

# Non-Technical Summary – Sub\_Project 4

Construction of Jurf and Saay Flood Protection Channels in Duqm

## TABLE OF CONTENTS

<b>1</b>	<b>INTRODUCTION .....</b>	<b>3</b>
1.1	Project Background –Jurf and Saay Flood Protection Channels in Duqm .....	3
1.2	Regulatory Context and Standards .....	4
1.2.1	<i>Omani Legislation and Guidance</i> .....	4
1.3	Environmental and Social Context .....	4
1.4	Documentation .....	5
1.5	The Purpose And Content Of NTS .....	5
<b>2</b>	<b>PROJECT DESCRIPTION .....</b>	<b>6</b>
2.1	Project Components .....	6
2.1.1	<i>Saay Channel</i> .....	6
2.1.2	<i>Jurf Channel</i> .....	7
2.1.3	<i>Construction Process</i> .....	7
<b>3</b>	<b>BASELINE CONDITION .....</b>	<b>8</b>
3.1	Baseline Assessment Summaries .....	8
3.1.1	<i>Climate and Meteorology</i> .....	8
3.1.2	<i>Rainfall</i> .....	8
3.1.3	<i>Humidity</i> .....	8
3.1.4	<i>Geology</i> .....	8
3.1.5	<i>Hydrology</i> .....	8
3.1.6	<i>Groundwater</i> .....	9
3.1.7	<i>Ambient Air Quality</i> .....	9
3.1.8	<i>Noise</i> .....	9
3.1.9	<i>Terrestrial Ecology</i> .....	9
3.1.10	<i>Socio Economic</i> .....	10
3.1.11	<i>Archaeology</i> .....	10
<b>4</b>	<b>SUMMARY OF ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT AND MANGEMENT PLAN11</b>	
4.1	Introduction .....	11
4.2	Environment And Social Management Plan (ESMP) .....	14
4.2.1	<i>Environmental Monitoring</i> .....	18
4.3	Climate Affairs .....	18
<b>5</b>	<b>FINDINGS AND CONCLUSIONS .....</b>	<b>19</b>

## ACRONYMS

ALARP	As Low As Reasonably Possible
CEMP	Construction Environment Management Plan
CSR	Corporate Social Responsibility
DGEA	Directorate General of Environmental Affairs
ESIA	Environment and Social Impact Assessment
EMP's	Environmental Management Plan
GHG	Green House Gases
GM	Grievance Mechanism
IUCN	International Union for Conservation of Nature
MD	Ministerial Decision
MECA	Ministry of Environment and Climate Affairs
NAAQS	National Ambient Air Quality Standards
NTS	Nontechnical Summary
O3	Ozone
PDC	Port of Duqm Company
PDD	Partnership and Development Department
RD	Royal Decree
ROP	Royal Oman Police
SEZ	Special Economic Zone
SEZAD	Special Economic Zone Authority Duqm
SEZD	Special Economic Zone Duqm
SLR	Sea Level Rise
SO2	Sulphur dioxide
STP	Sewage Treatment Plant
UNESCO	United Nations Educational, Scientific and Cultural Organization

# 1 INTRODUCTION

With a land area of 2,000 km<sup>2</sup> and 70 km of coastline along the Arabian Sea, the Duqm Special Economic Zone (SEZ) is the largest in the Middle East and North Africa region and ranks among the largest in the world. The Duqm SEZ is a model of an integrated economic development composed of zones: a sea port, industrial area, new town, fishing harbour, tourist zone, a logistics centre and an education and training zone, all of which are supported by a multimodal transport system that connects it with nearby regions (e.g., the Arabian Gulf countries, Middle East, East Africa and Southeast Asia). The Port of Duqm is seen as a catalyst for the development of the Al Wusta region, in particular, the Special Economic Zone at Duqm. The Port and the dry docks are being developed to increase cargo transshipments, ship repairs, manufacturing industry and tourism.

The Special Economic Zone is administered, regulated and developed by the Duqm Special Economic Zone Authority (SEZAD), a financially and administratively independent government entity. SEZAD was established as per the provision of the Royal Decree (RD) 119/2011 and is responsible for the management, regulation, and development of all economic activity in the SEZD.

## 1.1 PROJECT BACKGROUND –JURF AND SAAY FLOOD PROTECTION CHANNELS IN DUQM

The economic and social growth, and implementation of large scale infrastructure development projects has opened up new horizons for construction and economic boom in Duqm. It is necessary to provide protection to these investments against natural and man-made disasters.

Rainfall in Oman, just like most arid regions in the world, is sparse and erratic. When it does occur, it can result in serious consequences such as flash flooding resulting in human catastrophes and land degradation. There is thus a dire need to ensure a high level of flood protection for developments as well as inhabited areas from infrequent torrential floods resulting from sporadic rainfalls.

A comprehensive and integrated drainage system comprising dams and channels is a pre-requisite for development planning and human safety. The dams in the mountainous area can be used to hold back floodwaters, and the channels are designed to carry the flows released by the dams after heavy rainfall and the local flows generated by tributary wadis or channels. Drainage channels that is stable, cost effective, and environmentally acceptable can be designed by respecting the natural drainage patterns so as to provide safety of infrastructures built in the flood plain areas. These dams and channels can thus keep floodwaters out of the development planned areas.

In this project, two flood water conveyance channels downstream of the proposed Jurf and Saay Dams (henceforth called as Channel Project) will be constructed in the surrounding mountainous areas of Duqm as shown in Figure 1. The channels are designed to carry the flows released by the dams and local flow generated by tributary wadis or channels, keeping floodwaters out of the development planned areas.

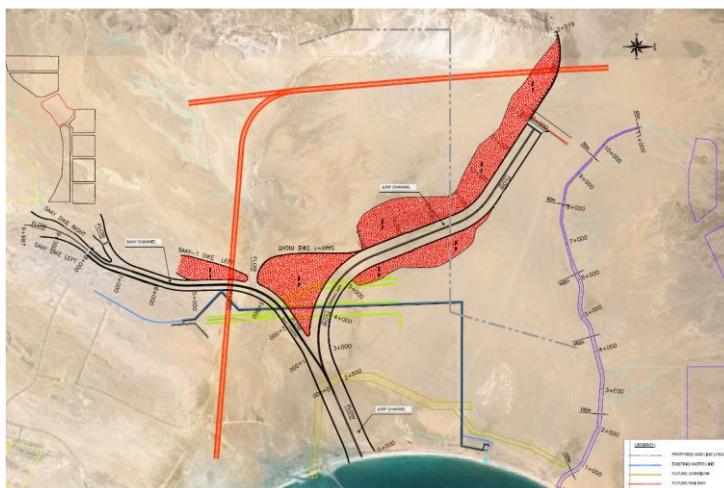


Figure 1: Layout of Jurf and Say Flood Protection Channel

## 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 was 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).

Omani environmental law has two main legal instruments, viz., Royal Decrees (RDs) and Ministerial Decisions (MDs). Typically, an RD provides a general framework relating to a particular area in need of statutory control, while MDs provide specific regulation using the framework provided in the RD. Where Omani environmental regulations and standards were not available, acceptable international environmental regulations and standards has been referenced.

The Channel Project will work within with the range of applicable legislation in Oman. The Omani environmental and social laws and regulations with regard to air emissions, noise, wastewater, solid and hazardous wastes, hazardous materials and chemicals, labour, cultural heritage etc., which are applicable to the project has been considered during the project phases. The summary of the Channel Project is as follows:

PROJECT	CONTRACT NO	CONTRACTOR	ORIGINAL PROJECT EXECUTION PROGRAMME	EXPECTED DATE OF COMPLETION
Construction of Jurf and Saay Flood Protection Channels in Duqm.	Contract C65/2016	SERKA Taahhut Insaat A.S. (Turkey) & Rajab & Aida Earthwork Company (RAECO)	32 Months	Q4 2019

## 1.3 ENVIRONMENTAL AND SOCIAL CONTEXT

Renardet SA & Partners has been awarded the Consultancy services for feasibility and detailed design study of the Duqm Development Drainage Network and Protection Schemes by SEZAD. They are also be involved in the construction supervision of the channels project. An Environmental Impact Assessment Study (EIA) has been conducted as part of the permitting process for the Channel Project by Renardet in 2015 and approval issued by SEZAD in the same CY.

No social consultation was conducted as part of the project. Existing survey data and information has been used to describe the baseline environment, the only project-specific surveys undertaken included a geological walkover and geotechnical survey. While a contractor-prepared CEMP was not prepared, the EIA Report included an outline EMP which summarised the mitigation measures for the impacts. Monitoring report are being prepared and submitted to SEZAD periodically.

Within the feasibility phase, hydrological assessment was carried out over the complete area and two dimensional models were established to show the effect of dam and channel implementation. Baseline condition for the channel area is summarized in Section 3 of this document.

SEZAD Corporate Social Responsibility (CSR) section of the Partnership and Development Department (PDD), provides access for communities to provide any grievance (written and in person) through the Grievance Mechanism (GM) form. The GM form is available on SEZAD website at <https://www.duqm.gov.om/sezad/csr/grievance-form>.

The ways grievance can be registered are as follows-

1. **Via Phone** - The Partnership & Development Department (PDD) can be contacted between the hours of operation (8am – 3 pm) Sunday to Wednesday on 24507216.

2. **Via Official Letter** - The Official letter can be directed to the Manager of the Partnership and Development Department and can be dropped of either directly to any one of our offices in DUQM or Muscat
3. **Via Email** - An Email can be sent to the Partnership & Development Department to CSR@duqm.gov.om
4. **Website Portal** - All information regarding the process of the grievance system is available as well as a form that can be filled online and sent directly to the Partnership and Development Department though <https://www.duqm.gov.om/sezad/csr/grievance-form>

All Grievance issues are handled by the Partnership and Development Department (CSR Section). In the event the department is unable to assist or respond, it will be raised to the Deputy CEO of SEZAD where responses will be answered within a 7 days from the date of the letter/ grievance received, however can change depending on the complexity of the grievance.

## **1.4 DOCUMENTATION**

The environmental reports available for the Jurf and Say Flood Protection project are as follows -

1. Duqm Development Drainage Network and Protection Schemes – Phase 1. EIA for Saay Dam, Saay Channel, Jurf Channel and Junction Channel, Renardet S.A and Partners Consulting Engineers LLC, July 2015.

The report mentioned above is available with SEZAD Environment Regulatory Department and can be accessed on email request to ERD Manager Mr.Ahmed Harib Al Balushi at [EMIPS @duqm.gov.om](mailto:EMIPS@duqm.gov.om)

## **1.5 THE PURPOSE AND CONTENT OF NON-TECHNICAL SUMMARY (NTS)**

This NTS provides an overview, in layman's terms, of the main environmental and social findings from the EIA of the Project. This current Section introduces the Project and the legal, environmental and social context. The following Section 2 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 with reference to ESMPs have been summarised in Section 4 for the Project's construction phase, while Section 5 provides the findings and conclusions of the EIA.

This Summary serves as an overarching disclosure document to disclose the Environmental and Social findings from the EIA study. 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 PROJECT DESCRIPTION

### 2.1 PROJECT COMPONENTS

The aim of the project is to provide a significant degree of flood protection to the free zone area under development. The construction of attenuation dams and flood conveyance channels is likely to form the principal components of such flood protection measures. Dams will be situated upstream of the target area and channels shall be designed to convey the remaining water safely through the development area.

The dams are designed to attenuate the 1,000-year flood event to the 100-year flood event. Consequently, both channels are designed to withstand the 100yrs natural flood which is equivalent to the 1'000yrs event with the upstream dam implemented

These two earth-filled dams are located upstream of the Jurf and Saay Wadis to hold back flood waters resulting from infrequent heavy rainfall events. The flood protection system consists of drainage channels within the Jurf and Saay Wadi. After rainfall event, the stored water will be released downstream of the dams in a controlled manner through bottom outlets of the dams and discharged to the sea. When there are no rainfall events, the flood protection dams will be dry.

The project components include

- Wadi Jurf Channel
- Wadi Saay Channel
- Collecting secondary channels and
- Sea outlet

Jurf Channel:

- Length: 11.95km (per Project Brief) / 16km
- Width varies from: 340m to 650m
- Discharge capacity: 2300m<sup>3</sup>/sec to 3900m<sup>3</sup>/sec

Saay Channel:

- Length: 9.980km up to junction with Jurf Channel.
- Width varies from: 90 to 320m.
- Discharge capacity: 990m<sup>3</sup>/sec



#### 2.1.1 Saay Channel

Wadi Saay channel is draining from the Saay dam and shall collect the remaining water from the dams and ensure its conveyance until the sea. Water from western area of the development area will be collected by the implementation of two secondary channels, Saay 1 and Saay 2.

The upper part of the Saay channel is actually leaning against a higher natural banks on right side which might be used as support for the channel implementation and provide a shallow slope of the left side to drain the area.

In addition, different changes in cross section width are made when secondary channels are joining the main alignment. At the second junction, dykes shall be implemented to contain the flow and ensure the backwater effect due to the downstream main junction is contained.

### **2.1.2 Jurf Channel**

Wadi Jurf channel is draining from the foreseen corresponding dam after the junction of the Wadi with the Wadi Ash Shinan. It shall collect the remaining water from the dams and ensure its conveyance until the sea. The retained alignment will convey the water through the development area.

The channel is then equipped with dykes before joining the Saay channel coming from southern part of the development area.

### **2.1.3 Construction Process**

The channels follow the natural Wadi watercourses to a large extent, collecting secondary channels. Jurf and Saay channels have a combined outlet to the sea at the approximate location of the current Wadi deltas. "Jurf" Channel was diverted slightly to follow the left bank of its natural watercourse thereby reducing the amount of excavation required;

"Saay" Channel starts at the existing Duqm village where the river banks are not so well defined. "Dangert 2 Channel" with a reduced cross section and starting further upstream since the natural water course of the Wadi conveys water to Jurf channel;

Jurf channel starts at the downstream of Jurf dam and is heading from west to south, then turned to west and ended by the sea with different bed widths started from 340 m to 650 m at the sea outlet. The total channel length is app. 16 km.

Saay channels started from the downstream of Saay dam along the natural Wadi route and heading from south to north till the junction with Jurf channel. This channel has also different bed widths started from 90 m to 320m when joined with Jurf channel.

The channel sides in certain areas will be protected by gabion boxes and levees wherever required as per the drawings. Water supply lines and other services may be encountered during the excavation. The junction of the channels is to be constructed in a flat area therefore the sides were provided with earth fill embankments protected with riprap.

The scope of works includes the following major components:

- Excavation of channels to levels and lines as per the drawings in different type of soil and the water level may be encountered in many sections,
- Construction of embankment with protection works;
- Providing protection works like Gabion boxes and riprap;
- Relocating the existing services



## 3 BASELINE CONDITION

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### 3.1 BASELINE ASSESSMENT SUMMARIES

This Section provides a summary of baseline data comprising primary data collection and secondary data available in separate reports, and presented as part of the EIA Report:

#### 3.1.1 Climate and Meteorology

According to the available data, the average yearly temperature varies to extremes during the seasons, while maximum may rise to 46° C in summer daytime. Minimum temperature may go down to 11° C on winter nights. The main weather systems that deliver rainfall to the region comprise:

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

#### 3.1.2 Rainfall

Rainfall data was sourced from General of Meteorology and Air Navigation (DGMAN) for the Duqm master plan study. Duqm, is subject to very minimal annual rainfall. The total recorded rainfall in Duqm over the ten years was 174mm (2003-2011), with an average annual rainfall of 17mm.,

#### 3.1.3 Humidity

According to the DGMAN of the Sultanate of Oman, monthly maximum & minimum humidity (%) for Duqm meteorological station is 70,5% maximum In August and a minimum of 53.6% in March as given in the following table. This data is based on observations from 2003 until 2011, where the average Relative Humidity for this period per year is 62%.

#### 3.1.4 Geology

The Duqm area is a junction of several major geological domains where the formations ranging from Late Precambrian to Miocene in age are represented, but numerous breaks are presents due to interruption of deposition during tectonic phases with faulting and removal by erosion of rocks mainly of extensive shelf type. Geotechnical investigation was conducted to understand the geological conditions in depth but for the dam and reservoir area.

#### 3.1.5 Hydrology

Duqm contains a complex network of tributaries and wadis, as well as a coastline with many distinctive physical features. Duqm, while subject to very minimal annual rainfall, is subject to larger intermittent storms with the potential to create strong regional flows. The coastline is subject to several factors that may influence development, including tidal fluctuation, storm surges, tectonic uplift, sea level rise, and wave-run-up that accompanies major cyclones.

Duqm is traversed by a rigorous network of natural tributaries and storm water wadis. Duqm’s coast is defined by a diverse mix of beaches, cliffs, rocky areas. These provide a range of conditions that offer different levels of suitability to development as well as result in different zones that will be susceptible to coastal environmental hazards.

### **3.1.6 Groundwater**

Ground water table was encountered during geotechnical investigation conducted for the project. The ground water level varied from 1.5 to 5.6 m below the existing ground surface as recorded during the field exploration. Based upon evaluation of ground water measurement, it appeared that ground water, at the time of field exploration, was flowing toward the southeast direction.

The chemical analyses of ground water samples indicate the highest total dissolved solids, chloride, sodium, calcium, total hardness and conductivities in borehole located in close proximity of the coastal line where sea water intrusion is present as evident in Sabkha ground. The TDS and other indicators for salinity are high in all the GW samples collected as part of geotechnical study. The analysis report is included in the EIA report.

### **3.1.7 Ambient Air Quality**

Ambient air quality studies undertaken for the region previously were conducted for the project. The studies recorded NO<sub>2</sub>, PM<sub>10</sub> and O<sub>3</sub> data higher in some instances which could be attributed to increased vehicular movement due to an increase in port activity in the month of March during that time, when the commercial quay was inaugurated for operations. As a result, exceedance in concentrations of O<sub>3</sub>, SO<sub>2</sub> and PM<sub>10</sub> in comparison with the standards were also recorded while all other pollutants are well within limits.

At the time of EIA study for the project, there was no major air quality problem located in the project area since the study area is wide open, with natural habitats and absence of major air pollution sources, such as industry or big traffic roads.

### **3.1.8 Noise**

A review of noise levels in the study area, from secondary data, found levels to be within the limit prescribed in MD 79/94 for industrial areas with some exceedance recorded in area close to Duqm Town. The noise assessment wasn't performed in any point near the Wadi Say Dam, Say Channel or the two Wadi junction channel, so it's not possible to present precise conclusions.

The Wadi Jurf channel area is basically absent from noise pollution sources, since there are no industrial activities or roads along the project area. The only exiting road is actually the main national road Muscat/Duqm that crosses transversally the project at approximately 5Km from the sea outlet of the junction channel, representing a very small part of the project and, therefore, not significant.

### **3.1.9 Terrestrial Ecology**

The Duqm region is important from the perspective of biological diversity which needs to be conserved for its productivity, regulation of climate and ecosystem services. The two most important areas near to the town are the sabkha and coastal habitat to the north in the area of the new port development and the Arabian Oryx reserve to the west.

Faunal populations in semi-arid areas tend to be spread out, occupying large areas at low densities. Many species are also nocturnal or are otherwise hidden or camouflaged, due to the climate and limited vegetation cover. This makes it difficult to obtain accurate data on species present on site.

Numerous species have been recorded within the local area, due to the diverse range of habitats, including carnivorous and other large mammals (e.g. red fox, ibex and Arabian Oryx), smaller mammals (e.g. hedgehogs and bats), rodents (e.g. jirds and gerbils), various reptiles, and numerous birds.

#### **3.1.9.1 Protected Areas**

Two protected area close to the project area are the Arabian Oryx Sanctuary and Important Bird Area. The sanctuary was also home to the largest wild population of the endangered Arabian Gazelle. Given its global ecological significance, the sanctuary was designated as a UNESCO World Heritage Site in 1994. However, due to poaching and habitat degradation, the site was delisted in 2007. At least 15 species of mammals have been

recorded in the sanctuary, such as the Arabian Oryx and the Arabian Gazelle. The Nubian Ibex lives on the huqf escarpment and in the eastern hills. Also present in the sanctuary, the Golden Eagle with the last wild breeding population of Houbara Bustard known in Arabia.

The Ghubbat Quwayrat (sabkha just north of the port) has been designated as an Important Bird Area by BirdLife International as it is an important area for native and migratory birds; 100,000s of birds feed, rest, and nest along its sandy beaches, khawars, and inland hills.

#### **3.1.9.2 Fauna**

The identified fauna of the Channels consists of Domesticated Mammals, Reptiles and Amphibians, Insects, Butterflies, Birds and Fowls (Avifauna). It's possible that some species were present but not identified, since the fauna in the area is extremely sensitive and normally camouflages or takes shelter out of human sight. Some of the identified fauna, in the project influence area are Arabian Gazelle, Arabian Oryx, camel, ants, grasshopper, dragonflies butterfly, donkeys, snails, spider, dor bugs, snakes, spiders and lizards. Further goat, felidae and hedgehog trails were also observed during the survey.

#### **3.1.9.3 Flora**

The project area embraces two types of habitats:

- Coastal habitats and Sabkha (salt flats): these areas contain a mixture of wetlands (e.g. lagoons), very saline areas with little vegetation, and less saline areas with some vegetation. These habitats support internationally important species and, of the three main habitats, are the least common in the region
- Wadis and gravel plains: the water provided by wadis supports a diverse range of vegetation, typified locally by open acacia woodlands, low shrubs and ephemeral grasses. Wadis act as wildlife corridors, along which mammals and birds travel.

Saay Channel design alignment was adjusted to avoid destroying a small community of trees that was found to be on the exact alignment of the channel as per the EIA report.

#### **3.1.10 Socio Economic**

Secondary data from previous studies was sourced for the Socio Economic study for the Channel project. The small scale economy of the Duqm city is mainly based on: Government Servants, Private Servants, Retired Government Servants, Trading, Fishing, Shopkeepers, Laborers, Cultivators and Pastorals. Duqm is oriented towards agriculture, fishing and raising stock (goats).

The area where the project is to be developed (Wadi Say, Wadi Jurf and the Junction area of the Channel sea outlets) has no major occupation in terms of land use terminology. Some construction activities are in the on-going stage in the vicinity of the area and some small farms were visible along the channels on a small scale.

The project did not predict the need of occupation of private residential areas, since there are no houses to be relocated from the Wadi bed where the channels were to be built. The project also did not consider the relocation of the animal shelters during the time of EIA study.

#### **3.1.11 Archaeology**

As Al Duqm is rich with archaeological remnants from several Stone Age settlements. The development location has a rich archaeological legacy with a number of findings on or within the vicinity of the site including burial mounds, shell midden sites, ceramic artifacts that hint at Bronze Age settlements, burial structures and pre-historic tombs. However, survey conducted as part of baseline study no archeological particulars, such ceramic artifacts, burial structures or tombs, were identified.

Further sites visits were conducted to investigate the Damman Formation. This formation consists of sequences of alternating bioclastic limestone and white chalky marl and the top of the sequence is very rich in large inner shelf fossil fauna with echinoids and molluscs.

## **4 SUMMARY OF ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT AND MANGEMENT PLAN**

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### **4.1 INTRODUCTION**

Impact matrix for both with and without mitigation measures for the selected Project has been developed and shown in Table 1 and Table 2 respectively. In this table both adverse and beneficial impacts on various environmental and social parameters have been indicated by assigning level of impact in the form of high, medium, low adverse or beneficial or insignificant/none. In subsequent paragraphs, mitigation measures have been proposed for only adverse negative impacts on different environmental parameters.

**TABLE 1: PROJECT INTERACTION MATRIX WITHOUT MITIGATION**

ENVIRONMENTAL COMPONENTS	PHYSICAL ENVIRONMENT										BIOLOGICAL ENVIRONMENT								SOCIAL ENVIRONMENT												
	Acquisition of Land	Acquisition of Temp. land / crop losses	Soils (Erosion/Stability/contamination)	Archaeological Monuments	Public/Private Utilities	Energy/Mineral Resources	Surface Water	Groundwater	Air Quality	Noise	Crops/vegetation	Aquatic Ecosystem	Terrestrial Ecosystem	Endangered Species	Migratory Species	Beneficial Plants	Beneficial Animals	Pest Plants	Disease Vectors	Public Health	Resource/Land Use	Accessibility	Employment	Worker safety	Public safety	Temporary Disruption of People	Resettlement/compensation	Community Stability	Cultural & Religious Values	Tourism And Recreation	Living Standards
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
PROJECT RELATED ACTIVITIES																															
Construction Phase																															
1. Excavation	MA	0	MA	MA	0	MA	0	0	MA	MA	MA	0	MA	MA	LA	LA	LA	0	0	LA	LA	LA	MB	LA	LA	LA	0	0	0	0	MB
2. Placement of material	0	0	0	0	0	LA	0	0	LA	LA	0	0	0	0	0	LA	LA	0	0	LA	LA	LA	MB	LA	0	0	0	0	0	0	MB
3. Loading & hauling	0	0	LA	0	0	0	0	0	MA	MA	0	0	MA	0	0	0	LA	0	0	LA	0	0	MB	LA	0	MA	0	0	0	0	MB
4. Construction Related Traffic	0	0	0	0	0	0	0	0	MA	MA	LA	0	MA	0	LA	LA	LA	0	0	LA	0	LA	LB	LA	MA	MA	0	0	0	0	MB
5. Construction Camp	0	0	MA	0	MA	MA	LA	MA	MA	LA	0	0	LA	0	0	LA	MA	0	0	LA	MA	LA	0	0	0	LA	0	0	0	0	MB
6. Compaction	0	0	0	0	0	0	0	0	0	MA	0	0	LA	0	0	LA	LA	0	0	0	LA	0	LB	LA	0	LA	0	0	0	0	0
7. Blasting/crushing	0	0	MA	0	MA	LA	0	MA	MA	HA	0	0	MA	MA	MA	0	MA	0	0	MA	0	0	LB	HA	HA	MA	0	0	0	0	MB
8. Concrete placement	0	0	MA	0	0	0	0	0	0	MA	0	0	MA	0	0	0	LA	0	0	MA	0	0	LB	LA	0	LA	0	0	0	0	MB
9. Use of chemicals	0	0	HA	0	0	0	0	LA	LA	0	0	0	LA	0	0	MA	MA	0	0	0	MA	0	0	MA	LA	0	0	0	0	0	0
10. Solid waste disposal	0	0	MA	0	0	0	0	0	0	0	0	MA	0	MA	MA	0	0	0	0	LA	0	0	0	0	0	LA	0	0	0	0	0
11. Use of heavy machinery	0	0	0	0	0	0	0	0	MA	MA	0	0	MA	0	0	0	MA	0	0	LA	0	0	LB	LA	LA	LA	0	0	0	0	MB
12. Vehicle/equipment maintenance	0	0	0	0	0	0	0	LA	0	0	0	0	LA	0	0	LA	MA	0	0	0	0	0	MB	0	0	0	0	0	0	0	MB
Weighted Overall	MA	0	MA	0	MA	MA	0	MA	MA	MA	MA	0	MA	0	0	MA	MA	0	0	MA	MA	LA	MB	MA	MA	MA	0	0	0	0	MB
Operation Phase																															
Local Effects																															
1. Reservoir operation	MA	0	0	MA	0	0	HB	HB	0	0	HB	0	HB	0	0	HB	HB	0	0	0	0	0	LB	0	LA	0	LA	HB	0	0	HB
2. Increased vehicular movement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Waste generation	0	0	0	0	0	0	0	0	0	0	0	MA	0	0	LA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4. Increased quantity of water	0	0	0	0	0	0	HB	HB	0	0	HB	0	HB	0	0	HB	HB	0	0	HB	0	0	0	0	0	0	0	0	0	0	HB
5. Pesticide spraying	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6. Increased commercial activity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7. Increased influx of tourists	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Weighted Overall	MA	0	0	0	0	0	HB	HB	0	0	HB	0	HB	0	0	HB	HB	0	0	HB	0	0	LB	0	LA	0	LA	HB	0	0	HB
Overall Project	MA	0	LA	0	LA	LA	MB	LB	LA	LA	LB	0	LB	0	0	LB	LB	0	0	LB	LA	LA	MB	LA	MA	LA	LA	MB	0	0	HB

High Adverse:

HA

Low Beneficial:

LB

Medium Adverse:

MA

Medium

Beneficial:

MB

Low Adverse:

LA

High Beneficial:

HB

TABLE 2: PROJECT INTERACTION MATRIX WITH MITIGATION

ENVIRONMENTAL COMPONENTS	PHYSICAL ENVIRONMENT										BIOLOGICAL ENVIRONMENT								SOCIAL ENVIRONMENT												
	Acquisition of Land	Acquisition of Temp. land / crop losses	Soils (Erosion/Stability/contamination)	Archaeological Monuments	Public/Private Utilities	Energy/Mineral Resources	Surface Water	Groundwater	Air Quality	Noise	Crops/vegetation	Aquatic Ecosystem	Terrestrial Ecosystem	Endangered Species	Migratory Species	Beneficial Plants	Beneficial Animals	Pest Plants	Disease Vectors	Public Health	Resource/Land Use	Accessibility	Employment	Worker safety	Public safety	Temporary Disruption of People	Resettlement/compensation	Community Stability	Cultural & Religious Values	Tourism And Recreation	Living Standards
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
PROJECT RELATED ACTIVITIES																															
Construction Phase																															
1. Excavation	0	0	LA	0	0	LA	0	0	LA	MA	LA	0	MA	0	0	LA	LA	0	0	LA	LA	LA	MB	LA	LA	LA	0	0	0	0	MB
2. Placement of material	0	0	0	0	0	LA	0	0	LA	LA	0	0	0	0	0	LA	LA	0	0	LA	LA	LA	MB	LA	0	0	0	0	0	0	MB
3. Loading & hauling	0	0	LA	0	0	0	0	0	LA	MA	0	0	MA	0	0	0	LA	0	0	LA	0	0	MB	LA	0	MA	0	0	0	0	MB
4. Construction Related Traffic	0	0	0	0	0	0	0	0	MA	MA	LA	0	MA	0	0	LA	LA	0	0	LA	0	LA	LB	LA	LA	MA	0	0	0	0	MB
5. Construction Camp	0	0	LA	0	LA	LA	0	LA	LA	LA	0	0	LA	0	0	LA	LA	0	0	LA	LA	LA	0	0	0	LA	0	0	0	0	MB
6. Compaction	0	0	0	0	0	0	0	0	0	MA	0	0	LA	0	0	LA	LA	0	0	0	LA	0	LB	LA	0	LA	0	0	0	0	0
7. Blasting/crushing	0	0	LA	0	LA	LA	0	MA	MA	MA	0	0	MA	0	0	0	MA	0	0	MA	0	0	LB	MA	LA	MA	0	0	0	0	MB
8. Concrete placement	0	0	LA	0	0	0	0	0	0	MA	0	0	LA	0	0	0	LA	0	0	LA	0	0	LB	LA	0	LA	0	0	0	0	MB
9. Use of chemicals	0	0	LA	0	0	0	0	LA	LA	0	0	0	LA	0	0	LA	LA	0	0	0	LA	0	0	MA	LA	0	0	0	0	0	0
10. Solid waste disposal	0	0	LA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	LA	0	0	0	0	0	LA	0	0	0	0	0
11. Use of heavy machinery	0	0	0	0	0	0	0	0	MA	MA	0	0	LA	0	0	0	MA	0	0	LA	0	0	LB	LA	LA	LA	0	0	0	0	MB
12. Vehicle/equipment maintenance	0	0	0	0	0	0	0	LA	0	0	0	0	LA	0	0	LA	LA	0	0	0	0	0	MB	0	0	0	0	0	0	0	MB
Weighted Overall	0	0	LA	0	LA	LA	0	MA	MA	MA	LA	0	MA	0	0	LA	MA	0	0	MA	LA	LA	MB	MA	LA	MA	0	0	0	0	MB
Operation Phase																															
Local Effects																															
1. Reservoir operation	0	0	0	0	0	0	HB	HB	0	0	HB	0	HB	0	0	HB	HB	0	0	0	0	0	LB	0	LA	0	0	HB	0	0	HB
2. Increased vehicular movement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Waste generation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4. Increased quantity of water	0	0	0	0	0	0	HB	HB	0	0	HB	0	HB	0	0	HB	HB	0	0	HB	0	0	0	0	0	0	0	0	0	0	HB
5. Pesticide spraying	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6. Increased commercial activity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7. Increased influx of tourists	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Weighted Overall	0	0	0	0	0	0	HB	HB	0	0	HB	0	HB	0	0	HB	HB	0	0	HB	0	0	LB	0	LA	0	0	HB	0	0	HB
Overall Project	0	0	LA	0	LA	LA	MB	LB	LA	LA	LB	0	LB	0	0	LB	LB	0	0	LB	LA	LA	MB	LA	LA	LA	0	MB	0	0	HB

High Adverse:

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## 4.2 ENVIRONMENT AND SOCIAL MANAGEMENT PLAN (ESMP)

The environmental management plan presents mitigation measures ensure that negative impacts are reduced to ALARP, and meet relevant Omani national laws and regulations, and internationally acceptable standards, where Omani standards are not available. An EMP with the process adopted and its organization, the mitigation measures for each phase and the scope of the supporting monitoring and management plans has been developed as part of the EIA study by Renardet.

Through SEZAD Corporate Social Responsibility (CSR) section of the Partnership and Development Department (PDD), SEZAD provides access for communities to provide any grievance (written and in person) through the Grievance Mechanism (GM) form. The GM form is available on SEZAD website at <https://www.duqm.gov.om/sezad/csr/grievance-form>.

Operational phase environmental management will be prepared before operation of the facility to ensure compliance with required Omani/International regulation and international conventions. The EIA report includes a mitigation management matrix (MMM) which can be considered as a core element of EMP. It will be used as the management and monitoring tool for the implementation of EMP. The mitigation management matrix is tabulated in Table 3.

**TABLE 3: MITIGATION MANAGEMENT MATRIX**

IMPACT	MITIGATION MEASURE	CONSTRUCTION/ OPERATION
SOIL EROSION/CONTAMINATION	<ul style="list-style-type: none"> <li>In case of borrow material, existing quarries will be used for aggregate material or if excavated from new sites, prior approval will be sought from the competent authority.</li> <li>Project facilities to be located in open flat areas located near the dams and the channel and near road</li> <li>access, avoiding constant transport by trucks. The facilities are not allowed inside sensitive areas, such as the Oryx Sanctuary, Rock garden etc and will be at a minimum distance of 500 m from any sensitive areas, such as the birds nest and feeding area.</li> <li>As far as possible, waste/barren land i.e. areas not under agricultural, residential or forestation use, and natural areas with a high elevation will be used for borrow material and setting up project facilities.</li> <li>Appropriate measures for slope protection, i.e. stone pitching, etc will be used at embankments.</li> <li>The contractors will be required to instruct and train the workforce in the storage and handling of materials and chemicals that can potentially cause soil contamination.</li> <li>Proper monitoring of the soil erosion and landslide prone areas will be carried out during operation phase and soil conservation measures (if needed) will be carried out like provision of physical structures e.g. gabion walls or retaining walls, etc.</li> </ul>	<b>CONTRACTOR/SEZAD</b>
WATER QUALITY	<ul style="list-style-type: none"> <li>Availability of water for campsite facilities and construction purposes will be ensured and permission would be taken from the concerned authority.</li> <li>Proper monitoring of the channel and sea outlet is to be performed during operation stage to avoid the obstruction of the channel and consequent lack of sediment supply to the beach</li> </ul>	
AIR QUALITY	<ul style="list-style-type: none"> <li>Good engineering practices will be used during the rock blasting at quarry areas (if required) to minimize the impact of dust emissions.</li> <li>If in use, crushers and concrete batching plants will be equipped with dust control equipment such as fabric filters or wet scrubbers to reduce the level of dust emissions.</li> <li>Vehicles and other construction machinery will be properly tuned and maintained, so as not to emit any smoke.</li> <li>Location of DG sets and other emission generating equipment will be established considering the predominant wind direction, avoiding disturbance with emissions affecting residential areas.</li> <li>Where necessary, dust emissions will be reduced by a regular sprinkling of water for keeping the dust settled, atleast twice a day.</li> <li>Haul-trucks carrying construction materials will be kept covered with tarpaulin to curtail the impact on air quality.</li> <li>If practical, stockpiling of excavated material will be regularly sprinkled and covered and delivered as needed during the course of construction.</li> </ul>	<b>CONTRACTOR/SEZAD</b>
NOISE QUALITY	<ul style="list-style-type: none"> <li>Mufflers and silencers will be provided on machines to keep</li> <li>noise to a minimum level.</li> <li>The noise standards as per MD 79/94 and 80/94 for noise in public and working environment respectively shall be strictly followed by the contractor in order to minimize the air and noise pollution in the project area</li> <li>Monitoring to be conducted for noise quality in the project area</li> </ul>	<b>CONTRACTOR/SEZAD</b>
EXPLOSIVES (IF REQUIRED)	<ul style="list-style-type: none"> <li>Effective measures shall be adopted to minimize the hazards related with explosives. Explosive material will be stored in a safe place and at a safe distance from the settlements and the construction camps. Warning signs shall be placed near the explosives storage areas. Before any explosion, the people shall be informed well before and if required, evacuation of livestock /residents shall be carried out.</li> <li>Transportation, storage, handling and operation of explosives shall be conducted as per Omani rules and regulations.</li> <li>Coordination with the concerned authority shall be done for creating awareness/ evacuation, if required, during use of explosives/ blasting operations</li> <li>Permits/NOC shall be obtained from ROP for use, handling and transport of explosives</li> </ul>	<b>CONTRACTOR</b>
ECOLOGY	<ul style="list-style-type: none"> <li>For the vegetation lost due to clearing of the strip/ piece of land for machinery path, hutments and labour camps, the area cleared will be replanted with local flora after construction is over.</li> </ul>	<b>CONTRACTOR/SEZAD</b>



IMPACT	MITIGATION MEASURE	CONSTRUCTION/ OPERATION
	<ul style="list-style-type: none"> <li>Labour will be strictly forbidden to cut any vegetation.</li> <li>Granary and stores be properly secured and safeguarded against rodents.</li> <li>Thin film of dust on leafs and vegetation can be removed by Jet-spray of water every afternoon along both sides of machinery path.</li> <li>Steps for immediate removal and safe disposal of solid waste will be taken so that wild animals could not eat the harmful eatables.</li> <li>After construction old/unusable stores/ unnecessary dumping/solid waste etc will be removed from site as quickly as possible for safety of wild life and terrestrial animals.</li> <li>Proper monitoring of the dam reservoir, channel and sea outlet is to be performed during operation stage to avoid the obstruction of the channel and consequent lack of sediment supply to the beach.</li> <li>NOC shall be obtained from the concerned authority for the protected areas in the project influence area including the Oryx Sanctuary</li> </ul> <p>Oryx Sanctuary:</p> <ul style="list-style-type: none"> <li>Works to be developed close to the Oryx Sanctuary must be approved by the Oryx sanctuary Reserve, this authority should be informed in written of any intention of work inside their territory and the contractor must have a written letter in case the permission is granted.</li> <li>Feeding, lay hold or hunting any animal inside these areas is strictly forbidden</li> <li>Any cut of the vegetation has to be with the project's needs, never as per the workers personal actions</li> </ul>	
SOCIO-ECONOMIC	<ul style="list-style-type: none"> <li>Blasting timing will be made known to all the people within 500 m from the blasting site in all directions. People, except those who actually light the fuse shall be evacuated from the area of 200 m from the blasting site in all directions at least 15 minutes before blasting.</li> <li>Employment to be provided to the local people, in consultation with the Wali, during the construction phase, to the extent feasible.</li> <li>Contractor will make sure that effective housekeeping measures will be taken into account in order to avoid unhygienic conditions within the camp areas.</li> <li>Workers to be made aware about local culture and traditions to avoid socio-cultural issues</li> <li>Employees and contractors to minimize their interaction with local residents and their disturbance in the community by timing the operations and transits through local communities to avoid disturbing worship, school, and other community gatherings</li> <li>Alternate paths and crossing points will be provided to livestock for easy access to areas open to grazing</li> </ul>	CONTRACTOR/SEZAD
ARCHAEOLOGY	<ul style="list-style-type: none"> <li>Workers to be provided a briefing on recognizing archaeological artefacts and how to respond when such sites are found. Proper training must be provided to all the workers performing earth works, such excavation, blasting, transport, filling, so that no impacts are accidentally caused to the natural heritage on site.</li> <li>NOC from SEZAD will be obtained, for the campsite and drainage channel route, prior to construction</li> <li>Operation phase does not predict any interaction with the sites, but this should be avoid in case any need to access the project and make use of the archaeological sites.</li> </ul>	CONTRACTOR
SOLID WASTE	<ul style="list-style-type: none"> <li>Hazardous waste shall be handled, stored and disposed according to MD 17/93, MD 57/2002</li> <li>Solid waste generated during construction and at campsites will be transported to the landfill site.</li> <li>Storage areas of hazardous wastes / hazardous materials will be enclosed to protect from rains and storm water. If storm water is suspected to be contaminated, it will be collected in collection pits and prevented from entering surface drains. Normally run-offs from areas where hazardous substances (oils and chemicals) are stored will not occur. If there are any accidental spillages of hazardous substances on the soil, such areas will be immediately remediated to avoid the run-offs being contaminated.</li> <li>Separation of recyclable and non-recyclable waste must be introduced and recycling practices must be implemented when possible. The hazardous materials will be stored in a designated area.</li> <li>Liquid waste from the camps including oil, grease etc. will be transported through mobile trucks to the nearest available approved disposal site</li> <li>The Contractor will prepare an Emergency plan, including training and responsibilities on actions to be taken for:</li> </ul>	CONTRACTOR/SEZAD

IMPACT	MITIGATION MEASURE	CONSTRUCTION/ OPERATION
	<ul style="list-style-type: none"> <li>✓ Responding promptly to exterior spills to prevent waste materials from entering the surface water system and soil.</li> <li>✓ Cleaning up liquid spills such as oils, paints, and pesticides with absorbent material rather than hosing them into drains. Although the Project generally do not accept these liquids, they might find their way into the waste stream in small quantities</li> <li>• Proper monitoring of the dams reservoir, channel and outlet is to be performed during operation stage to avoid the obstruction of the channel and consequent lack of sediment supply to the beach</li> </ul>	
SEWAGE AND WASTEWATER	<ul style="list-style-type: none"> <li>• Treatment facility of sewage and any other industrial/ chemical wastewater generated at the site shall be provided during construction phase by the contractor or the wastewater will be discharged to Duqm STP.</li> <li>• In case of installing an STP, the water from it shall be used to the extent possible for construction activities and dust suppression</li> <li>• Construction equipment and vehicles will be water washed periodically to remove any accumulated dirt. No detergents will be used. Washing will be done in a designated area (washing ramp) and the washings will be collected into a settling tank in order to separate suspended solids and oil &amp; grease;</li> <li>• The clarified effluent will be sent to an onsite sewage treatment plant (STP) / nearest STP for further treatment and disposal; and the separated oil will be skimmed off or removed using soaking pads and the collected oil will be disposed as hazardous waste. The settled solids from the bottom of the tank will be removed periodically and disposed in accordance with regulations.</li> <li>• Storage areas of hazardous wastes / hazardous materials will be enclosed to protect from rains and storm water. If storm water is suspected to be contaminated, it will be collected in collection pits and prevented from entering surface drains.</li> <li>• Liquid waste from the camps including oil, grease etc. will be transported through mobile trucks to the nearest available/existing disposal area</li> </ul>	<b>CONTRACTOR</b>

#### 4.2.1 Environmental Monitoring

Monitoring will be carried out to ensure compliance with the requirements of the EIA. The mitigation matrix provided in previous section will be used as a management and monitoring tool. Monitoring will be the responsibility of all organizations involved in the construction i.e. the Contractors. The monitoring plan is as highlighted in Table 4.

**TABLE 4: MITIGATION MANAGEMENT MATRIX**

PARAMETER	MONITORING	REPORTING	REMARKS
Waste	Continuous	Quarterly	Waste Inventory including quantity generated and disposed
Air Quality	Quarterly		PM10, PM2.5
	Continuous		H2S when detected
Noise	Monthly		Measurement of the noise levels due to construction activities, movement of equipment and vehicles
Health and Safety	Continuous		Monitoring of the occupational health and safety aspects of the workers
Flora & Fauna	Continuous		Visual checks to assess the situation, especially in the Oryx sanctuary reserve area

### 4.3 CLIMATE AFFAIRS

Climate change is a reality that will have an impact on the design life of the proposed Project. Climate assessment was undertaken based on MECA's 2013 guideline. Changes in climate can potentially impact operations in the SEZ potentially leading to higher maintenance and operational costs.

EIA Report also outline mitigation and adaptation measures to reduce and/or minimise climate change impacts during project design and construction and include measures for improving resource efficiency, for instance, production of a carbon management plan, use of energy efficient lighting, use of bio-fuels and use of recycled materials etc. Climate risk and vulnerability assessment was carried out as part of the sub projects' EIA and as the national legislation. Based on the guideline, vulnerabilities related to a changing climate include changes in frequency and intensity of heatwaves, dust storms, cyclones drought, sea-level rise and increased extreme precipitation events. According to MECA's Initial Communication Under the United Nations Framework Convention on Climate Change (2013: 57), the Al Wusta Governorate is most vulnerable under high sea level rise scenarios, i.e., greater than 2 meters.

The Channel project is designed for extreme events such as floods, cyclones, storms, and rains. These are events that can happen under normal circumstances irrespective of potential climate change conditions such that the required design parameters for such conditions are well established. Therefore, the requirement for any needed adaptations to climate change is low for this project. The emergency response plan will contain the necessary actions to be taken in case of extreme weather conditions.

GHG emissions from the Project are expected to represent a small fraction of national and global GHG emissions. Project construction GHG emissions are estimated to amount to 132.02 metric tons CO<sub>2</sub>e within the two-year construction period. Negligible GHG emissions are anticipated during operation but this is dependent on the resources required to monitor the channel projects during the operational phase.

It should be noted that during the construction phase the major source of GHG emissions will be attributed to the movement and operation of the various construction equipment. During the operation phase the major source of GHG emissions will be from the maintenance activities. The same shall be reported to SEZAD, as required.

## 5 FINDINGS AND CONCLUSIONS

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The overall assessment obtained from the investigation and EIA study indicate that the project is environmentally feasible and substantial benefits are very likely to affect majority of the project environment if all the mitigation measures will be considered. Adopted technology and design criteria ensure that no long-term negative impacts are to result from the development. Nevertheless, unavoidable minor negative impacts that are often associated with construction works should be expected and they are likely to result from excavation, transport and deposition of construction material. Such undesirable impacts are limited, and should be cleared upon the commissioning of the project.

The channel and the Wadi site have mainly coastal habitats and Sabkha, Wadis and gravel plains and hill slopes and escarpments. The channels have been designed and aligned in such a way to avoid the small communities of Acacia trees. Further several sites of archaeological importance were identified during initial survey and these natural sites were considered during the design stage of the Wadi Say dam and the dam axis was relocated downstream so that the natural heritage can be preserved from any construction activity

The project doesn't envisage the need of occupation of private residential areas, since there are no houses to be relocated from the Wadi bed were the channels will be built. There are a few small animal shelters that may be relocated, mainly because the owners often move the shelters according to their needs and they may move some onto the channel alignment before construction starts. The potential environmental impact will be slight to medium significance, site specific and through the implementation of mitigation measured the impact is considered to be ALARP. The technology and design criteria has been selected such that no long term negative impacts are to result from the project development. The contractors will follow wide ranges of management and construction techniques and procedures to minimize and/or eliminate the pollution hazard; minimize visual intrusion and noise and air monitoring during construction by following the applicable Omani law and regulation; provide sanitation facilities and safeguard health of laborer's and conduct environmental monitoring during and after construction for the concerned element.