulk Berths Project* (WorleyParsons Oman Engineering, 2015) and the *Raz Markaz Oil Pipeline Concept Study & FEED Environmental Impact Assessment Report* (WorleyParsons Oman Engineering, 2016).

The previous baseline noise studies included measurements in and around Project components and relevant receptors but were carried out during periods of high winds. These are considered to be invalid measurements. A further survey was therefore carried out by WSP.

ENHANCED BASELINE BASED ON NEW SURVEYS

The noise environment around the Project components and the surrounding inhabited areas has been characterised over a series of site surveys, carried out to international standards, using calibration equipment. Figure 2-2 shows the surveys locations.

Figure 2-2: Baseline Noise Survey Locations (April, 2017)



In general, there are few existing anthropogenic sources of noise other than infrequent road traffic, sound levels tend to be dictated by natural sources (e.g. wind interaction with obstacles, waves breaking). Recorded baseline levels are summarised below (and Appendix B of the Consolidated Report).

Table 2-5: Summarised Baseline Noise Survey Measurement Results

LOCATION	DATE, dd/mm/yy	TIME PERIOD, hrs	PERIOD DESCRIPTION	L _{Aeq} RANGE, dB	L _{A90} RANGE, dB	WIND SPEED, m/s	PRIMARY NOISE SOURCE(S)
Wadi Saay Location 1	25/04/17	1509 – 1539	Day	50 – 51	45 – 46	2 – 3	Distant construction noise along Highway 32, wind
	26/04/17	0922 – 0952	Day	52	44	2 – 3	Occasional road traffic & construction activity on Highway 32, wind
	24/04/17	1807 – 1837	Evening	52 – 53	45	3 – 5	Very occasional road traffic on Highway 32, wind
	24/04/17	2317 – 2332	Night	45 – 46	41	2 – 4	Wind
Wadi Saay Location 2	25/04/17	1554 – 1624	Day	46 – 47	40 – 41	2 – 3	Wind
	26/04/17	1001 – 1031	Day	44 – 45	39	3 – 4	Wind
	24/04/17	1911 – 1956	Evening	49 – 51	41 – 43	4 – 5	Wind
	25/04/17	0004 – 0034	Night	42 – 44	38	4 – 5	Wind
Wadi Saay Location 3	26/04/17	1038 – 1108	Day	52	43 – 44	2 – 3	Occasional road traffic & construction activity on Highway 32, wind
	26/04/17	1804 – 1834	Evening	49 – 50	44	4 – 5	Very occasional road traffic on Highway 32, wind
	25/04/17	2328 - 2358	Night	51 – 52	40 – 41	4 – 5	Wind
Nafun Location 1	25/04/17	1212 – 1242	Day	41 – 42	39	2 – 3	Wind, very occasional local vehicles
	25/04/17	2217 - 2232	Evening	42	38	2 – 3	Wind, very occasional local vehicles
Nafun Location 2	25/04/17	1303 – 1348	Day	54	52 – 53	4 – 5	Wind, sea
	25/04/17	2241 – 2253	Evening	48	45	4 – 5	Wind, sea – note: measurement cut short for safety reasons
Antoot Fishing Area	25/04/17	1053 - 1123	Day	42 – 44	35 – 36	4 – 5	Wind / sea
Dhahr Location 1	26/04/17	1226 – 1256	Day	46 – 47	38	5 - 7	Occasional local vehicles, wind
Dhahr Location 2	26/04/17	1309 – 1339	Day	46 – 48	39 – 41	4 – 5	Occasional local vehicles, wind
Dhahr Location 3	26/04/17	1403 – 1433	Day	43 – 45	36	2 – 3	Occasional local vehicles, wind

2.2.4

Visual and Landscape

PREVIOUS BASELINE WORK

Amongst the secondary sources of information used as part of the new landscape and visual assessment were the EIAs for Duqm Refinery, the Duqm Industrial and Free Zone Masterplan and Service Corridor (HMR Consultants, 2015).

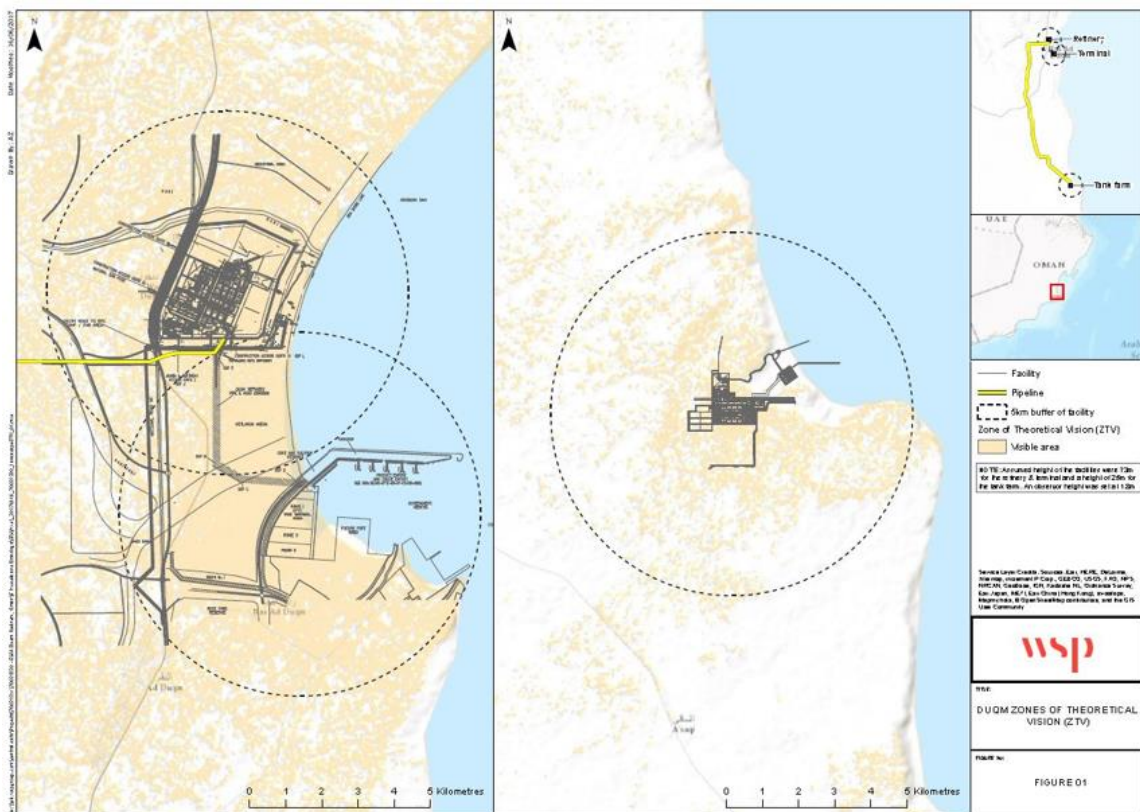
Information from the geology, ecology and land use sections of these reports and observations from investigations carried out on socio-economics and health contributed to an understanding of the

landscape baseline. The Communities' chapters set out a range of potential visual receptors, although there was a lack of consistency, perhaps due to the changeable nature of the local population. The Free Zone Masterplan EIA (Jurong, 2011) includes a full classification of local landscape types which have been adopted to apply to the study area of this Report.

ENHANCED BASELINE BASED ON NEW WORK

The study area for visual effects extends to the area from which the Project could be visible, cut off at a distance of 5km from the Project component site areas. The Zone of Theoretical Visibility (ZTV) has been established to show the area of land from which there could be a view of any part of the proposed Project. The ZTV was determined by digital modelling using specialist GIS software to analyse a Digital Terrain Model (DTM) and the output is shown below.

Figure 2-3: ZTV for Project Components



The study area for landscape effects covers the proposed Project site and the wider landscape context within which the Project may influence landscape character. The study area for both landscape and visual impacts has been cut off at a radius of 5km from each of the Project components, in order to focus on potentially significant effects. This reflects the largely flat, undeveloped landscape, lacking substantial vegetation which would interrupt views towards the Project, which would be of a large scale and therefore readily visible. It is considered that even though the development may be visible from greater distances, it would not constitute a dominant element in the view, and would therefore be unlikely to cause significant landscape and visual effects.

Factors such as geology, topography, the presence of waterbodies, vegetation and human influence and land use are used to describing the different elements that make up the landscape in the study area. This information is used to define landscape character types within the study area: geographical areas made up of a distinct combination of elements and aesthetic or perceptual aspects.

The assessment of overall landscape sensitivity combines the judgements on the susceptibility of receptors (see below) to the proposed development.

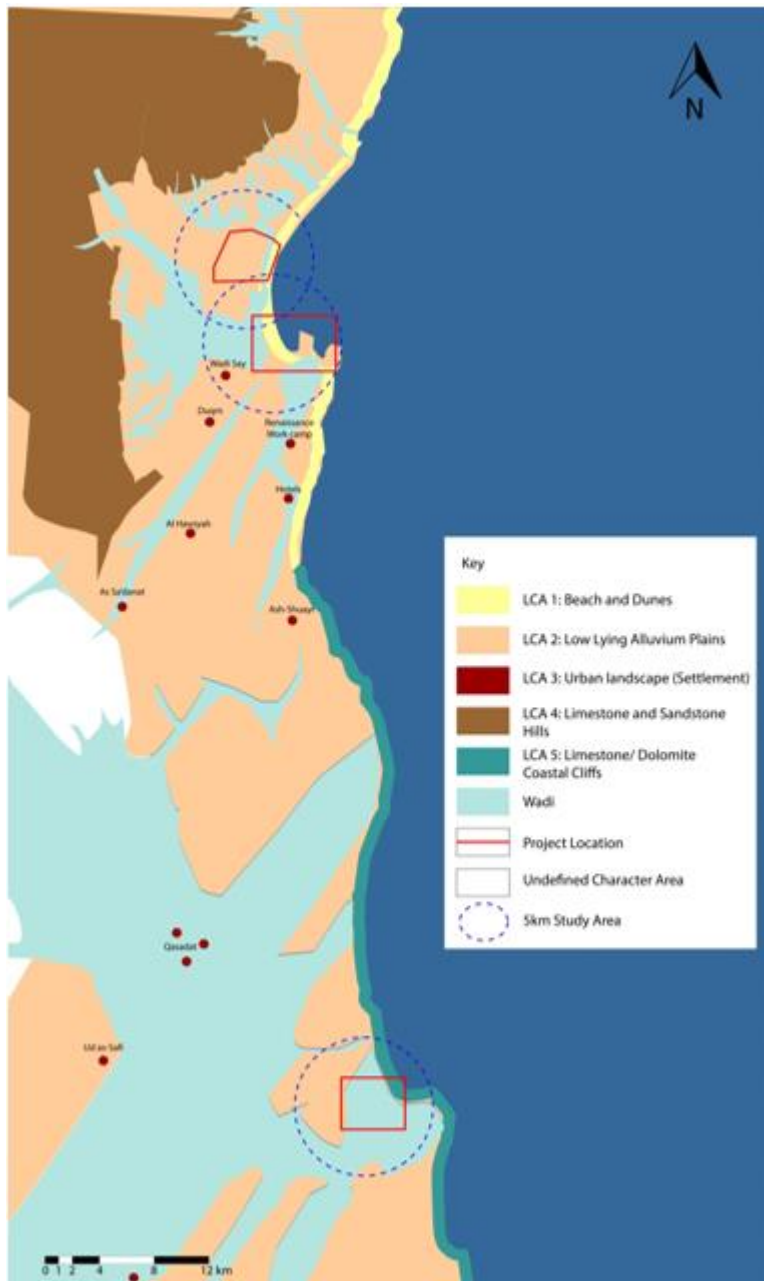
Evaluating 'visual amenity' involves determining the extent of visibility of the development proposals, followed by identification of visual receptors and their sensitivity to changes in their surroundings. In terms of receptors, the area currently supports a limited population in scattered small settlements. Receptors include people seasonally inhabiting the few local temporary residences and fishermen on the beach and passing at sea.

The development of the Duqm SEZ will boost the population and introduce an increasingly industrial and urban character to the landscape, of which the Project will form a part. The landscape in the wider project area is characterised by a number of other projects that are currently being developed or close to their completion, i.e., Port of Duqm, Ship Repair Yard and Dry Dock, Fishery Harbour, Duqm Airport.

There are no formal landscape designations applicable to this area, although the coast is protected by any development being set inland from its immediate edge. 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 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 topography of the Project site is very variable and ranges up to 190m above sea level. The coastal area is particularly scenic due to the intersection of land and sea which provides increased geological and ecological diversity and extensive views.

The following local landscape character area descriptions LCA1-4 were set out in the Duqm Industrial and Free Zone EIA Report (Jurong Consultants/Five Oceans, 2011) and have been used in the Consolidated ESIA. These are briefly described, below Figure 2-4.

Figure 2-4: Landscape Character Areas in the Project Area



More details on Visual and Landscape baseline can be found in Appendix C of the Consolidated Report.

2.2.5 Biodiversity

PREVIOUS BASELINE WORK

Significant ecology studies have been carried out in the Project area as part of EIAs for the Project and wider development.

FINDINGS OF THE PREVIOUS WORK

The Project Area includes biodiversity, habitats and receptors, however, impacts on these were not assessed in Project documentation, for example:

- Information on two Important Bird and Biodiversity Areas (IBA) near Duqm Refinery and the Liquids Terminal lacking in those respective EIA Reports
- Lack of assessment of indirect impacts on biodiversity receptors;
- Only a limited impact assessment (i.e. with a focus on loss of habitats) in the Crude Pipeline EIA;
- Limited impact assessment on oil spill with respect to receptors at the Ras Markaz Crude Oil Terminal and potential collisions with marine species not mentioned; and
- No consideration of potential impacts on turtles or whales species in the impact assessment of the Liquids' Terminal.

ENHANCED BASELINE BASED ON NEW SURVEY

The majority of the Project area is represented by arid desert, semi-desert or coastal habitats. The benthic habitat 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.

The presence of the Duqm Important Bird Area (the 'Duqm IBA') as designated by BirdLife International and the significance of the coastal zone from Duqm to Ras Madrasah is well reported across the various EIA/Ecological Baseline Survey (EBS) documents. A second – Jiddat al Harasis IBA – is located to the north and west and considered to be in the indirect AoI. Of the bird species reported to utilise the Duqm IBA, the majority are marine/shoreline species (62%) and/or migratory (54%). Some species can be included in both categories.

Part of the IBA has already been removed from the development of the Duqm Port and area, the area of sandy, shallow bay habitat for which the IBA is noted, has been reduced and inputs of water from inland wadi systems into the IBA have been altered by development of the Port. The Export Terminal is within the Port and the IBA and the Refinery is within one km from Duqm IBA.

27 mammal species may inhabit the area, including six feral/domestic mammal species. Some of these references will be of historical significance only – for example, the Arabian Oryx (*Oryx leucoryx*) which is now confined to the Al Wusta Wildlife Reserve.

Extensive information on the baseline is provided in Appendix D of the Consolidated Report, which includes sub-appendices on: the survey record and harmonized habitat mapping.

2.2.6 Socio-economics and Health

PREVIOUS BASELINE WORK

Most of the previous EIA Reports include a limited socio-economic baseline, mainly based on the last national census statistic (2010), population density and existing infrastructure. The EIAs for the Duqm Refinery (HMR, 2015) and Duqm Refinery Construction Camp (HMR, 2014) did not. To fill in the identified gaps in baseline, the WSP team carried out further information collection in Duqm.

ENHANCED BASELINE BASED ON NEW SURVEYS

The socio-economic and health baseline in the Project area is characterised by a sparsely populated desert area where communities have historically engaged in fishing and camel rearing/selling. Since mid-2006 and after the creation of the SEZ, the wider Duqm area, as well as some local settlements located in the project area, underwent significant changes and growth in population and development of infrastructure.

The main villages covered by the project area, include: Nafun, Al Tayari, wider Duqm area (which includes smaller settlements), and a smaller, informal settlement, Antoot.

The socio-economic survey carried out in the project area included household surveys and engagement with fishermen. This revealed that most working-age adults in the Project area do not have high levels of education, and are mainly relying on camel selling and property renting activities

(e.g. a house or fishing boat) as their main livelihood strategies. The average income levels in the project area are generally in line with the national average. Respondents to household surveys mentioned the main diseases to have affected members of their household in the past three years as diabetes, hepatitis and asthma. The Consolidated Report and its Appendix E holds details.

2.2.7 Cultural Heritage

PREVIOUS BASELINE WORK

There have been two prior archaeological surveys of the Duqm area:

- A general scientific study of the region carried out by the Central Oman Palaeolithic Survey (COPS) Research Project in 2008 and 2009; and
- A targeted assessment of heritage assets within the Duqm IDZ in 2010.

The COPS project mapped 16 archaeological findspots in the southern part of their survey area that overlaps with the IDZ. 5OES was subsequently commissioned to assess the rest of the IDZ, identifying 182 heritage sites in and around Duqm including cemeteries, enclosures, lithic scatters, graves, shell middens, temporary mosques, potsherds, structures, triliths, and isolated graves.

ENHANCED BASELINE BASED ON NEW SURVEY

Previous surveys in the area did not formally cover the extent of the pipeline Right of Way or the DRPIC Crude Oil Tank area at Ras Markaz. Therefore, a field survey was undertaken from 23rd to 27th April 2017 along the Crude Pipeline Right of Way and at Ras Markaz. The Cultural Heritage Baseline Report (DRPIC Report Ref. 06-C-Base-Cul), included in Appendix F of the Consolidated Report, provides the detail.

The cultural heritage baseline and assessment was based on best practice (e.g. IFC PS6 on Cultural Heritage) approach to protecting items, fragments and sites of archaeological (prehistoric), palaeontological, historical, cultural.

During the new field survey, architectural structures were mapped at sites, including circular stone cairns, stone fireplaces, circular stone houses, large anchor stones (perhaps for tent poles or livestock enclosures), and a trilith feature. A total of 24 archaeological features were identified, where nine of the sites are situated within 100m of the development corridor. Most of these standing structures are located within 100m of the development corridor and require mitigation.

The landscapes around the Port, the construction camps, and the Refinery have already been so heavily altered by construction activities that traces of potential archaeology have been erased. No mitigation strategy is required within these zones.

3

PROJECT DESCRIPTION

3.1 PROJECT COMPONENTS

The Duqm Refinery Project comprises the Refinery and a number of off-site facilities are described below and listed under rows A and B in Table 3-1.

The new Refinery complex will be designed and operated by DRPIC on a prepared plot covering 9 km² within the proposed Heavy Industry Zone of the Duqm SEZ. Once operational, the Refinery will have a nominal capacity of 11.5 million (M) tonnes per annum or approximately 230,000 barrels per day. The Refinery will generate a number of products for the export market including liquefied petroleum gas (LPG), Naphtha, Diesel, kerosene jet fuel (Jet A-1), Petroleum coke and Sulphur.

Accommodation for the workers will be necessary during the construction phase. There are currently two construction camp locations being considered, each containing their own support services including, power generation, water supply and wastewater treatment utilities to house workers for the Refinery construction. The Camps are expected to hold a maximum workforce of 20,000 personnel during activities.

Under IFC 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. The IESC also identified the relevant AFs in the Duqm Refinery Project and these are presented (in a third category, 'C') below. EIA Reports have previously been prepared for most of these AFs.

Table 3-1: Duqm Refinery Project and AFs

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 storage facility at the Ras Markaz Crude Oil Terminal: eight tanks located within, and part of the wider Tank Farm, some 80km from DR. The large-scale Tank Farm (Oman Oil Tank terminal Company, OTTCO) in its entirety is 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, including pipeline and services themselves under the refinery)

REF.	PROJECT COMPONENT	DESCRIPTION
		<p>(SEZAD/Marafiq). Note: SEZAD has overall responsibility for the Pipeline Corridor, excluding the Duqm Refinery pipelines and cables, extending from the Refinery Boundary Marker fence line to the Port fence line.</p> <p>iii. The marine scope including dredging and reclamation and jetty and quay wall construction of the Duqm Export Terminal. (SEZAD).</p> <p>iv. Haul road or dedicated lane (on Existing Road) for solid product from DR to Duqm Export Terminal. (SEZAD).</p> <p>v. Duqm Integrated Power and Water Plant (DIPWP) supplying electricity and desalinated water to DR (and in the future other consumers in Duqm SEZ). (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. (Marafiq).</p> <p>viii. Offshore oil import facilities (including offshore single point mooring (SPM) and crude oil pipeline to shore at RM. (OTTCO).</p>

3.2 PROJECT ALTERNATIVES

The historic EIAs document how the Project considered alternatives to the Refinery and offsite components in relation to their siting and size as well as the technologies employed. In all instances a 'No Project' Option was considered in which the Refinery or its offsite facilities were not built.

In respect of the Refinery, it was considered that the 'No Project' Option would significantly hamper the development of Oman and the Al Wusta region with the consequent 'loss of economic opportunity' to local businesses and communities. Some of the key considerations and preferred options for delivering the Refinery are:

- An analysis of national, regional and global demand for petrochemical products was undertaken to confirm what the Refinery should produce and the type of technology required for their production;
- Alternatives for the sourcing of power and water were analysed for the construction and operation from both onsite and offsite facilities; and
- An analysis of the techniques and technologies specified by the Refinery design was carried out to review the applicability of the best available technologies s in order to minimise the Project's environmental impacts.

The off-site components were identified as being are required to support the operation of the Refinery with the major consideration being how these could be delivered in a technologically robust and cost effective way while causing the least damage and disturbance to the local environmental and local inhabitants. Some of the key considerations and preferred options for delivering the offsite components are summarised below.

- **Ras Markaz Crude Oil Storage Terminal** – several alternative locations were considered for the siting of this facility including the Port of Duqm and another site at Madrakah, 20km further to the south of Ras Markaz. The former proposal was discarded due to geology of the port location and the prohibitive cost of developing a port with sufficient depth for the delivery vessels. The latter proposal was discarded due to issues of coastal vulnerability. The current Project location at Ras Markaz is considered to provide an alternative route to the Strait of Hormuz for the export of crude oil in the region. The development of the entire Crude Oil Storage Terminal was planned to be of strategic importance not only for Oman but also for the Arabian Gulf and indeed Asia region, being located on the Red Sea and connected to South East Asian shipping routes.

- **Pipeline** – early on, it was clear that the only technically feasible and realistic option to transport large volumes of crude oil from the storage facility at Ras Markaz to the Refinery was through pipelines; alternate modes of transport of crude were not considered. A comprehensive assessment of the optimal corridor for Pipeline was undertaken before looking in greater detail at the exact route alignment. The design of the pipeline system sought to maximise its operability, minimise its cost and minimise environmental impact.
- **Product Export Terminal** – since the DRPIC related works for this only include the construction of storage tanks, sheds and handling equipment for the Duqm Refinery products, alternatives for marine works are not considered. Two scenarios were considered for the export of refined products: the first was that these would be pumped directly from the Refinery storage tanks to the berths for loading onto ships with no storage facilities at or near the berths. An alternative to this was to provide storage and terminal facilities close to the berths allowing continuous transfer of product from the Refinery to the tank storage near the jetty using smaller pumps and pipelines. The distance to the berths is approximately 15km which presents issues in product handling so the second intermediate storage option was preferred.
- **Duqm Refinery Construction Camp** –the plot of land for the Camp was provided by SEZAD based on following general criteria:
 - Availability of land within SEZAD and the overall SEZAD Master Plan;
 - Proximity to the Refinery area;
 - Availability of water;
 - Availability of power from the grid (RAECO);
 - Current and proposed land use of the site;
 - Access and proximity to major roads connecting to Muscat; and
 - No other major constraints for the development.

4 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT PROCESS

4.1 INTRODUCTION

Environmental impacts from planned and non-planned activities during all phases of the Project life-cycle have been assessed on the basis of studies, reviews, surveys, analysis, knowledge, assessment, and industry experience of such activities.

A wide range of prediction methods including quantitative and semi-quantitative techniques were used to predict impacts, in what is an objective exercise to determine what is likely to happen to the natural, social and socio-economic environment as a consequence of the Project and its AFs.

The overall approach and methodology, a summary of scoping activities and a description of the Aol were outlined in Section 1.4 above. This Section describes the way in which impact significance has been attributed in the assessment process.

4.2 IMPACT ASSESSMENT METHODOLOGY

4.2.1 Defining the Impact

The assessment followed a systematic process that predicted and evaluated the impacts that the Project could have on resources and receptors of the physical, biological, social/ socio-economic and cultural environment. It then identified measures that the Project could take to avoid, minimise/reduce, mitigate, offset or compensate for adverse impacts. It includes potentially positive impacts and enhancements, where relevant. The specialists utilised the following elements of assessment in order to identify both impacts and mitigation measures.

- **Nature of the Impact** - Environmental impacts arise as a result of Project activities either interacting with environmental or social receptors directly (direct impacts), or causing changes to the existing environment such that an indirect effect occurs (causing an indirect impact). The nature of an impact is either positive or negative and can be from planned (e.g. routine operational) events or unplanned, for instance, as a result of an accident (e.g. spill and fire). Cumulative impacts occur where two or more a Project impacts, perhaps from third party projects adjacent to the development site, act together to affect the same resources and/or receptors.
- **Scale of Impact** - Impact 'extent' relates its geographic reach, and can be local, regional, national, international and/or transboundary of the impact.
- **Duration of Impact** - Impact duration refers to the time period over which a resource or receptor will be affected, and includes: 'temporary' impacts (i.e. short duration, reversible and intermittent/occasional in nature); ; "short-term' impacts (for the life of the proposed short-term activity (e.g. construction) and, say three months after completion; ' and 'long-term' impacts that would continue for an extended period of time after the Project activity ceased (e.g. ten years), or cause permanent change in the affected receptor beyond the Project lifetime.
- **Probability of the Impact** - the probability of an event occurring and creating an impact on a given receptor is designated using a qualitative scale from 1 to 4, the higher values being more probable that an impact will occur (i.e. 1 – unlikely, 2 – low probability, 3 – medium and 4 – high).

- **Severity of the Impact** – upon a given receptor, also using a rating scale from 1 to 4 and defined in Table 4-1 below.

Table 4-1: Definitions of Severity used in the ESIA

CATEGORY	ENVIRONMENTAL RECEPTORS – PHYSICAL AND BIOLOGICAL	SOCIO ECONOMIC RECEPTORS
4 – High	<ul style="list-style-type: none"> • Major, long term national, international or transboundary effects • Deterioration of the existing habitat or ecosystem baseline conditions is significant; rehabilitation required • Results in changes/reduction in the abundance and biodiversity of populations (may/may not recover) • Major non-compliance with national and international regulatory standards 	<p>Highly significant, loss or major damage with medium to long-term effect on cultural and/or natural resources of national and regional importance which are essential for communities' livelihood.</p> <p>Highly significant negative impacts on the national and international community (regional, i.e. neighbouring countries).</p> <p>Immediate intervention by governmental bodies requiring rapid implementation of response measures.</p> <p>National and International media and community concerns and ongoing long term complaints.</p>
3 – Medium	<ul style="list-style-type: none"> • Moderate, medium-term deterioration/ impact on the ecosystem on a local/ national level, leading to observable/measurable changes. • Moderate deterioration and changes/reduction in the abundance and biodiversity of the area with moderate recovery periods to baseline conditions. • Non-conformance with national and international regulatory standards 	<p>Moderate damage to archaeological, cultural or key natural resources of local or national importance.</p> <p>Moderate negative impacts on the regional or national population. Vulnerable groups significantly affected. Changes affecting livelihoods, amenity values, convenience and quality of life of study population;</p> <p>National and potentially international media and community concerns and ongoing long-term complaints.</p>
2 – Low	<p>Minor, short term and local effect, leading to observable and measurable changes recoverable within short durations</p> <p>Potential non-conformance with regulatory standards. Unlikely to result in concerns being raised by governmental bodies or stakeholders</p> <p>Minor deterioration of ambient environmental conditions and recovery requires little or no intervention.</p>	<p>An effect will be experienced but they will be Minor, short term effects recoverable within short durations.</p> <p>Unlikely to result in concerns being raised by governmental bodies or stakeholders.</p> <p>Measurable negative impacts that are intermittent or affect a small minority of the local population and/or vulnerable groups. May result in concerns from local communities.</p>
1 – Very Low	<p>Deemed 'imperceptible' or indistinguishable from natural background conditions.</p>	<p>Deemed 'imperceptible' or indistinguishable to current social norms and variations.</p> <p>No public interest.</p>

4.2.2 Assessment of Significance

A convenient way of representing the overall significance is through a matrix of severity versus probability (shown below).

Table 4-2: Significance Matrix

Significance			Probability Rating			
			Very low	Low	Medium	High
			1	2	3	4
Severity Rating	Very low	1	1 Negligible	2 Minor	3 Minor	4 Minor
	Low	2	2 Minor	4 Minor	6 Moderate	8 Moderate
	Medium	3	3 Minor	6 Moderate	9 Moderate	12 Major
	High	4	4 Minor	8 Moderate	12 Major	16 Major

The categories above are used in the Consolidated ESIA and reflect the following:

- Negligible – no additional action is required and the impact is already reduced to as low as reasonably practicable (ALARP);
- Minor or moderate – additional mitigation is required and/or further studies are needed;
- Major – changes to the Project are required which requires a re-assessment of applicable mitigation and/or reconsideration of alternatives and options (e.g. by engineers).

4.2.3 Identification of Mitigation and Enhancement Measures

A key component of the Consolidated ESIA process has been to carry through existing mitigation measures identified in the previous EIAs as well as explore any additional practical ways of avoiding or reducing potentially significant impacts of the Funded Project. These are commonly referred to as mitigation measures which are aimed at preventing, minimising or managing significant negative impacts and optimising and maximising any potential benefits of the Project.

5 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT OUTCOMES

5.1 INTRODUCTION

Section 2.2 above outlined a summary of the baseline situation for each of the six main parameters being investigated in detail in the Consolidated ESIA process. The Impact Assessment associated with each of these is presented in Sections 5.2 to 5.7 below. Each sub-section deals with predicted impacts for both the construction and operation phases, and then describes any relevant mitigation measures required to avoid, eliminate, reduce or minimise that impact to acceptable levels. Any residual impact remaining (i.e. after the application of mitigation) is stated, where relevant.

5.2 AIR QUALITY

Impacts

Air quality receptors were selected on the basis of their sensitivity, proximity to the refinery, the off-site facilities, haulage road and the port, and their typical representation of the potentially affected area, specific to air quality. The receptors used in the air quality assessment are shown in the table below.

Table 5-1: Sensitive Receptor Locations

RECEPTOR NAME	RECEPTOR TYPE LOCATION	LOCATION	
		X	Y
Wadi Al Khaban	Zero population	568363	2184049
Wadi Ad Dishayshah	Zero population	562123	2184981
Wadi Dhanjart	Small population	563747	2183480
Wadi Quadih	Zero population	564547	2182308
Wadi Say	Small population	569311	2173730
Duqm Town	Large population	566460.2	2170498
Port of Duqm	Small population in workers' residential accommodation	570534.7	2167524
Nafun	Medium size village/population, 13 km to the north of the site	575066	2189521

Construction

Machinery, earthworks and construction vehicles will be the main source of air emissions during the construction of the Funded Project. It is highly likely that ground level concentrations of O₃ and PM₁₀ during construction will exceed international air quality standards due to the baseline concentrations already being elevated.

Emissions of SO₂, CO, NMHCs and PM_{2.5} during the construction phase have not been assessed, as the list of plant to be used, operation times and non-combustion emissions from construction works is unknown at this stage. However as the baseline concentrations for SO₂, CO, NMHCs are very low, it is highly likely that potential effects during construction will not be significant for SO₂, CO and NMHCs. However the significance of effects for PM_{2.5} during construction is highly likely to replicate that for PM₁₀.

Emissions from construction works including material handling, material crushing movement of vehicles and earthworks on site have been assessed qualitatively. There is judged to be a medium risk of dust impacts to both human health and loss of amenity due to vehicle trackout. Despite the large magnitude of dust emissions, the lack of receptors within 350m of construction areas leads to a low risk of construction dust impacts from earthworks and construction activities.

Operation

Ground Level concentrations of pollutants have been predicted during the operation of Duqm Refinery including process heaters, incinerators, boilers, and flaring. It is predicted that only regulatory limits for Particulate Matter (PM₁₀ and PM_{2.5}) will be exceeded due to their high existing baseline concentrations and that the likelihood of significant impacts on the current air quality baseline at sensitive receptors such as domestic residences is very low.

Sources of emissions of odour from the Refinery include crude oil, sulphur tanks, desulphurisation and waste water treatment. While the frequency, magnitude and duration of odorous emissions is unknown at this time, Wadi Dhanjart and Wadi Quadih, both were within 2.5km from the Refinery site, are considered to be sensitive odour receptors and at moderate risk of odour nuisance as a result of emissions from the Refinery. All other locations were considered to be at a slight or lower risk.

Mitigation

Construction

Standard control measures associated with construction site planning and management as well as construction traffic management measures will minimise emissions of dust, hydrocarbons and exhaust emissions. These will include training of staff in measures to minimise dust emissions; periodic site environmental audits to assess their implementation and installing hard surfacing on site to reduce dust creation associated with trafficking and maintaining this in a good condition.

Operation

Mitigation measures have been identified to minimize planned and fugitive emissions from operation of the Refinery with respect to volatile organic carbons, dust, smoke and fumes.

These will include design stage consideration with respect to the use of low nitrogen and sulphur content fuels, ensuring an adequate stack height for air dispersal and fitting emissions monitoring equipment to the plant including the stack. Recommendations are also made with respect to regular maintenance and corrective actions.

Further mitigation measures have been captured and put forward from the Duqm AFs ESIAs, which includes dust suppression measures, site preparation activities and measures to reduce emissions sourced from both traffic and the operation of heavy plant machinery.

5.3

NOISE

Impacts

Sixteen receptor locations were selected to represent the off-site locations likely to be affected by noise from the construction and operation of the Project. These were chosen using SEZAD area maps and satellite imagery and then the locations were checked with DRPIC and local consultants. The receptor sites are in the main residential comprising town, village and villa locations as well as existing worker camps.

Table 5-2: Representative Receptor Locations

RECEPTOR ID	RECEPTOR LOCATION	UTM(40N) COORDINATE EAST	UTM(40N) COORDINATE NORTH
R01	Saay village – north	567632	2172865
R02	Saay village – south	565291	2167942
R03	Saay village – west	564607	2170536
R04	Nafun village – west	575426	2190842
R05	Nafun village - east	577032	2190027
R06	Frontier town	572040	2165207
R07	Frontier town - hotels	573561	2164098
R08	Renaissance Village work camp	570982	2169128
R09	150 Villas	565435	2162472
R10	Shuwayr village	574005	2155963
R11	Proposed residential area	567102	2165752
R12	Royal Oman Police	566180	2160193
R13	Dhahr village - northwest	563379	2132097
R14	Dhahr village - northeast	566744	2130791
R15	Dhahr village – east	567532	2129212
R16	Dhahr village - south	566336	2126120

In addition, on-site exposure of workers exposure to noise from plant used during construction and future operation was also assessed.

Construction

The construction noise assessment estimated noise emissions during peak periods of construction activity based on the latest outline construction programme and indicative construction plant lists provided in the existing ESIA's. The assessment focussed on the worst-case scenario with numerous pieces of noisy equipment all operating at the same time.

The predicted noise level estimates were used to build indicative noise contours for each peak activity period which were applied to the 16 receptor locations. There are no Omani standards for construction noise and therefore IFC Noise Guidelines were applied which set both daytime and night time guide limits for noise at residential receptors.

Off-Site Exposure

The predicted noise level estimates indicate that, for all for all locations, predicted noise levels will be below the IFC Noise Guidelines for daytime and night-time except at one location. At the receptor location representing the northeast dwellings in Dhahr village, predicted noise levels are below the IFC daytime noise limits for each peak activity period, but above the IFC night-time limit during rock drilling for the crude oil pipeline construction when at its closest approach to the village.

On-Site Exposure

The indicative construction plant lists show that operation of some equipment may give rise to worker exposure above the IFC action level for worker hearing protection and in some instances if the worker is close to very noisy plant, pain and even instantaneous hearing damage could arise.

Rock drilling, breaking, crushing and foundation piling activities can give rise to very high noise levels at close range.

The on-site construction noise impacts identified would be negative, direct, local, short-term and of low to medium severity. The probability of the impacts occurring would depend on work plans and equipment selections. The significance of the impacts in the absence of mitigating measures would therefore be considered to be **moderate adverse**.

Operation

The estimated operational noise levels from the Refinery and its off-site facilities, derived from modelling, showed that the areas subject to the highest levels of industrial noise would be Saay village (north), Renaissance Village work camp and Saay village (west), while the lowest impacts are predicted in the 150 Villas, Shuwayr village and the Royal Oman Police. In all cases the operational noise from the project is not expected to exceed the industrial noise limits set out in the Local Omani Ministerial Decision 79/94 or IFC Guideline noise limits.

The assessment of on-site worker exposure to noise from the Refinery operation predicted that the majority of work areas are expected to have noise levels below the IFC threshold for hearing protection. A small number of areas within the Refinery show predicted noise levels above the action threshold and in these areas mitigation and/or hearing protection would be required.

Mitigation

Construction

Limitations on night-time working may be required or noise control measures enforced to reduce off-site noise from the noisiest plant. Control measures should follow appropriate guidance such as that set out in British Standard (BS 5228-1) for controlling noise on construction sites. Where noise levels are still expected to exceed these limits after careful equipment selection, further mitigation such as localised barriers and temporary earth bunds may be required to further reduce off-site noise. Assuming these measures are in place then it is expected that construction noise impacts at all receptors can be reduced to **very low** severity, and **negligible** significance.

Mitigation for on-site construction noise exposure will follow a similar process as for on-site operational noise exposure, including using low-noise equipment, examining noise control options and supplying appropriate hearing and vibration protection. Assuming the adoption of suitable measures as described, it is expected that construction noise impacts will be controlled to meet the IFC Guidelines. The probability of negative impacts on workers' hearing occurring is therefore expected to be **very low**, and therefore considered of **negligible** significance.

Monitoring of construction noise will be carried out within the site and at the site boundary to ensure noise levels are within acceptable limits. Monitoring will be conducted on a monthly basis, or in response to any complaints. Measurements of noise emission levels during the operational phase will be carried out during commissioning of the Refinery at the boundary, to confirm noise levels are within the limits set out in this ESIA.

Operation

No mitigation is anticipated to be required during the operational phase at off-site receptors.

To minimise exposure to workers during the operational phase it is advisable that noise data for equipment is submitted to assess noise levels. If equipment noise cannot be directly reduced to below the thresholds required then hearing protection should be provided to all workers to reduce noise exposure to below the threshold action levels and workers should also be provided with sufficient training in its use. Visible signage should be set up to inform workers of mandatory hearing

protection zones. Periodic hearing checks should also be offered to all employees who work in high-noise areas.

Assuming suitable plant selection, design and noise hazard area designation implementation, it is expected that the probability of impacts occurring can be reduced to **very low**, and therefore the significance of the impact would be considered **negligible**.

5.4 VISUAL AND LANDSCAPE ASSESSMENT

Impacts

Through the landscape and visual impact appraisal process no 'major' negative effects have been identified. Effects with 'moderate' negative significance have been summarised in terms of the impact and the significance of the impacts.

A number of the Project Facilities also form part of a larger AF and therefore the impacts of each are summarised below.

Eight Tanks for DRPIC at Ras Markaz Crude Oil Storage Terminal (Project Facility)

- LCA2 – **minor negative** significance at both the construction and operational phases;
- LCA5 – no impact at construction phase, **minor negative** at operational phase; and
- Visual Intrusion – **minor negative** significance at both the construction and operational phases.

Overall Ras Markaz Crude Oil Storage Terminal (Associated Facility)

- LCA2 – **moderate negative** significance at both the construction and operational phases;
- LCA5 – **moderate negative** significance at the construction phase and minor negative at the operational phase; and
- Visual Intrusion – **moderate negative** at the construction phase and minor negative at the operational phase.

Crude Import Facility (Project Facility)

- LCA2 – **minor negative** at the construction phase and negligible once operational;
- Visual Intrusion – **moderate negative** (high sensitivity receptors) at the construction phase and minor negative (high sensitivity receptors) at the operational phase; and
- Visual Intrusion – **minor negative** (low sensitivity receptors) at the construction phase and negligible (low sensitivity receptors) at the operational phase.

Duqm Refinery (Project Facility)

- LCA2 – **moderate negative** significance at both the construction and operational phases;
- Visual Intrusion – **moderate negative** (high sensitivity receptors) at both the construction and operational phases; and
- Visual Intrusion – **minor negative** (low sensitivity receptors) at both the construction and operational phases.

Topside, Duqm Export Terminal (Project Facility)

- LCA1 – **moderate negative** significance at both the construction and operational phases;

- Visual Intrusion - **moderate negative** (high sensitivity receptors) at both the construction and operational phases; and
- Visual Intrusion - **minor negative** (low sensitivity receptors) at both the construction and operational phases.

Overall Duqm Export Terminal, including marine works (Associated Facility)

- LCA1 – **moderate negative** significance at both the construction and operational phases;
- LCA2 – **minor negative** significance at the construction phase and negligible significance at the operational phase;
- Visual Intrusion - **moderate negative** (high sensitivity receptors) at both the construction and operational phases; and
- Visual Intrusion - **minor negative** (low sensitivity receptors) at both the construction and operational phases.

Mitigation

The following mitigation measures summarise measures which would benefit the landscape in the Project area:

- Encourage areas used for construction (including laydown and support areas) to be the minimum physical footprint in order to avoid unnecessary disturbance of existing landform and vegetation;
- Minimise lighting levels, duration of use, eliminating unnecessary lighting and over specification of light use, to reduce nightglow and extent of the visibility of the development;
- Minimise the use of reflective materials in construction (without compromising worker safety standards) and safe operations while encouraging the use of local stone and aggregate and muted colour schemes to avoid glare and to maximise the integration into the local environmental context; and
- Any landscaping as appropriate to climatic conditions, including native species
- Given the proposed heights and scale of the Project Facilities, screening options are not considered feasible, although there may be potential to use this approach in the vicinity of visual receptors as local screening outside the Project Site Boundary.

5.5 BIODIVERSITY

Baseline

An extensive and detailed assessment of biodiversity was undertaken in August 2017 following observations on the ground in May 2017. That practical work was carried out with local specialists Five Oceans Environmental Services and the results of this are documented in the Consolidated Impact and Mitigation Report and its appendices, namely:

- Appendix A – Survey Record;
- B – Harmonised Habitat Mapping;
- C – Critical Habitats' Assessment;
- D – Invasive Species' Assessment;
- E – Biodiversity Offsetting Framework; and

- F – Ecosystem Services Assessment.

A number of Important Ecological Features (IEFs) were identified that have the potential to be affected by the Project. These including two designated sites, six groups of terrestrial natural habitats, three marine natural habitats and four groups of marine species:

- Duqm Important Bird Area (IBA), Jidat Al Harrasis IBA and Arabian Sea Humpback Whale are considered to be features of **Very High** ecological importance.
- Intertidal mudflats, sand, lagoon areas, endangered, endemic plant species (*Salsola omanensis*, *Ochradenus harsusiticus*), endangered carnivores (striped hyena, Arabian wolf, Ruppell's Sand Fox), Indian Ocean Humpback Dolphin and turtles (Green, Loggerhead and Hawksbill) are considered of **High** ecological importance.
- Mountain areas, wadis, ibex, gazelle, shallow coastal habitats (0-20m), deep water habitats (20-200m), Oceanic habitats (>200m), other whales and dolphins are considered as **Medium** ecological importance.

Figure 5-1 below, displays a map showing the proximity key biodiversity features to the Duqm Refinery Project.

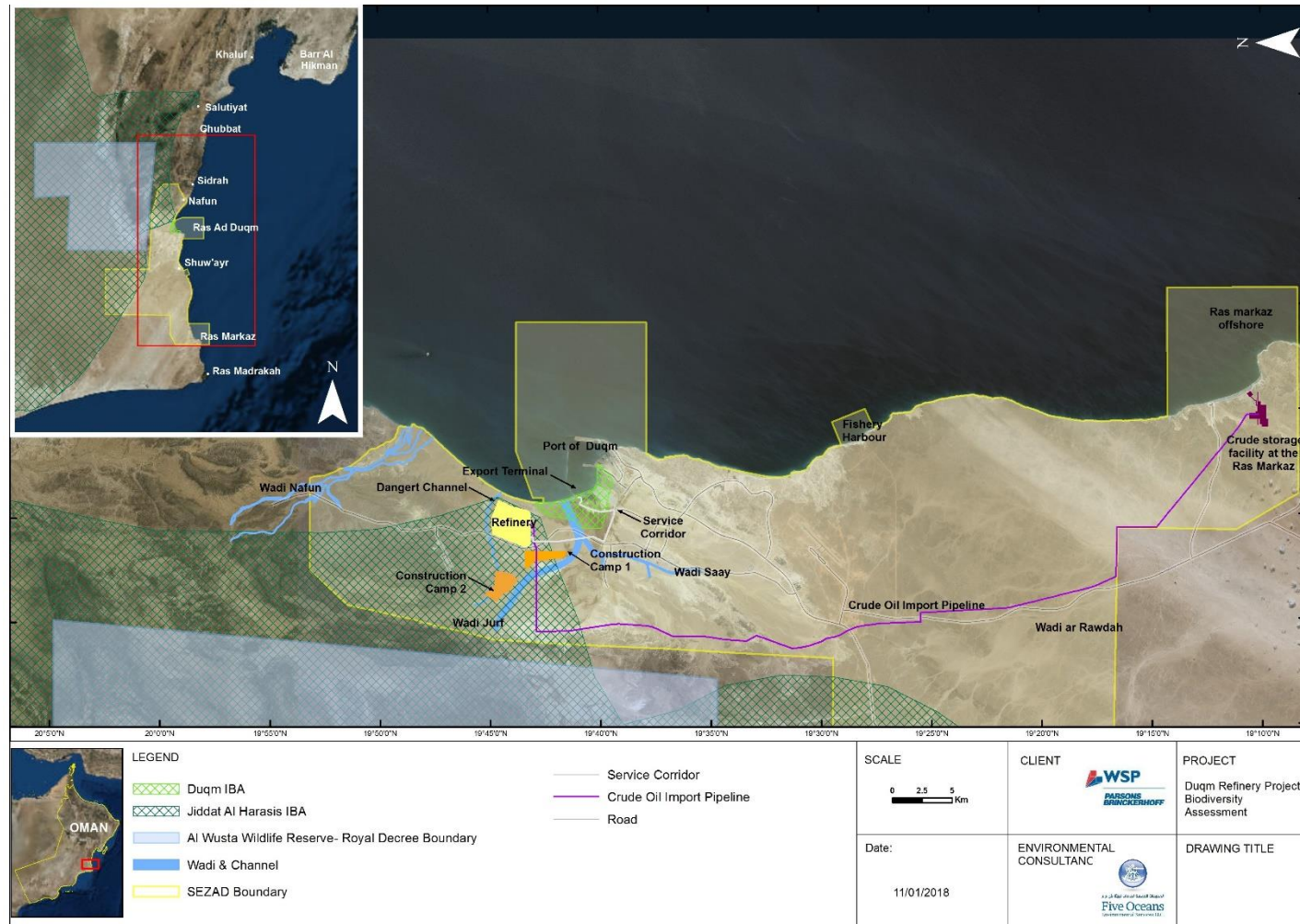


Figure 5-1 Map of Key Biodiversity Features

Impacts

Construction

Potential **major adverse** impacts on IEFs are predicted during construction of the Project as a result of:

- Habitat loss during construction of the Ras Markaz crude oil pipeline and construction camps near mountains and wadis;
- Loss of habitat associated with rare and endangered endemic plant species from land take and damage associated with air emissions (e.g. dust);
- Loss of habitat and disturbance of the Duqm IBA during construction of the Export Terminal, which is an AF; and
- Disturbance to marine species and changes in prey distribution from the activities of AFs, for example, ship movement (associated with strikes), underwater noise and dispersion of sediments during dredging.

Operation

Potential **major adverse** impacts on following IEFs were identified associated with:

- Disturbance to birds in the Duqm IBA caused by the presence of vehicles and personnel during maintenance operations;
- Damage to plant and lichen communities in mountainous areas and on escarpments due to air emissions from the Refinery;
- Injury (and potentially death) of whales through accidental oil spills from the Export Terminal;
- Injury and potentially death of terrestrial IEFs through contamination of fauna, flora and ground water resulting from spills from the DRPIC Crude Oil Pipeline;
- Introduction of non-native, invasive species from shipping and entrapment of fish or marine organisms in water intake systems; and
- Death or injury to whales from collisions with ships and disturbance to marine mammal navigation and communication caused by marine noise and vibration.

Mitigation

Construction

Mitigation measures to be incorporated into EPC activities in the Project areas include minimisation of the construction footprint for the Refinery site and off-site facilities and strictly controlling dust generating activities (e.g. tracking of vehicles) close to reserves; reinstatement of wadi crossings to ensure natural passage of seasonal flood waters; and compensatory landscape planting using native/endemic species. Enhancement of existing and creation of new wetland would help mitigate impacts on the Duqm IBA. Commitments to ensure these activities are actioned are contained in a Biodiversity Management Plan, developed at the same time as the Consolidated ESIA work.

Operation

Mitigation measures will incorporate 'soft start' protocols during maintenance activities to reduce disturbance to birds, ensuring staff only use designated walk ways which are screened from bird habitat; provision of designated staff recreation areas and bird conservation inductions to all staff to mitigate impacts on the Duqm IBA. Regular monitoring of bird use of the IBA by a competent ornithologist in migration and wintering bird seasons will inform adaptive measures to address sources of noise, vibration or other activities which are known to disturb birds.

Ambient air monitoring including of wet/dry deposition on mountain areas and escarpment habitats followed by dispersion modelling will be used to define the extent of the area of mountain and escarpment habitat potentially affected by pollution.

An Oil Spill Response Plan will be produced to mitigate impacts terrestrial and marine flora and fauna including all IEFs.

DRPIC, as the Refinery operator, will also seek assurance from its supply chain and conduct regular reviews to check that stringent environmental controls are in place to prevent marine invasive species introduction to reduce impacts on marine IEFs

DRPIC should also contribute to an integrated biodiversity action plan, working collaboratively with SEZAD and other tenants in the industrial area. An initial focus of the integrated biodiversity action plan should be to obtain more accurate distribution, abundance and movement data for target species to further inform mitigation planning.

5.6 SOCIAL AND HEALTH

Impacts

Project receptors are the local communities located within the SEZAD area that may be impacted by the Project (as a result of their proximity to the Refinery site and/or associated infrastructure). The following receptors were chosen based on site observations and were agreed with DRPIC and local consultants to ensure their relevance:

- Nafun (located within 9 km from the Refinery Location);
- Al Tayari (7km from the location of the proposed Refinery Construction Camp 1);
- Antoot (located within 1 km from the Refinery and 3km from the Export Terminal);
- Wider Duqm area (located within the wider SEZAD area and the concurrently developing wider SEZAD area) ;
- The Duqm Hospital (located within 5.5km distance from the pipeline site and sponsored by the government/Ministry of Health authorities);
- Refinery Construction Camps 1 and 2; and
- The 150 Housing Units area (located within 9km distance from the pipeline site).

The Table below summarises the socio-economic and health impacts that were identified. By and large, the impacts are expected to be limited to the local communities. However, there are a few activities that may impact the wider SEZAD area, such as employment opportunities.

Table 5-3: Identified Social Impacts and Receptors

Potential Impacts (Construction & Operation)		Receptors and Stakeholders
Employment and Economy		
<ul style="list-style-type: none"> • Increase in local employment opportunities • Increase in business development opportunities 	<ul style="list-style-type: none"> • Local government • Local communities and fishermen • Local businesses 	
Community Health		
<ul style="list-style-type: none"> • Increase in communicable diseases 	<ul style="list-style-type: none"> • Local residents • Foreign workers (including contractors) • Local health care providers and infrastructure 	
Community Safety and Security¹		
<ul style="list-style-type: none"> • Increased potential for safety issues associated with the presence of new infrastructure 	<ul style="list-style-type: none"> • Local communities • Construction workers (including contractors) 	
Environmental Emissions		
<ul style="list-style-type: none"> • Increase in noise and vibrations (construction only) • Increase in dust leading to health implications (construction only) 	<ul style="list-style-type: none"> • Local communities • Foreign workers (including contractors) 	
Community Infrastructure and Services		
<ul style="list-style-type: none"> • Increased pressure on community infrastructure and services 	<ul style="list-style-type: none"> • Local communities and fishermen • Foreign workers (including contractors) • Local infrastructure providers 	
Social Networks		
<ul style="list-style-type: none"> • Introduction of new people to the area potentially leading to changes in social structures • Change in the skills set among local job-seekers 	<ul style="list-style-type: none"> • Local communities and fishermen • Foreign workers (including contractors) • Local service providers 	

A major long-term positive and moderate long-term positive impact of an increase in employment opportunities and demand for goods and services will be introduced during construction and operation phases respectively. The Project will provide employment opportunities for the wider SEZAD area. It is anticipated that over 3,000 direct and indirect employment opportunities (for Refinery only) will be created during the operation phase planned for 2022-2050 although the number of people employed by the Project will decrease in the operation phase in comparison to construction.

An increase in the transmission of communicable diseases may occur as the result of the introduction of workers into the area. Hence, a moderate long-term negative impact on community health is expected during the construction phase in particular.

A minor long-term negative impact arises from the potential safety and security risks in the local area during construction and operation. A moderate short-term negative and negligible impact was identified during construction and operation phase respectively for the potential safety and security risks in the local area cause by environmental emissions.

¹ Note that due to the Project area being located in a scarcely populated part of the country, the expected increase in traffic is considered to be negligible.

Impacts on community infrastructure and services (such as hospitals) are identified as moderate temporary negative and negligible during construction and operation phase respectively.

Mitigation

DRPIC has developed an ESMP which will help mitigate potential community socio-economic and health impacts and include: the Community Health and Safety Plan, Socio-Economic and Health Monitoring Plan and Stakeholder Engagement Plan. These Plans include the following measures to mitigate potential negative impacts on community health:

- Implementation of CESMP procedures include an Environmental Monitoring Plan (e.g, air emissions, dust) to monitor potential changes to ambient air quality;
- Early notification of local authorities and Walis on critical or exceptionally busy construction periods and air-polluting/dust- and noise-generating activities;
- Dust suppression by water spraying in dry seasons, particularly in the areas close to sensitive residential and community receptors;
- As part of the induction process for new employees and workers, the construction contractors will provide training for all workers on the transmission routes and common symptoms of communicable diseases; and
- Additionally, construction contractors will provide suitable medical facilities within the workers camps providing both routine medical care and emergency medical services suitable for a large construction site with a peak labour force of approximately 20,000 in total.

In addition the construction contractor will also implement their own management plans including the following:

- Traffic Management Plans which will minimise the potential risk of road traffic accidents, injuries and near misses; and
- A Project Code of Conduct to be adopted by all workers on site to prevent behaviour which could give rise to conflicts with local inhabitants.

5.7 CULTURAL HERITAGE

Impacts

A total of 24 archaeological sites, with varying features, sizes, density and from a range of time periods, were identified as being likely to be impacted by the development corridor. Nine of these are located within 100m of the development corridor.

Most of the archaeological sites mapped were associated with naturally occurring outcrops of chert, flint, quartz and quartzite, raw material sources for stone tools throughout prehistory. Most of these sites were located in the north-western part of the survey area.

A number of architectural structures mapped included circular stone cairns, fireplaces, circular stone houses and a trilith feature; the majority of these are located within 100m of the development corridor and are likely to date from the Palaeolithic periods from 8,000 years ago.

Areas surrounding the Port, worker's camps and Refinery had been significantly altered by construction activities in the past and therefore any traces of NAEHS have been erased. Some areas along the northern side of the have been previously excavated and any NAEHS removed.

Mitigation

The archaeological sites identified were split into four mitigation ranking groups (1-4), these are detailed below:

- Mitigation Rank #4 consisted of isolated surface finds or areas of minimal scientific value which do not require special action.
- Mitigation Rank #3 were diffuse lithic (stone) find spots where it is advised that use of heavy machinery for site clearance does not take place and collection of any stone artefacts should be conducted to mitigate the loss of any archaeological finds.
- Sites classified as Mitigation Rank #2 were recorded as high density, stone artefact scatters which have scientific value for further study. Bulldozing and driving over these sites should be avoided. Two of the sites are within 50m of the development corridor and for these sites a systematic collection of these artefacts should take place to avoid the loss of any archaeological data.
- Sites ranked as Mitigation Rank #1 include those with stone structures or other standing architectural features. These features are considered to be a key part of Oman's heritage landscapes and are therefore required to be preserved where possible. With the exception of two sites all the other Rank #1 sites are within 100m of the development corridor and should be marked out to restrict vehicle access at these sites. One particular site, the trilith at site is an important Iron Age feature and it has been recommended that any impact within 100m is avoided.

It should be noted that the areas around the Port, worker's camps and Refinery are already impacted by construction works (Refinery site preparation by DRPIC and ongoing port expansion by the Port of Duqm Authority, i.e., a third party) and therefore do not require mitigation. This was also noted to be the case for the active artesian springs have already been disturbed by previous construction activities unrelated to the Project.

The cultural heritage assets identified are shown in Table 5-4.

Table 5-4 Archaeological Sites, Location, description and Mitigation Rank

SITE #	SITE FEATURES	LAT (N)	LONG (E)	SIZE (SQ M)	DENSITY (ARTIFACTS/SQ M)	TIME PERIOD(S)	MITIGATION RANK	DISTANCE TO IMPACT ZONE (M)
DQM01	Lithics	19.59091	57.56823	100	4-10	Late Pal., Neolithic	3	170
DQM02	Lithics	19.58927	57.56620	60	0-3	non-diag. Holocene	4	360
DQM03	Lithics	19.57980	57.56984	n/a	isolated	Lower Pal.	4	>400
DQM04	Lithics	19.56423	57.56656	?	0-3	non-diag. Holocene	4	>400
DQM05	Lithics	19.55364	57.56948	?	4-10	non-diag. Holocene	3	50
DQM06	Lithics	19.57122	57.56927	n/a	isolated	non-diag. Holocene	4	>400
DQM07	lithics, structures	19.54445	57.57032	?	0-3	Neolithic, Bronze/Iron Age	1	130

SITE #	SITE FEATURES	LAT (N)	LONG (E)	SIZE (SQ M)	DENSITY (ARTIFACTS/SQ M)	TIME PERIOD(S)	MITIGATION RANK	DISTANCE TO IMPACT ZONE (M)
DQM08	lithics, hearth, shells	19.54457	57.57009	25	11-50	Neolithic, Bronze/Iron Age	1	130
DQM09	stone cairn(s)	19.51266	57.56126	n/a	n/a	Bronze/Iron Age	1	<50
DQM10	stone cairn(s)	19.51205	57.56125	n/a	n/a	Bronze/Iron Age	1	<50
DQM11	stone cairn(s)	19.49571	57.56743	n/a	n/a	Bronze/Iron Age	1	<50
DQM12	lithics, hearth	19.43329	57.58154	10	0-3	Late Pal.	4	>400
DQM13	lithics	19.32171	57.60125	n/a	isolated	Middle Pal.	4	>400
DQM14	lithics	19.31081	57.60460	n/a	isolated	non-diag. Holocene	4	>400
DQM15	lithics, structures, shells	19.17716	57.74119	?	4-10	non-diag. Holocene	1	<50
DQM16	lithics	19.65763	57.57535	n/a	isolated	non-diag. Holocene	4	>400
DQM17	lithics	19.62802	57.57809	30	11-50	Late Pal., Neolithic	2	<50
DQM18	lithics, Trilith	19.62568	57.57666	40	11-50	Middle Pal., Neo., Iron Age	1	<50
DQM19	lithics	19.62214	57.57257	200	11-50	Late Pal.	2	>400
DQM20	lithics	19.61743	57.57114	20	4-10	Late Pal.	3	>400
DQM21	lithics, structures, grave	19.61471	57.57154	30	4-10	Middle Pal., Neolithic	1	<50
DQM22	lithics	19.61173	57.56966	?	0-3	Lower Pal., non-diag. Holocene	4	>400
DQM23	lithics	19.60331	57.56762	30	4-10	Lower Pal., non-diag. Holocene	3	250
DQM24	lithics, structures, hearths	19.58807	57.57014	30	11-50	non-diag. Holocene	1	<50

5.8 CUMULATIVE IMPACTS

A Cumulative Impact Assessment (CIA) has been conducted in order to assess the interaction between the impacts arising from the construction and operation of the Projects and those of the AFs and wider third party development within the SEZAD area.

The CIA has been based on IFC guidance, which sets out a six-step structure for conducting a comprehensive CIA as presented in Figure 5-3. Due to the particular specifications of the Duqm Refinery Project or lack of information about third party projects/initiatives in the Duqm area, it is not always possible to follow this methodology word-for-word and the IFC document is a guide. The assessment was adapted and modified throughout the course of compiling the CIA.

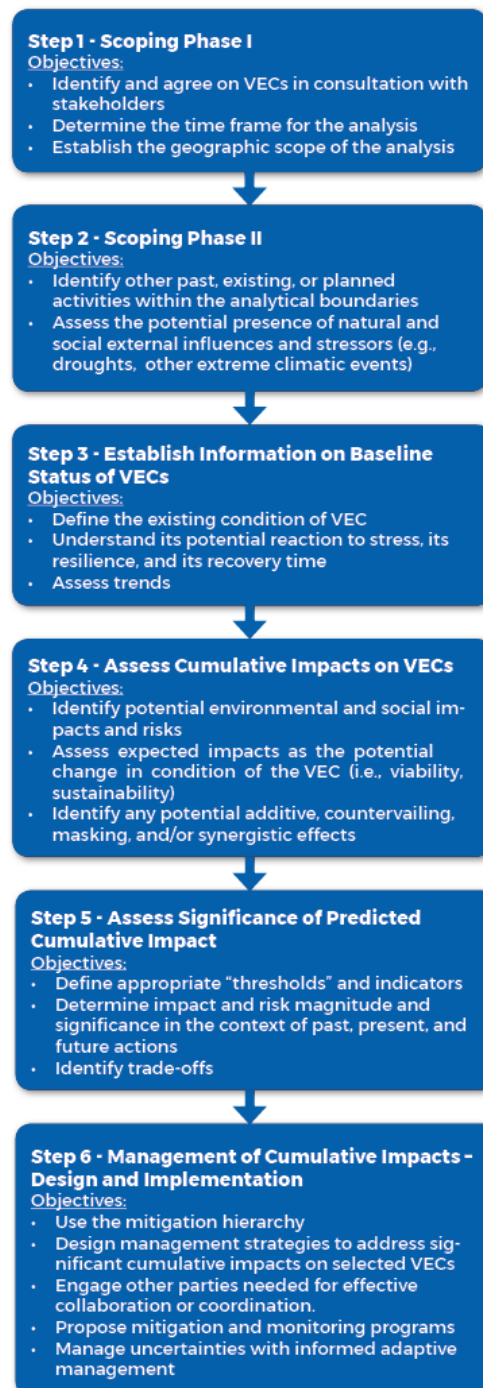


Figure 5-3: IFC (2013) CIA Guidance Process

During the initial scoping stage, a set of Valued Environmental and Social Components (VECs) and their respective baseline conditions was established based on data within the existing DRPIC Project's EIAs and the updated baseline data produced by WSP. The VEC categories chosen were as follows:

- Ecosystems Services VECs (natural resources);
- Physical environment VECs (air quality, GHGs, noise, groundwater, soils, surface water quality (freshwater / marine) and landscape);
- Biodiversity VECs (marine and terrestrial habitats flora and fauna);
- Socio-economic VEC (resident population, local businesses and the economy; road infrastructure and transport; and other infrastructure including hospitals);
- Community and Health; and
- Cultural heritage and archaeology.

The location and extent of the VECs was established as well as their character via an evaluation of their rarity and importance at a local, regional and national level as well as their sensitivity to impacts and their ability to recover.

Next the Zone of Influence (ZOI) was established for each of the identified VECs in order to identify the area within which cumulative impacts are likely to occur. This is the area of overlap of the impacts of other projects with the impacts from the Projects. The maximum assigned area of overlap for terrestrial VECs was 10km and for marine VECs a 250km ZOI was established associated with the wider impact of shipping and the potential for oil spills. This is presented diagrammatically in Figure 5-2.

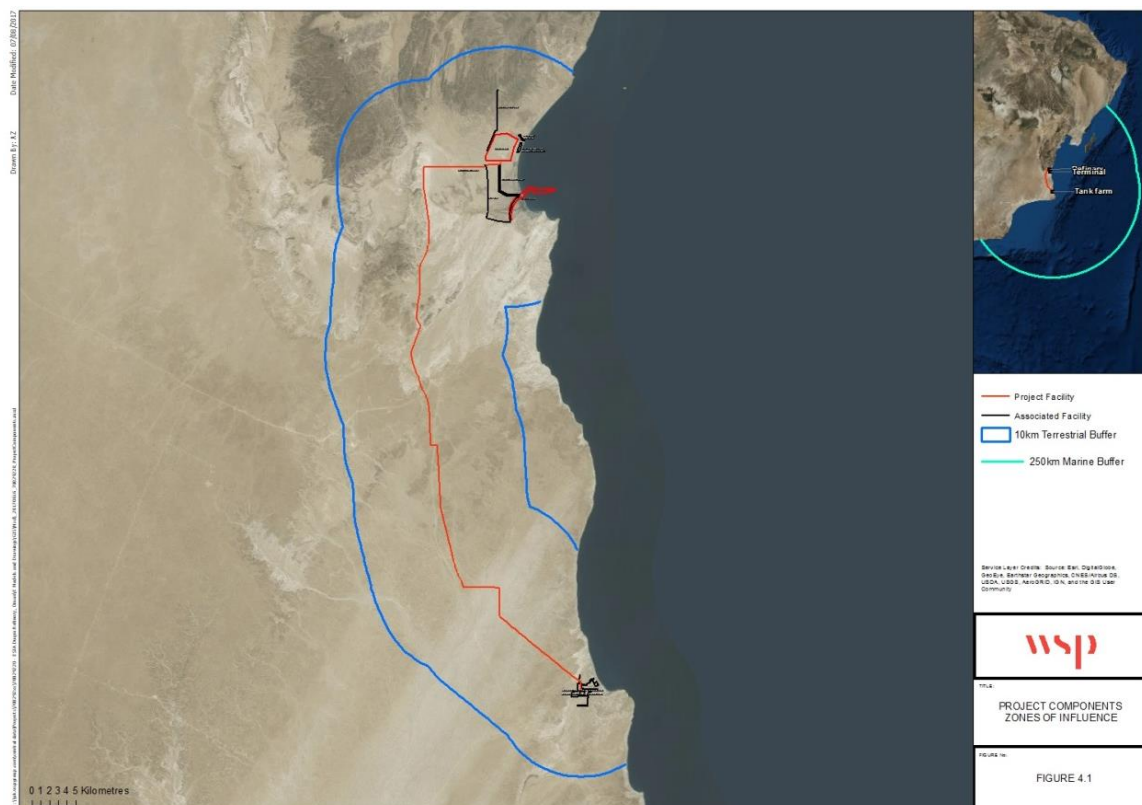


Figure 5-2: Proposed Zones of Influence for the various VECs

The predicted project timeframes for the Project during construction and operation were identified in order to evaluate the period of time over which the cumulative effects would occur.

- The construction period, including the operation of associated construction camps, was predicted to be 3 – 4 years; and
- The operational design life for the Funded Projects is 35 years, with full operation commencing at the end of 2019 and activity continuing until 2055.

During the secondary scoping stage, a list was drawn up of all the projects understood to be entering into construction or operation over a similar timeframe to the Project. This included AFs as well as other projects within the wider SEZAD development. It was determined that little or no ESIA information was available for the wider SEZAD development and thus it was not possible to assess the cumulative impacts for these in any detail however qualitative assessment was undertaken where 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*'.

Impacts

The CIA established that air quality, social-economic and health and cultural heritage VECs would experience **minor adverse** impacts with one **minor positive** impact associated with socio-economics and growth of local businesses. Several **major adverse** impacts were however identified with respect to ecology.

The significance of the cumulative impact for natural capital, GHG emissions, groundwater, surface water and noise relevant to community health during construction phase are considered to be negligible. There were no cumulative impact on land use, soil, landscape and visual and noise (operation phase).

Air Quality

Cumulative air quality impacts on VECs (local residents and workers as well as habitats) were considered likely to arise during the construction phase of the project due to the accumulation of dust (particulate) during the development of numerous plots of land as well as roads to service the new developments. The dusty and dry nature of the locality increases the potential for windblown dust from construction and further elevation of particulate matter concentrations locally above air quality standards which are already exceeded (refer back to Section 4.1 of this NTS).

It was however considered that neither the Omani nor, where applicable, IFC air quality standards would be exceeded with respect to industrial air pollutants during the operation of the facilities and associated with increases in traffic.

Topography/Landscape

As stated in the landscape and visual appraisal, 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.

Impacts were also predicted during the operation phase at the Duqm Refinery, the topside development of the Duqm Export Terminal and at the Export Terminal including marine works.

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 industrial area.

Cultural Heritage

Cumulative impacts to archaeological remains are most likely during intrusive temporary works for site platforms and haul roads and for permanent works such as underground pipes and foundations.

The operational phase of the Project, AFs and the wider SEZAD developments will result in a long term increase in human activity introducing noise and light pollution which will alter the setting of the heritage assets. These may also be further impacted by increased public visitation.

Ecology

During the construction phase, the Duqm IBA, Arabian Sea Humpback Whale and Indian Ocean humpback dolphin could be subject to major adverse impacts associated with loss of habitat, oil spillages and for marine VECs, potential for strikes and noise associated with shipping.

Two of the key issues identified for terrestrial and marine species were as a result of the following construction phase cumulative impacts:

- The cumulative loss of the IBA means as a result of the development of the SEZAD as a whole means that it is unlikely to be able to support the numbers of wetland bird species for which it was designated; and
- The construction of the Single Point Mooring at the Ras Markaz Oil Terminal and construction of the Export Terminal (both AFs) 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.

Moderate adverse impacts were identified during the construction phase with respect to habitat loss, in particular from the wadi systems which provide trees cover and water and the resulting potential impacts on several endangered, endemic plant species as well as endemic animals including ibex and gazelle.

A moderate to minor significant impact on green, loggerhead and hawksbill turtles could be expected during the operation phase from general disturbance and lighting on site.

Social and Health

The presence of approximately 20,000 migrant workers during the three to four years of the construction phase was considered one of the most significant adverse socio-economic cumulative impacts on local communities and also their health, safety and security, as well as local infrastructure and services.

Minor adverse impacts during construction and operation phase on socio-economic factors including community air quality and archaeological sites were identified. However, minor positive impacts on socio-economic factors (local economy) were also assessed.

Mitigation

Air quality mitigation of abatement and suppression of particulate emissions and dust re-entrainment in areas close to boundaries of the Project and AF sites should include assisting in containing excessive dust, curbing potential dust nuisance to reduce the incidence of elevated Particulate Matter.

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.

At a strategic level for biodiversity, the following mitigation includes:

- Requesting assurance and conduct regular audits of mitigation strategies implemented by OTTCO, Port of Duqm 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).
- Working 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.
- Suggesting the formation of an 'advisory panel' that guides mitigation and monitoring through linking industry together government, conservation and research interests.

Also, during construction phase, DRPIC should seek to work to implement mitigation measures to minimise impact on the Duqm IBA, such as clean-up of litter and at a strategic level the potential enhancement of the remaining IBA via onsite and off-site creation of constructed wetland e.g. using dredged material.

The minimisation of the construction footprint of wadi crossings, their reinstatement and compensatory measures will help mitigate impacts on wadis VECs. Moreover, preconstruction surveys, translocation and native plant propagation scheme are suggested to reduce impact on endangered and endemic plant species during the construction phase.

. DRPIC should seek assurance from SEZAD who should contribute to an integrated Biodiversity Management Plan to avoid development in wadis and flood prone areas and to protect mammal habitat for wide ranging species such as large carnivores, gazelle and ibex.

Impacts on socio-economic will be remedied through the implementation of the ESMP and ongoing engagement and consultation with local communities and SEZAD.

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.

6 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLANS

An ESMP, comprised of a set of sub-plans (summarised in **Table 6-1** below) have been developed for the Project for the construction phase only. These are based on the mitigation and monitoring recommendations contained within historic EMPs which have been updated in the light of the recommendations in the Consolidated ESIA. The commitments made in the ESMP will be actioned on the ground during construction, primarily by the appointed EPC Contractors and with oversight from DRPIC.

Table 6-1 Environmental Management and Monitoring

ASPECT	SCOPE OF MANAGEMENT AND MONITORING
Waste Management Plan	Assessment of waste generated; development of Waste Management Implementation Plans and Procedures; identification or development of waste treatment facilities; and life cycle of all project generated waste.
Test Water Management Plan	Managing sourcing, treatment, use and disposal of water used for hydrostatic testing of equipment, piping and pipelines related to achieving environmental performance standards. Cleaning of equipment and piping.
Pollution Prevention Plan	Outline the minimum requirements for the prevention of pollution regarding to resource efficiency, emissions, hazardous material management and pollution prevention measures.
Biodiversity Management Plan	Avoidance, protection and mitigation of the designated nature conservation site Important Ecological Features (IEFs), habitat IEFs and animal and plant species IEFs.
HSSE&S Assurance Plan	Assurance monitoring; inspections and audits; targets; key performance indicators; contractors assurance and performance review; management review; and corrective actions.
Environmental Monitoring Plan	Monitoring of ambient water quality, liquid effluents, groundwater, ambient air quality, air emissions, ambient noise, soil and waste.
Cultural Heritage Management Plan	Minimize the chance of damage to any archaeological or culturally significant sites during construction.
Environmental and Social Management Plan Framework	Outline the Construction Environmental and Social Management Plan (CESMP) to be undertaken by the COMPANY and CONTRACTORS during the execution phase of the Project.

ASPECT	SCOPE OF MANAGEMENT AND MONITORING
Cumulative Impact Management Plan	Management of site-specific, project-wide and project cumulative impact on air quality, biodiversity, socio-economics and health and cultural heritage.
Socio-economic and Health Monitoring Plan	Outline the key monitoring requirements (or key performance indicators/KPIs) to monitor the social performance of the project.

7

FINDINGS AND CONCLUSIONS

7.1 FINDINGS AND CONCLUSIONS

The process of preparing a Consolidated ESIA was driven by the need to address a number of gaps in the Project EIAs in relation to the requirements of international standards such as IFC Environmental and Social PS.

In pursuing an ESIA to international standards, DRPIC carried out scoping, resulting in the selection of six key topics (i.e. air quality and odour, noise, landscape character and visual intrusion, biodiversity and ecology, socio-economics and health and cultural heritage) that required further investigation. Surveys and desk-based assessments enhanced information on the baseline. A record of that and the subsequent impact assessment of the Refinery Project, and identification of mitigation measures, is documented in the Consolidated Report and its Appendices as well as within the Cumulative Impact Assessment and its Appendices.

Information contained in the Consolidated Report and ESMP will be an important and up-to-date reference point, as civil works Contractors, DRPIC, authorities/regulators and lenders engage in follow-up initiatives, such as audits, checks and monitoring to assess the Project's performance. The commitments integrated into that documentation is key to ensuring a robust approach to managing environmental and social aspects of the Project.

The Refinery will be operational for decades so the temporal and spatial extent of activities will be ongoing and long-term. The management and monitoring of environmental and social aspects is also long-term and will thus become part of everyday activities. At the same time, legislation in Oman, and potentially new environment-related Conventions, as well as new requirements from SEZAD (e.g. technical guidance, audit visits, monitoring reporting) will grow in scope and rigour. To that end, DRPIC's ESMS and ESMP will evolve to keep pace with any changes. Staff will be appointed to take responsibility of environmental and social/socio-economic matters.

In addition to these proponent-led initiatives, the appointed Contractors will be required to produce well-understood and practical documents that are fully-compatible with DRPIC's own policies, and the Consolidated ESIA package of information, ESMS and ESMP. The Contractors will develop their own systems, documentation and staff to effectively implement measures in the ESMP and be able to demonstrate how compliance is being met.

The identified impacts in the realms of air quality (e.g. increased emissions contributing to new baseline, potential cumulative impact from multiple Project developments and third party projects), the influx of significant numbers of construction workers (e.g. change to cultural/social dynamics in Duqm), and the threats of construction activities upon ecological receptors (and hence biodiversity) are the most important to be identified. Those involved in the Project will need to regularly liaise with stakeholders, such as the neighbouring Port of Duqm), other proponents in the Duqm SEZ and the regulator/landlord SEZAD. Tackling the more strategic challenges that transcend the Duqm Refinery Project will take time and a teamwork approach. A number of joined-up-thinking initiatives are proposed – for instance in asking and helping SEZAD to take a leadership stance on biodiversity protection across the Duqm SEZ. Through collaboration, the assets of Duqm and the region can be better protected while growth of the region will help Oman attain its goals and ambitions for economic prosperity.

8

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