FEWA 150 MIGD SWRO Independent Water Project

Umm Al Quwain, UAE

Environmental & Social Impact Assessment (ESIA)

Volume 2 - Main Text, Tables & Figures

Prepared for:

ACWA POWER

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CONTENTS

LIST OF ABBREVIATIONS

Abbreviation	Meaning
CESMP	Construction Environmental Management Plan
CO_2	Carbon dioxide
CoV	Coefficient of Variation
dB (A)	A-weighted decibels
DAF	Dissolved Air Flotation
E&S	Environmental & Social
EIA	Environmental Impact Assessment
ESIA	Environmental & Social Impact Assessment
EAD	Environment Agency Abu Dhabi
EMS	Environmental Management System
EPs	Equator Principles
EPFIs	The Equator Principles Financial Institutions
ESMS	Environmental & Social Management System
FEWA	Federal Electricity and Water Authority
FEA	Federal Environment Agency
Flux lmh	Liter/m^2/h
GCC	Gulf Cooperation Council
GMF	Granular Media Filter
IFC	International Finance Corporation
IFIs	International Financial Institutions
IUCN	International Union for Conservation of Nature
IWP	Independent Water Project
LLA	Land Lease Agreement
Leq (A)	A-weighted Equivalent Continuous Sound Level
MIGD	Million imperial gallons per day
NO_2	Nitrogen Dioxide
O&M	Operation and Maintenance
OESMP	Operational Environmental and Social Management Plan
PHED	Public Health and Environment Department
PM_{10}	Particulate matter with an aerodynamic diameter of less than 10 micrometres.
$PM_{2.5}$	Particulate matter with an aerodynamic diameter of less than 2.5 micrometres.
RAK	Ras Al Khaimah (Emirate)
RO	Reverse Osmosis
SWRO	Sea Water Reverse Osmosis
TSS	Total suspended solids
UAQ	Umm Al Quwain
VOC	Volatile Organic Compounds
WHO	World Health Organisation
WPA	Water Purchase Agreement

1 INTRODUCTION

To meet the future potable water demand of the Emirate of Umm Al Quwain, the Federal Electricity and Water Authority (FEWA) is proposing to sponsor the development of a Sea Water Reverse Osmosis (SWRO) desalination plant neat Marjan Island, south of the border with the Emirate of Ras Al Khaimah. The proposed project, originally planned as Phase 1 (45 MIGD, 2018) has been increased this year to a capacity of 150 MIGD (including Phases 1 and 2) and will be owned and operated by a Consortium including ACWA Power, Mubadala and FEWA.

According to the Federal Law No. 24 of 1999, the project will be required to obtain a license from the Public Health and Environmental Department (PHED) of Umm Al Quwain Municipality prior to the commencement of the project. It is also understood that the project will seek an amount of its financing from International Financial Institutions (IFIs) who will likely be signatories of the Equator Principles (EP) or have their own internal Environmental and Social (E&S) investment guidelines such as the IFC. In line with their requirements and guidelines the IFIs will require the submission of an Environmental and Social Impact Assessment (ESIA).

As a result, 5 Capitals Environmental & Management Consulting (5 Capitals) has been commissioned by ACWA Power to prepare an Environmental & Social Impact Assessment (ESIA) Report for the proposed project. The ESIA has been informed by the Environmental Scoping Report (Ref. Appendix A) prepared by 5 Capitals and has been prepared in accordance with Umm Al Quwain PHED requirements.

Table 1-1KeyProject Information

Project Title	FEWA150 MIGD SWRO IWP, Umm Al Quwain, UAE
Project Proponent/Sponsor	Federal Electricity and Water Authority (FEWA)
Engineering Consultant	Veolia
Project Developer	ACWA Power
EPC Contractor	China Energy Engineering Group Guangdong Power Engineering Co., Ltd SIDEM (Water Technology)
Operation and Maintenance Company	NOMAC
Environmental Consultant	5 Capitals Environmental and Management Consulting PO Box 119899 Dubai, UAE Tel: +971 (0) 4 343 5955 Fax: +971 (0) 4 343 9366 www.5capitals.com
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1.1 Project Rationale

The UAE is considered as one of the most water stressed countries in the world. Due to its geographical location, the UAE has very few sources of natural fresh water, with little rain, no rivers and limited amount of groundwater. As a result, the natural water resources cannot meet the increasing demand for fresh water. This increasing demand is influenced by the population growth and expansion of industrial and residential infrastructure.

As a result, the UAE government is investing in infrastructure and water efficient technology in order to meet current and future water needs. The proposed SWRO is therefore necessary to provide a reliable clean water supply to Umm Al Quwain and other Northern Emirates in the UAE. In addition, it is in line with the National Agenda and the UAE 2021 Vision to enhance water capacity in order to meet the shortfall and ease the pressure on the exploitation of groundwater resources.

1.2 Background and Context

On 13th June 2018, FEWA confirmed the appointment of a Consortium led by ACWA Power as the preferred bidder for the 45 MIGD SWRO IWP Desalination project. The project was an Independent Water Project (IWP) and was expected to be commercially operational in the 2nd quarter of 2020. The proposed Project Company shareholdings were as follows - ACWA Power to hold forty percent (40%) shares in the project equity while Mubadala Investment Company PJSC and FEWA will own forty percent (40%) and twenty percent (20%) of the shares respectively.

The initial scope of works as per the 2018 bid (Tender 39EW/2016) included the installation of the plant along with the associated intake and outfall facilities to produce 45 MIGD (204,500 m^3/day) of desalinated water. However, in March 2019 under the UAE Ministerial Council for Development Decree No. 34M/10T/2018, FEWA invited ACWA Power & Mubadala under Tender 39E/2016 to submit a proposal for the best technical and commercial discounted proposal to upgrade the IWP 45 MIGD to 150 MIGD (681,900 m^3/day) SWRO desalination plant. After the submission of the proposal by ACWA Power and Mubadala and its review by FEWA, the revised Project Agreement was signed on 30th May 2019.

As a result, 5 Capitals arranged a meeting with PHED on 13th June 2019 to discuss the change in the capacity of the project and determine whether PHED would require 5 Capitals to update the existing 45 MIGD Environmental Scoping Report (submitted to PHED on 14th August 2018 and approved on 10th October 2019) or whether PHED had new conditions for the ESIA. PHED advised 5 Capitals that a new Environmental Scoping Report would not be required and the only condition for preparing the project EISIA was to provide a discussion on why the project capacity was increased from 45 MIGD to 150 MIGD.

Additional meetings were also held with the Umm Al Quwain Department of Planning and Survey in November 2018, June and July 2019 to discuss the location of the project sites 1& 2 in relation to the boundary between the Emirates of Umm Al Quwain (UAQ) and Ras Al Khaimah (RAK). After the review of the project boundaries and site Affection Plan, the Planning Department advised that the northern boundary of the project site must be moved 14m south of the UAQ boundary in order to adhere to the required 30m buffer zone between the two Emirates. This was facilitated by the issuance of new Affection Plans for sites 1 & 2 with revised coordinates reflecting a 30m buffer zone between the project boundary and the UAQ & RAK boundaries.

1.3 Project Alternatives

In line with good practice for Environmental and Social Impact Assessment and in order to ensure that the objectives of the proposed project have accounted for social, environmental, economic and technological options, the evaluation of various project designs and activity alternatives should be considered.

For this purpose, the following project alternatives have been considered:

- No Project Alternative
- Alternative Site Location; and
- Desalination Technology Options

1.3.1 No Project Alternative

In order to meet future potable water demand of the Emirate of UAQ and other northern Emirates, a 'No Project alternative' is not considered to be viable for this project due to the socio-economic benefits associated with its development. The continued increase in population and socio-economic development has led to an increase in fresh water demand. In addition, UAE as a whole is characterized by low and variable precipitation patterns, limited renewable groundwater sources, groundwater salinity and the absence of fresh water sources such as streams and rivers. As a result, these scenarios make the development of the 150 MIGD SWRO plant vital in ensuring that UAQ and the other northern Emirates can meet its increasing water demand for domestic, commercial and industrial purposes.

1.3.2 Alternative Site Location

According to the preliminary ESIA for the 2× 45 MIGD SWRO Desalination Plant, the proposed location was selected through a series of feasibility and high-level screening studies. The following criteria were used:

- Geological and land area requirement;
- Biological resources;

- Oceanographic conditions;
- Concentration discharge area;
- Proximity to consumers; and
- Raw water quality and proximity.

The Increase to 150 MIGD was sanctioned by FEWA and has been based on agreement with ACWA Power for a lower supply tariff and also to allow for water distribution to both Umm Al Quwain and other Northern Emirates. The design has therefore been amended to account for the increased water capacity including the extension of the marine outfall from 2.6 to 3.6km which has been assessed within updated marine hydrodynamic and brine dispersion modelling.

1.3.3 Desalination Technology Options

The most common types of desalination technology include the following:

- Reverse Osmosis (RO);
- Thermal Desalination;
- Multi-Stage Flash (MSF); and
- Multi-Effect Distillation (MED)

Globally, RO is the most commonly used method of desalination based on its relative energy efficiency and desalination capacity (Sackinger, 1982). In addition, it is noted that there has been a downward trend in the costs and energy use of desalinated water over the last 30 years, due to technological advances enabling better performance

1.4 Objectives of the ESIA

The objectives of this ESIA in relation to this project include and are not limited to the following:

- Assessment of baseline conditions prior to the development of the project site through review of available data and conducting surveys;
- Assessment of the project's environmental and social impacts for the construction (including commissioning) and operational phases;
- Review of compliance obligations, including applicable federal, local and international regulations and standards;
- Determination of applicable mitigation and management measures to be implemented in order to avoid or minimise potential impacts;
- Consideration of alternatives that can be used for the project leading to greater environmental and social gains; and
- The consideration of, inclusion and consultation with potentially affected stakeholders.

1.5 Structure of the ESIA

This ESIA has been prepared in accordance with PHED requirements for environmental assessment and international best practices. The ESIA is presented in the following format:

- **Volume 1:** Non-Technical Summary
- **Volume 2:** Main Text, Tables, Figures and Plates
- **Volume 3:** Framework Environmental and Social Management Plan
- **Volume 4:** Appendices

Volume 1 provides a Non-Technical Summary of the ESIA, including main outcomes, and conclusions.

Volume 2 comprises the main text of the ESIA and full impact assessment, with mitigation, management and monitoring measures identified. Volume 2 follows the following chapter structure:

1. Introduction
    - ESIA Objectives
    - ESIA Structure
    - Key Project Information
    - Project Rationale
    - Project Alternatives
2. Approach to the ESIA
    - ESIA Scope of Works and Key deliverables
    - ESIA Team
    - ESIA Methodology
3. Regulatory framework
4. Project Information
    - Project Location
    - Land Use and Land Condition
    - Sensitive Receptors
    - Project Description
    - Associated Facilities
    - Project Construction Requirements
    - Project Schedule
    - Project Operation and Maintenance Requirements

- Project Decommissioning Requirements

5. Marine Environment (same structure for environmental aspects 6 to 9 & 11 to 14)
    - Standards and Regulatory Requirement
    - Observation and Baseline Conditions
    - Receptors
    - Potential Impacts
    - Impact Significance, Mitigation, Management Measures & Residual Impacts; Monitoring
6. Terrestrial Ecology
7. Soils, Geology and Groundwater
8. Air Quality
9. Noise and Vibration
10. Waste and Wastewater Management (Same structure for environmental aspects 15 & 16)
    - Standards and Regulatory Requirements
    - Observations and Baseline Condition
    - Potential Impacts
    - Mitigation and Management Measures
    - Monitoring
11. Traffic and Transportation
12. Archaeology and Cultural Heritage
13. Socio-economics
14. Landscape and Visual Amenity
15. Community Health, Safety & Security
16. Workers Conditions & Occupational Health & Safety
17. References

Volume 3 provides a framework for the development of the Construction Environmental and Social Management Plan (CESMP) and the Operational Environmental and Social Management Plan (OESMP) based on the findings from this ESIA and is issued to the EPC Contractor and FEWA (Project Proponent) to develop the project specific Management Plans.

Volume 4 comprises Technical Appendices which are as follows:

- Appendix A – Environmental Scoping Study Report including the letter from UAQ Municipality PHED
- Appendix B: Stakeholder Consultation Letters
- Appendix C: Layout of the Project site and Laydown Areas
- Appendix D – Marine Water and Sediment Analysis (2017 & 2018);
- Appendix E – Marine Ecology Survey Report;
- Appendix F – HR Wallingford Marine Modelling;
- Appendix G – Soil Analysis Laboratory Results (2018 & 2019);
- Appendix H – Groundwater Analysis Laboratory Results;
- Appendix I– Pond Water Analysis Results;
- Appendix J – Ambient Air Quality Instrument Calibration Certificates;
- Appendix K – Air Quality Laboratory Results;
- Appendix L -Sound Level Meter Calibration Certificate;
- Appendix M– Noise Monitoring Results;
- Appendix N – Laboratory Accreditation Certificates;
- Appendix O – Vehicle Composition During the Construction Phase

2 APPROACH TO THE ESIA

2.1 ESIA Scope of Work and Key Deliverables

An Environmental Scoping Report for the project was submitted to the Health and Environment Department (PHED) at Umm Al Quwain Municipality for review on the 14th August 2018 (see Appendix A). The Scoping Report was written to identify sensitive receptors and the key environmental impacts/risks associated with the construction and operational phases of the project at an early stage in order to ensure that the baseline surveys and assessment techniques for the subsequent ESIA addresses these issues specifically.

The general content of the scoping report included:

- Preliminary identification and brief description of the existing environmental conditions of the project site and its immediate surroundings based on a review of available information;
- Identification of the structure and content of the ESIA report;
- The key features of the proposed project facilities;
- A gap analysis of existing baseline information to determine the additional information that needs to be gathered for the ESIA report (air quality monitoring, terrestrial ecology field surveys, noise monitoring etc.) and;
- Potential environmental issues, constraints and possible opportunities associated with the proposed project activities and facilities based on the existing information.

On 10th October 2018, 5 Capitals received a letter from UAQ Municipality PHED advising to proceed with the preparation of the project ESIA. The letter did not include any additional comments or conditions with respect to the proposed scope of the ESIA. In June 2019, 5 Capitals was advised that the proposed scope would also be suitable for the 150 MIGD project. Therefore, the planned surveys and modelling have been updated accordingly.

2.2 Delineation of Project Study Boundaries

This ESIA has assessed the potential impacts related to the construction, commissioning and operation phase of the proposed project.

2.2.1 Assessment of the Project Area

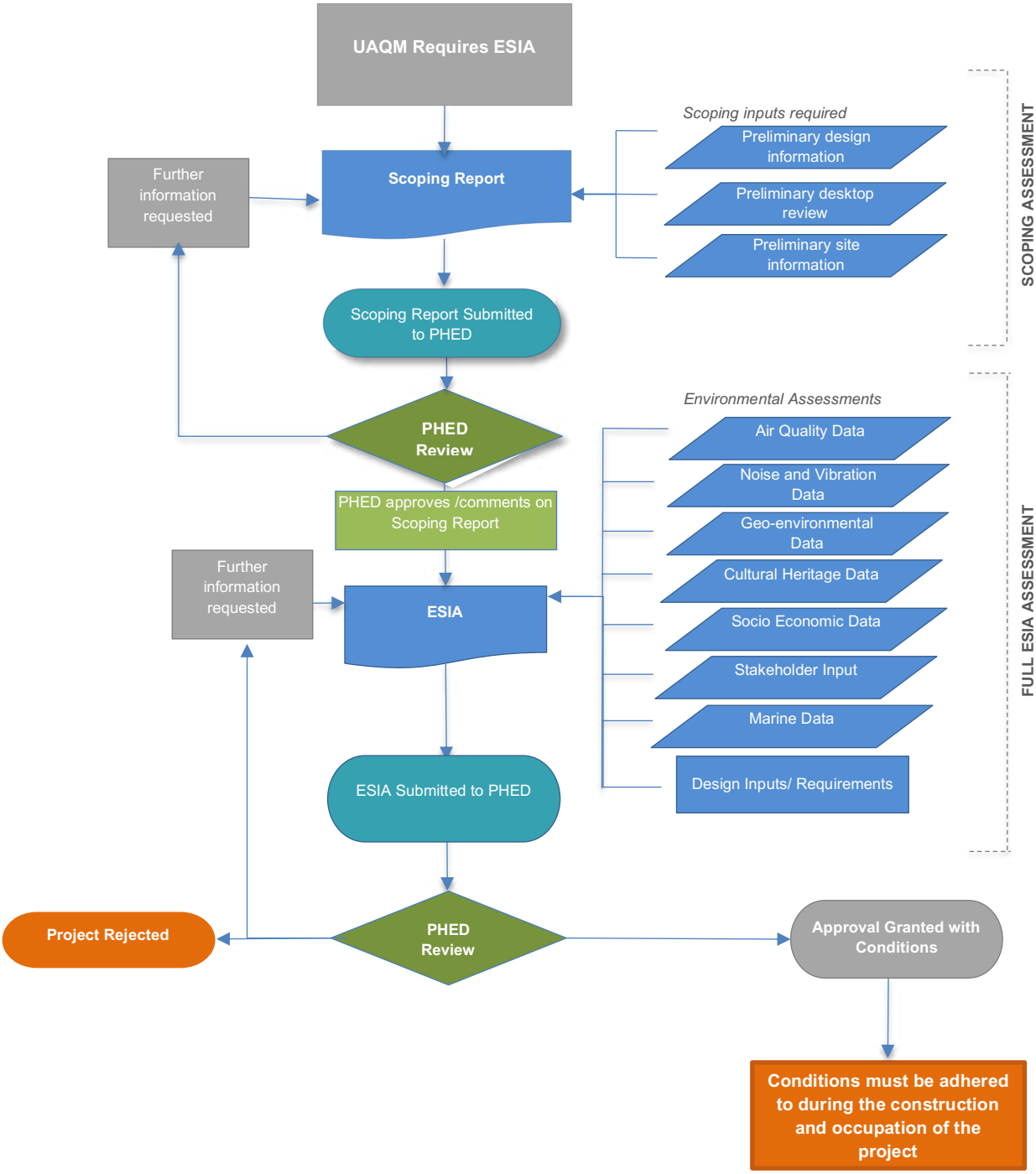
The ESIA has considered the primary study area which comprises of the site footprint for the installation of a 150 MIGD SWRO Independent Water Project at the Project site in Umm Al Quwain. It will also include the construction site laydown areas, seawater intake and outfall routings both onshore and offshore.

In addition, this ESIA has also endeavoured to assess impacts relating to ancillary facilities such as worker accommodation areas. Even though the exact location of the accommodation facilities has not been confirmed, the workers will be housed in existing labour camps within a 10km radius from the project site. The necessary mitigation and management measures for accommodation areas have been included to the relevant 'Worker Conditions 'section of this ESIA.

2.3 The ESIA Process Flow

The figure below provides an outline of the ESIA process for the project.

Figure 2-1ESIA Process Flow



2.4 ESIA Team

ACWA Power has engaged 5 Capitals Environmental & Management Consulting (5 Capitals) to lead the environmental & social process with regard to this project. This includes obtaining applicable approval from PHED and to support ACWA Power to reach Financial Close with their respective lenders.

5 Capitals is an established Environmental and Management Consultancy with Headquarters in Dubai and operations in Madrid, Bangkok & Riyadh, together with partner offices in Ho Chi Minh City and Johannesburg.

5 Capitals has developed a rich portfolio of projects and are trusted advisors to several long-term clients particularly in the Power, Water, Mining, Development Planning and Compliance Management Sectors.

5 Capitals is a leading E&S consultancy in the power sector, having worked with developers, lenders, Export Credit Agencies (ECAs), Engineering, Procurement and Construction (EPC) Contractors and Operation and Maintenance (O&M) Companies, on projects worldwide. This has included various inputs on a host of renewable and conventional power projects, from due diligence and project development through to implementation. 5 Capitals is familiar with projects requiring international financing or having compliance obligations consistent with lender requirements, such as the Equator Principles, OECD Common Approaches and World Bank & IFC Performance Standards & EHS Guidelines.

The 5 Capitals Technical Team to undertake the ESIA studies for the proposed SWRO Plant is as shown in the table below.

Table 2-1 5 Capitals' Core Project Team

Names	Project Position	Qualifications	Key Areas of Expertise
Kenneth Wade	Project Director	MSc, BSc, CBiol, MIBiol,	ESIA, EMS, SEA, Due Diligence, Biology, Ecology, Marine Environment
Eva Kimonye	Project Manager	BSc, MSc	ESIA, Environmental Auditing, Due Diligence, ESMS
Max Burrow	Operations Manager	BSc (Hons)	ESIA, Project Management, Lender Requirements, Auditing, Due Diligence, ESMS, Air Quality, Noise
Harry George	Senior Environmental Consultant (Marine)	BSc, MSc	ESIA, Environmental Auditing, Due Diligence, ESMS

2.5 ESIA Methodology

This section provides information about the data collection and consultation process required to inform the ESIA and the methodology that will be used to describe the sensitivity of environmental and social receptors; predict the magnitude of environmental and social

impacts on the identified receptors and assess/evaluate the significance of the effect of the project activities on each relevant environmental and social aspect or component.

2.5.1 Baseline data collection

Forming an integral part of the ESIA, the baseline data collection provides a benchmark of the existing conditions by which the potential impacts of the proposed project can be assessed for the construction and operational phases.

This ESIA has been informed by a review of relevant desktop information as well as a series of physical site surveys. Desktop information, which has been reviewed and has informed the environmental baseline include:

- Environmental Scoping Report for the project;
- Environmental Impact Assessment for the project (December 2017); and
- Historical satellite mapping of the project site.

The physical surveys undertaken across the project site and its immediate surroundings relating to various environmental aspects include:

Table 2-2 List of Surveys undertaken for the Proposed SWRO Plant

Surveys	Period
Site Walkover	July/September 2018
	June 2019
Land use	July/September 2018
	July 2019
Air Quality monitoring	September 2018
Noise monitoring	September 2018 & November 2018
	June 2019
Soil Survey and Laboratory Analyses	September 2018
	June 2019
Groundwater sampling/Analyses	September 2018
Surface water sampling/Analyses	September 2018
Marine Survey and Laboratory Analyses	September 2018
	November 2018
Terrestrial Ecology (dusk/dawn/night surveys)	September 2018
	November 2018
	June 2019
	July 2019

The baseline survey data for the different environmental aspect are described in respective chapters herein, with results provided, and included in the applicable appendices.

2.5.2 ESIA Consultations and Stakeholder Engagement

Stakeholder identification and consultation has been an ongoing process for the Umm Al Quwain Project for the last one year (reference the table below). The methods used for the on-going stakeholder engagement process include bilateral meetings, emails, telephone calls and letters. Public consultations and meetings are not allowed under the UAE national law although for this project there has been in-depth consultation with government entities to ensure that any project concerns are addressed within the project design and this ESIA.

A stakeholder Engagement Plan (SEP) will be prepared for the project describing the proposed engagement process to be undertaken during the construction and operational phase of the project. The scope of the SEP will provide the project with methods of efficiently managing and facilitating future engagement with stakeholders through various stages of the project lifecycle.

The SEP will align with the requirements of Equator Principles 5 and 6 that describes Stakeholder Engagement and Grievance Mechanism respectively, and the IFC Performance Standards with particular relevance to IFC Performance Standard 1 on "Assessment and Management of Environmental and Social Risks and Impacts" which describes the stakeholder's engagement requirements in more depth. However, it is recognised that elements of stakeholder engagement are included in all IFC Performance Standards.

Table 2-3 List of Stakeholder Identified for the Project

ID	Name	Reason for inclusion	Yes/No	Dates of Meetings/Letters
1.	UAE Ministry of Climate Change & Environment	Mission is to work with Partners to Protect the Environment, Preserve and Develop their Resources and Invest them Efficiently to Ensure their Sustainability.	Yes	Project approval would have been obtained from the consultation within UAE government ministries as part of strategic planning process.
2.	UAE Ministry of Energy and Industry	Organizing and developing energy, water, mining and industry sectors through setting and developing public policies, legislation, strategies and building partnerships in cooperation and coordination with concerned entities.	Yes	
3.	Ministry of Infrastructure Development (MOID)	Ministry in charge of federal infrastructure projects (public facilities & utilities) and supervision of their implementation in accordance with best international practices in coordination with concerned authorities.	Ongoing	The EPC Contractor will obtain a NOC from MOID before any tunnelling/drilling is conducted under E11
4.	Ministry of Interior (MOI)	Ministry in charge of ensuring peace and security and is responsible for the army optic cable running along E11 between Project site 1 and 2.	Before construction works commence	The EPC Contractor will obtain a NOC from MOI before any tunnelling/drilling is conducted under E11 in order to secure the optic cables.
5.	Federal Electricity & Water Authority (FEWA)	Authority charged to cater for the needs of electricity and potable water for the population of the Northern Emirates. FEWA is also the Project Proponent	Yes	Multiple times during the bid and post bid stage
6.	Umm Al Quwain Public Health and Environmental Department (PHED)	PHED governs all matters directly relating to the environment in Umm Al Quwain	Yes	Multiple meetings have been held between PHED and 5 Capitals post bid in 2018 & 2019

ID	Name	Reason for inclusion	Yes/No	Dates of Meetings/Letters
				to discuss the scope of the project and ESIA requirements.
7.	Umm Al Quwain Department of Urban Planning and Survey	Authority involved in functions of urban planning, and the required elements to regulate housing and related development of cities and suburbs.	Yes	Multiple meetings have been held between UAQ Department of Urban Planning and Survey, ACWA Power and 5 Capitals in 2018 & 2019 regarding the project boundary in relation to Umm Al Quwain and Ras Al Khaimah Emirates boundaries. An official consultation letter was sent to the Planning and Survey Department on 18th June 2019 requesting them to submit comments of feedback including any available data relevant to the project ESIA.
8.	Ras Al Khaimah Municipality	Plays an important role in driving and supporting t	Yes	Consultation letters were sent to these authorities on 18th June 2019 requesting them to submit any comments or feedback including data relevant to the proposed project (See Appendix B for the consultation letters)
9.	Ras Al Khaimah Tourist Development Authority	Interest in the development of the project (they are located approximately 440 m north of the project site).	Yes	
10.	Road Transport Authority (RTA)	Government roads & transportation authority with interest in the development of project components that will have an impact on E11 highway.	Yes	
11.	Umm Al Quwain Coastguard	Interest in the development of the project (i.e. intake and outfall)	Yes	5 Capitals has engaged the coastguards several times during the application of marine survey permits
12.	Du	A telecommunication company in the UAE with fibre optic cables running parallel to the E11 west of project site 1	Before construction works commence	The EPC Contractor will obtain a NOC from du before any tunnelling/drilling is conducted under E11 in order to secure the fibre optic cables.

ID	Name	Reason for inclusion	Yes/No	Dates of Meetings/Letters
13.	Al Jazirah Aviation Club	Private air field located approximately 2.1km form the project site with its paragliders and light air crafts flying over the project site.	Before construction works commence	ACWA Power/EPC Contractor to notify the RAK Municipality and/or the aviation club on the construction schedule and necessary adjustments of flight path.
14.	Camel Holding Area Owners	During site visits, camels from the camel holding area have been observed grazing near the laydown area 2.	Before construction works commence	ACWA Power/EPC Contractor to notify the UAQ Municipality and/or the camel herder owner on project details and site access restrictions

2.5.3 Identification and Evaluation of Sensitive Receptors

Sensitive receptors are defined as:

- Elements of the **environment** that are of value to the functioning of natural systems (i.e. areas or elements of ecological, landscape or heritage value, species, habitats and ecosystems, soil, air and water bodies or land-use patterns);
- **Human** receptors, such as stakeholders (i.e. users of dwellings, places of recreation, places of employment, community facilities or household relocation) and human systems (e.g. employment market, population disease susceptibility and disease communicability, exposure to toxicity of chemicals).

The environmental value (or sensitivity) of the resource or receptor has been defined by using the criteria in the table below.

Table 2-4 Environmental Value of Receptor or Resources

Value (sensitivity)	Description of Value
Very High	• High importance and rarity on an international scale and limited or no potential for substitution. • The receptor has already reached its carrying capacity, so any further impact is likely to lead to an excessive damage to the system that it supports. • Locations or communities that are highly vulnerable to the environmental impact under consideration or critical for society (e.g. indigenous peoples, hospitals, schools).
High	• High importance and rarity on a national scale, and limited potential for substitution. • The receptor is close to reaching its carrying capacity, so a further impact may lead to a significant damage to the system that it supports. • Locations or communities that are particularly vulnerable to the environmental impact under consideration (e.g. residential areas, vulnerable/marginalized groups).
Medium	• High or medium importance and rarity on a regional scale, limited potential for substitution. • The receptor is already significantly impacted, but it is not close to reaching its carrying capacity. Further impacts will get increase the stress of the underlying system, but evidence does not suggest that it is about to reach a critical point. • Locations or groups that are relatively vulnerable to the environmental impact under consideration (e.g. commercial areas).
Low (or Lower)	• Low or medium importance and rarity on a local scale. • The receptor is not significantly impacted and shows a large spare carrying capacity. Impacts are not likely to generate any noticeable stress in the underlying system. • Locations or groups that show a low vulnerability to the environmental impact under consideration (e.g. industrial areas).
Very Low	• Very low importance and rarity on a local scale. • The receptor is not impacted and shows a very large spare carrying capacity. Impacts are very unlikely to generate any noticeable stress in the underlying system.

Value (sensitivity)	Description of Value
	• Locations or groups that show a very low vulnerability to the environmental impact under consideration (e.g. industrial areas).

2.5.4 Identification and Evaluation of Potential Impacts

During the evaluation undertaken as part of the ESIA process, the following types of impacts have been considered:

- **Direct Impacts** - Potential impacts that may result from the construction and occupation of the Project acting directly on an environmental or social receptor (e.g. land take for construction of the camps);
- **Indirect Impacts** – Potential impacts which are not a direct result of a Project activity, often produced later in time or further removed in distance, but are normally a result of a complex pathway (e.g. dust deposition on vegetation which causes reduction in photosynthetic rates);
- **Beneficial Impacts** – Those impacts that have a positive, desirable or favourable effect on the sensitive resources or receptors (e.g. landscape providing artificial habitat for a variety of species, creating jobs during the construction and/or occupation phases of a project);
- **Adverse Impacts** – Those impacts that are detrimental and have a negative influence on sensitive resources or receptors;
- **Secondary Impacts** - Potential impacts that may result from the implementation of protection measures applied to mitigate potential direct impacts;
- **Event Related Impacts** - Potential unplanned or accidental impacts stemming from an unintentional event such as fire, explosion, oil spill, etc.; and

2.5.5 Defining Impact Magnitude

The magnitude of the impact will be defined wherever possible in quantitative terms. The magnitude of an impact has a number of different components, for example:

- The extent of physical change;
- The level of change in an environmental condition;
- The permanence of impact and the reversibility of the impacted condition;
- Its spatial footprint;
- Its duration, its frequency; and
- Its likelihood of occurrence where the impact is not certain to occur.

The criteria used for identifying the magnitude of impacts is provided within the table below.

Table 2-5 Criteria for Magnitude of Impacts

Magnitude of Impact	Description of Magnitude
Major	*Adverse:* Loss of resource and/or quality and integrity; severe damage to key characteristics, features or elements. A major impact is usually large scale, permanent and irreversible. *Beneficial:* Large scale or major improvement of resource quality; extensive restoration or enhancement; major improvement of attribute quality.
Moderate	*Adverse:* Significant impact on the resource, but not adversely affecting the integrity; Partial loss of/damage to key characteristics, features or elements. Moderate impacts usually extend above the site boundary, and are usually permanent, irreversible or cumulative. *Beneficial*: Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality.
Minor	*Adverse:* Some measurable change in attributes quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements. Minor impacts usually are only noticeable within the site and are temporary and reversible. *Beneficial:* Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of negative impact occurring.
Negligible	*Adverse:* Very minor loss or detrimental alteration to one or more characteristics, features or elements. *Beneficial:* Very minor benefit to or positive addition of one or more characteristics, features or elements.
No change	No loss or alteration of characteristics, features or elements; no observable impact in either direction.

2.5.6 Determination of Significance of Effects

The significance of effects is a combination of the environmental value (or sensitivity) of a receptor or resource and the magnitude of the project impact value (change). In other words, it is this product of the impact acting on the receptor that produces an environmental effect. The table below provides criterion used for determining the significance of environmental effects through consideration of the potential magnitude of impact and sensitivity of the associated receptor. Definitions of each significance categories are provided.

Table 2-6 Criteria for Determining Significance of Effects

		Magnitude of impact (degree of change)				
		No change	**Negligible**	**Minor**	**Moderate**	**Major**
Sensitivity of Receptor	**Very High**	Neutral	Minor	Moderate to Major	Major	Major
	High	Neutral	Minor	Minor to moderate	Moderate to Major	Major

	Medium	Neutral	Negligible to minor	Minor	Moderate	Moderate to Major
	Low	Neutral	Negligible to minor	Negligible to minor	Minor	Minor to moderate
	Very Low	Neutral	Negligible	Negligible to minor	Minor	Minor

In some cases, above, the significance is shown as being one of the two alternatives. In these cases, a single description is decided upon with reasoned judgement for that level of significance chosen.

Table 2-7 Definition of Significance of Effects

Significance Category	Criteria
Very Large	Only adverse effects are normally assigned this level of significance. They represent key factors in the decision-making process. These effects are generally, but not exclusively, associated with sites or features of international, national or regional importance that are likely to suffer a most damaging impact and loss of resource integrity. However, a major change in a site or feature of local importance may also enter this category.
Large	Important considerations at a local scale but, if adverse, are potential concerns to the project and may become key factors in the decision-making process.
Moderate	These effects, if adverse, while important at a local scale, are not likely to be key decision-making issues. Nevertheless, the cumulative effect of such issues may lead to an increase in the overall effects on a particular area or on a particular resource.
Slight	Local issue unlikely to be of importance in the decision-making process. Effects do not exceed statutory limits. Nevertheless, they are of relevance in enhancing the subsequent design of the project and consideration of mitigation or compensation measures.
Neutral	No effect or effect that is beneath the level of perception, within normal bounds of variation or within the margin of forecasting error. No mitigation is required.

The significance of the effect is determined by comparison, wherever possible with company, local, national or international accepted standards and requirements. If no standards are available then it is paramount to develop project specific limits, based on guidance or best practice as necessary. Such standards or limits are referred to as the **Significance Threshold.** Where the size and type of effect is greater than the significance threshold, this is termed as **Significant Effect.** Potential significant effects need to be avoided and are therefore prioritised identifying mitigation measures to reduce the effect to an acceptable level. Significant effects will be those, which are 'Major' or 'Moderate or Major'.

Note: All predicted impacts with a beneficial impact have been colour coded green.

3 REGULATORY FRAMEWORK

This chapter presents the regulatory requirements this ESIA has considered for the project in accordance with federal and international regulations and standards. Applicable environmental legislative framework considered includes:

- National environmental legislation, regulations and standards (UAE Federal Law); and
- International and Regional Conventions and Protocols signed and/or ratified by the UAE

3.1 National Regulations

3.1.1 UAE Federal Environmental Law, Regulations and Standards

The Federal Law No. 24 of 1999 for the Protection and Development of the Environment was the first and most comprehensive federal environmental law in the UAE. The main objective of this Law is to promote the protection and conservation of the environment across the UAE through:

- Control of all forms of pollution and avoidance of any immediate or long-term harmful effects resulting from industrial, economic or agricultural development;
- Conservation of natural resources and biological diversity;
- Protection and conservation of the quality and natural balance of the environment, human health and the health of other living creatures from environmentally harmful activities; and
- Compliance with international and regional conventions ratified or approved by the UAE regarding environmental protection and control of pollution.

Federal Law No. 24 of 1999 contains several environmental principles and standards as part of its Executive Order, which was issued by the Cabinet of Ministers in two Decrees:

- Ministerial Decree No. 37 of 2001 including the following regulations:
  - Regulation concerning Environmental Impact Assessment of Projects;
  - Regulation concerning Handling of Hazardous Substances, Hazardous Wastes and Medical Wastes; and
  - Regulation concerning Protection of the Marine Environment.
- Ministerial Decree No. 12 of 2006 on Regulation concerning the Protection of Air from Pollution.

Other Federal Laws also applicable to this Project are:

- Federal Law No. 8 of 1980 concerning Regulation of Working Relations, as amended by Law No 12 of 1986. This is known as 'Labour Law' and is a comprehensive law that regulates all aspects of labour relations between employers and employees from

employee entitlements to industrial safety, preventive measures, health and social care for workers and its Ministerial Orders or Decrees:

- Ministerial Order No. 32 of 1982 Specifying Preventive Methods and Measures for Protecting Workers against Work Hazards;
- Ministerial Decision No. 37/2 of 1982 on the Medical Care which the Employer is Obliged to Provide to his Workers;
- Cabinet Resolution No. 13 of 2009 Approving the General Standards Manual of the Labour Collective Accommodation and Attached Services;
- Ministerial Decree No. 764 of 2015 on Ministry approved Standard Employment Contracts;
- Ministerial Decree No. 765 of 2015 on Terminating Employment; and
- Ministerial Decree No. 766 of 2015 on Rules and Conditions for granting Work Permits.
- Federal Law No. 11 of 2002 for 'Regulation and Control the International Trade in Species of Wild Fauna & Flora'; and
- Federal Law No. 21 of 2005 concerning 'Traffic Law'.

3.2 International and Regional Treaties and Conventions

The proposed Project must comply with the environmental requirements of the following regional protocols and conventions listed in table below to which the UAE is a signatory:

Table 3-1Regional Protocols and Conventions

Name of Regional Protocol/ Convention	Signed/ Ratified
Convention on Conservation of Wildlife and its Natural Habitats in the GCC Countries, 2001	2003

The UAE is a signatory to, and has ratified, several international protocols and conventions. As such the UAE is committed to the principles and policies therein. The proposed Project must therefore comply with the environmental requirements of the international treaties and conventions listed in the table below to which the UAE is a signatory:

Table 3-2 International Protocols and Conventions

Name of International Protocol/Convention	Signed/ Ratified
Memorandum of Understanding concerning the Conservation of Migratory Birds of Prey in Africa and Eurasia	2008
Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC), 1997 - Non-Annex I Country	2005
Stockholm Convention on Persistent Organic Pollutants (POPs), 2001	2002
Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC), 1997 - Non-Annex I Country	2005
United Nations Convention to Combat Desertification (UNCCD), 1994	1999
United Nations Convention on Biological Diversity, 1992	1999

Name of International Protocol/Convention	Signed/ Ratified
United Nations Framework Convention on Climate Change (UNFCCC), 1992	1995
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, 1989 and amendments in 1995	1992
Montreal Protocol on Ozone Depleting Substances, 1987 and Montreal Amendments (London 1990, Copenhagen 1992, Vienna 1995, Montreal 1997, Beijing 1999)	1989
Vienna Convention for the Protection of the Ozone Layer, 1985	1989
Geneva Convention on Long-Range Transboundary Air Pollution, 1979	-
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 1973	1990
Convention Concerning the Protection of World Cultural and Natural Heritage, 1972	-
Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar), 1971	2007

In addition to the above, the UAE contributes to many regional and international organisations that are concerned with the protection of environment and conservation of natural resources, such as the United Nations Environment Program, World Health Organisation, United Nations Food and Agriculture Organization, World Meteorological Organization, UNESCO, the Regional Organization for Protection of Marine Environment and the relevant organizations working under the Arab League.

The UAE is also a member of the International Labour Organisation (ILO). The ILO is committed to advancing opportunities for women and men to obtain decent and productive work in conditions of freedom, equity, security and human dignity. Its main aims are to promote rights at work, encourage good employment opportunities, enhance social protection and strengthen dialogue in handling work-related issues.

3.3 Lender Requirements

3.3.1 Equator Principles

The Equator Principles have been detailed in 'The ESIA Process' section herein. As per Equator Principle 3, an Equator Principle aligned ESIA is required to assess environmental and social impacts in accordance with the IFC Performance Standards on Environmental & Social Sustainability and IFC EHS Guidelines.

3.3.2 IFC Performance Standards on Environmental and Social Sustainability

The IFC Performance Standards are a key component of the IFC's Sustainability Framework and directed towards clients (i.e. party responsible for implementing and operating the project that is being financed), providing guidance on how to identify risks and impacts. The IFC Performance Standards are designed to help avoid, mitigate, and manage risks and impacts

throughout the life of a project as a way of doing business in a sustainable way, including stakeholder engagement and disclosure obligations of the client in relation to project-level activities.

The 2006 version of the IFC Performance Standards was reviewed and made applicable to all new projects from 1st January 2012. The updated IFC PSs reflect IFC's stronger commitment to climate change, business and human rights, corporate governance and gender equality as well as strengthening the due diligence process for IFIs. Such updates include comparable labour terms for migrant and non-migrant workers, clarification of levels of stakeholder engagement, monitoring of supply chains and an enhanced focus on energy efficiency.

IFC is a shareholder in ACWA Power, and therefore all ACWA Power projects must comply with the IFC Performance Standards and IFC EHS Guidelines.

The following presents the IFC Performance Standards (2012) and their main characteristics:

Table 3-3 IFC Performance Standards (2012)

Performance Standard	Details and Requirements
PS 1	**Assessment and Management of Environmental and Social Risks and Impacts** It underscores the importance of managing environmental and social performance throughout the life of a project. It requires the Client to conduct a process of environmental and social assessment, and establish and maintain an Environmental and Social Management System (ESMS) appropriate to the nature and scale of the project and commensurate with the level of its environmental and social risks and impacts. The ESMS must be a dynamic and continuous process initiated and supported by management, and involves engagement between the client, its workers, local communities directly affected by the project (the Affected Communities) and, where appropriate, other stakeholders. • Requires stakeholder engagement beyond Affected Communities; • Clarifies levels of stakeholder engagement under different circumstances; • Requires development of a formal environmental and social policy reflecting principles of the Performance Standards; • Introduces participatory monitoring (when appropriate) as an option during implementation; and • Requires periodic performance reviews by senior management.
PS 2	**Labour and Working Conditions** Recognizes that the pursuit of economic growth through employment creation and income generation should be accompanied by protection of the fundamental1 rights of workers. The requirements set out in this PS have been in part guided by a number of international conventions and instruments, including those of the International Labour Organization (ILO) and the United Nations (UN) • Establishes requirement for comparable terms and conditions for migrant workers compared to non-migrant workers; • Introduces quality requirements for workers' accommodation; • Requires ongoing monitoring of working conditions for workers under the age of 18 years old;

Performance Standard	Details and Requirements
	• Requires establishing policies and procedures to manage and monitor compliance of third parties with this PS; • Requires alternatives analysis in case of retrenchment; and • Requires ongoing monitoring and "safety' trigger in primary supply chain.
PS 3	**Resource Efficiency and Pollution Prevention** Outlines a project-level approach to resource efficiency and pollution prevention and control in line with internationally disseminated technologies and practices. During the project life-cycle, the client will consider ambient conditions and apply technically and financially feasible resource efficiency and pollution prevention principles and techniques that are best suited to avoid, or where avoidance is not possible, minimize adverse impacts on human health and the environment.3 The principles and techniques applied during the project life-cycle will be tailored to the hazards and risks associated with the nature of the project and consistent with good international industry practice (GIIP). • Introduces a resource efficiency concept for energy, water and core material inputs; • Strengthens focus on energy efficiency and greenhouse gas measurement; • Reduces greenhouse gas emissions thresholds for quantification and reporting to IFC from 100,000 tons of CO_2 to 25,000 tons of CO_2 per year; • Introduces concept of "duty of care" for hazardous waste disposal; and • Requires determination of accountability with regards to historical pollution.
PS 4	**Community Health, Safety and Security** Addresses the client's responsibility to avoid or minimize the risks and impacts to community health, safety, and security that may arise from project related-activities, with particular attention to vulnerable groups. This PS addresses potential risks and impacts to the Affected Communities from project activities. Occupational health and safety requirements for workers are included in PS 2, and environmental standards to avoid or minimize impacts on human health and the environment due to pollution are included in PS 3. • Requires evaluation of the risks and impacts to the health and safety of the Affected Communities during the project life- cycle and the establishment of preventive and control measures consistent in line with GIIP • Considers risks to communities associated with use and/or alteration of natural resources and climate change through an ecosystems approach.
PS 5	**Land Acquisition and Involuntary Resettlement** Recognizes that project-related land acquisition and restrictions on land use can have adverse impacts on communities and persons that use this land. Involuntary resettlement refers both to physical displacement (relocation or loss of shelter) and to economic displacement (loss of assets or access to assets that leads to loss of income sources or other means of livelihood) as a result of project-related land acquisition and/or restrictions on land use. Where involuntary resettlement is unavoidable, it should be minimized and appropriate measures to mitigate adverse impacts on displaced persons and host communities3 should be carefully planned and implemented. • Extends scope of application to restrictions on land use;

Performance Standard	Details and Requirements
	• Strengthens requirements regarding consultations; and • Introduces a requirement for a completion audit under certain circumstances.
PS 6	**Biodiversity Conservation and Sustainable Management of Living Natural Resources** Addresses how clients can sustainably manage and mitigate impacts on biodiversity and ecosystem services throughout the project's lifecycle in order to protect and conserve biodiversity; to maintain the benefits from ecosystem services; and to promote the sustainable management of living natural resources through the adoption of practices that integrates conservation needs and development priorities. • Clarifies definitions of and requirements for various types of habitats; • Introduces stronger requirements for biodiversity offsets; and • Introduces specific requirements for plantations and natural forests as well as for management of renewable natural resources.
PS 7	**Indigenous People** It requires clients to anticipate and avoid adverse impacts of projects on communities of Indigenous Peoples, or when avoidance is not possible, to minimize and/or compensate for such impacts and to promote sustainable development benefits and opportunities for Indigenous Peoples in a culturally appropriate manner. It also requires the client to establish and maintain an on-going relationship based on Informed Consultation and Participation (ICP) with the Indigenous Peoples affected by a project throughout the project's life-cycle. • Expands consideration of Indigenous Peoples' specific circumstances in developing mitigation measures and compensation; • Introduces requirement for land acquisition due diligence with regards to lands subject to traditional ownership or under customary use; and • Introduces the concept of Free, Prior and Informed Consent under certain circumstances.
PS 8	**Cultural Heritage** Aims to ensure that clients protect cultural heritage from the adverse impacts of project activities and support its preservation and promote the equitable sharing of benefits from the use of cultural heritage in line with the Consistent with the Convention Concerning the Protection of the World Cultural and Natural Heritage.

3.3.3 World Bank and IFC EHS Guidelines

The World Bank Group and IFC Environmental, Health and Safety Guidelines (EHS Guidelines) are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP), as defined in IFC's PS 3: Resource Efficiency and Pollution Prevention. IFC uses the EHS Guidelines as a technical source of information during project appraisal activities.

The World Bank Group International Finance Corporation (IFC), Environmental, Health and Safety (EHS) General Guidelines of April 2007 superseded the World Bank Handbook issue of 1998. The updated EHS Guidelines serve as a technical reference source to support the implementation of the IFC Performance Standards, particularly in those aspects related to PS

3: Resource Efficiency & Pollution Prevention, as well as certain aspects of Occupational and Community Health and Safety. The General EHS Guidelines contain information on crosscutting environmental, health, and safety issues potentially applicable to all industry sectors. On the other hand, there are industry sector guidelines that have been developed and are relevant to the SWRO plant such as the EHS Guidelines for Water and Sanitation.

The General EHS Guidelines contain the performance levels and measures that are normally acceptable to IFC, and that are generally considered to be achievable in new facilities at reasonable costs by existing technology.

3.4 ESIA Requirements

3.4.1 Local Requirements

In accordance with Federal Environmental Law No. 24 of 1990, Article 3 states that "The Agency, in consultation with the competent authorities and concern parties shall to set the standards, specifications, principles and regulations for the assessment of environmental impact of the projects and establishment applying for license and shall specially undertake the following:

- Identification of categories of projects, which due to their nature may cause harm to the environment.
- Identification of areas and sites of special environmental importance or sensitivity such as historical and archaeological sites, wet lands, coral reefs, natural reservations and public parks.
- Identification of natural resources and major environmental problems of special importance.

In addition to this, Article 4 states that "No project or establishment shall start the activity before obtaining the license aforementioned in the previous article including environmental impact assessment."

3.4.2 Lender Requirements

It is understood that ACWA Power are seeking project finance from International Lenders who are likely to be signatories to the voluntary set of guidelines for managing environmental and social risks, known as the Equator Principles. As such there are a number of separate requirements for the Environmental Impact and Social Assessment of the project as set out below.The Equator Principles (EPs) form the baseline for the assessment and management of environmental and social risks in project financing. They also stipulate the reporting and monitoring requirements to be met by a project for the Equator Principles Financial Institutions (EPFIs).

Based on the Equator Principles, FEWA 150 MIGD SWRO Independent Water Project is located in a Non-Designated Country (UAE), the project will therefore be required to undergo an assessment process. The assessment process evaluates compliance with the then applicable IFC Performance Standards on Environmental and Social Sustainability (Performance Standards) and the World Bank Group Environmental, Health and Safety Guidelines (EHS Guidelines).

The Equator Principles consist of the following 10 Principles:

Table 3-4 Equator Principles III (2013)

Equator Principle	Details
Principle 1	**Review and Categorisation** EPFIs will categorise a project proposed for financing based on the magnitude of its potential impacts and risks in accordance with the environmental and social screening criteria of the International Finance Corporation (IFC). These categories are: **Category A-** Projects with potential significant adverse social or environmental risks and/or impacts that are diverse, irreversible or unprecedented; **Category B** – Projects with potential limited adverse social or environmental risks and/or impacts that are few in number, generally site-specific, largely reversible and readily addressed through mitigation measures; and **Category C** – Projects with minimal or no social or environmental risks and/or impacts.
Principle 2	**Environmental and Social Assessment** For all Category A and Category B Projects, the EPFI will require the client to conduct an Assessment process to address, to the EPFI's satisfaction, the relevant environmental and social risks and impacts of the proposed Project (which may include the illustrative list of issues found in Exhibit II). The Assessment Documentation should propose measures to minimise, mitigate, and offset adverse impacts in a manner relevant and appropriate to the nature and scale of the proposed Project. The Assessment Documentation will be an adequate, accurate and objective evaluation and presentation of the environmental and social risks and impacts, whether prepared by the client, consultants or external experts. For Category A, and as appropriate, Category B Projects, the Assessment Documentation includes an Environmental and Social Impact Assessment (ESIA). One or more specialised studies may also need to be undertaken. Furthermore, in limited high-risk circumstances, it may be appropriate for the client to complement its Assessment Documentation with specific human rights due diligence. For other Projects, a limited or focused environmental or social assessment (e.g. audit), or straightforward application of environmental siting, pollution standards, design criteria, or construction standards may be carried out
Principle 3	**Applicable Environmental and Social Standards** The Assessment process should, in the first instance, address compliance with relevant host country laws, regulations and permits that pertain to environmental and social issues. EPFIs operate in diverse markets: some with robust environmental and social governance, legislation systems and institutional capacity designed to protect their people and the natural environment; and some with evolving

Equator Principle	Details
	technical and institutional capacity to manage environmental and social issues. The EPFI will require that the Assessment process evaluates compliance with the applicable standards as follows: • For Projects located in Non-Designated Countries, the Assessment process evaluates compliance with the then applicable IFC Performance Standards on Environmental and Social Sustainability (Performance Standards) and the World Bank Group Environmental, Health and Safety Guidelines (EHS Guidelines) (Exhibit III). • For Projects located in Designated Countries, the Assessment process evaluates compliance with relevant host country laws, regulations and permits that pertain to environmental and social issues. Host country laws meet the requirements of environmental and/or social assessments (Principle 2), management systems and plans (Principle 4), Stakeholder Engagement (Principle 5) and, grievance mechanisms (Principle 6). The Assessment process will establish to the EPFI's satisfaction the Project's overall compliance with, or justified deviation from, the applicable standards. The applicable standards (as described above) represent the minimum standards adopted by the EPFI. The EPFI may, at their sole discretion, apply additional requirements.
Principle 4	**Environmental and Social Management System and Equator Principles Action Plan** For all Category A and Category B Projects, the EPFI will require the client to develop or maintain an Environmental and Social Management System (ESMS). Further, an Environmental and Social Management Plan (ESMP) will be prepared by the client to address issues raised in the Assessment process and incorporate actions required to comply with the applicable standards. Where the applicable standards are not met to the EPFI's satisfaction, the client and the EPFI will agree an Equator Principles Action Plan (AP). The Equator Principles AP is intended to outline gaps and commitments to meet EPFI requirements in line with the applicable standards.
Principle 5	**Stakeholder Engagement** For all Category A and Category B Projects, the EPFI will require the client to demonstrate effective Stakeholder Engagement as an on-going process in a structured and culturally appropriate manner with Affected Communities and, where relevant, Other Stakeholders. For Projects with potentially significant adverse impacts on Affected Communities, the client will conduct an Informed Consultation and Participation process. The client will tailor its consultation process to: the risks and impacts of the Project; the Project's phase of development; the language preferences of the Affected Communities; their decision-making processes; and the needs of disadvantaged and vulnerable groups. This process should be free from external manipulation, interference, coercion and intimidation. To facilitate Stakeholder Engagement, the client will, commensurate to the Project's risks and impacts, make the appropriate Assessment Documentation readily available to the Affected Communities, and where relevant Other Stakeholders, in the local language and in a culturally appropriate manner. The client will take account of, and document, the results of the Stakeholder Engagement process, including any actions agreed resulting from such process. For Projects with environmental or social risks and adverse impacts, disclosure should occur early in the Assessment process, in any event before the Project construction commences, and on an on-going basis.

Equator Principle	Details
Principle 6	**Grievance Mechanism** For all Category A and, as appropriate, Category B Projects, the EPFI will require the client, as part of the ESMS, to establish a grievance mechanism designed to receive and facilitate resolution of concerns and grievances about the Project's environmental and social performance. The grievance mechanism is required to be scaled to the risks and impacts of the Project and have Affected Communities as its primary user. It will seek to resolve concerns promptly, using an understandable and transparent consultative process that is culturally appropriate, readily accessible, at no cost, and without retribution to the party that originated the issue or concern. The mechanism should not impede access to judicial or administrative remedies. The client will inform the Affected Communities about the mechanism in the course of the Stakeholder Engagement process.
Principle 7	**Independent Review** ***Project Finance*** For all Category A and, as appropriate, Category B Projects, an Independent Environmental and Social Consultant, not directly associated with the client, will carry out an Independent Review of the Assessment Documentation including the ESMPs, the ESMS, and the Stakeholder Engagement process documentation in order to assist the EPFI's due diligence, and assess Equator Principles compliance. The Independent Environmental and Social Consultant will also propose or opine on a suitable Equator Principles AP capable of bringing the Project into compliance with the Equator Principles, or indicate when compliance is not possible. ***Project-Related Corporate Loans*** An Independent Review by an Independent Environmental and Social Consultant is required for Projects with potential high-risk impacts including, but not limited to, any of the following: • Adverse impacts on indigenous peoples • Critical Habitat impacts • Significant cultural heritage impacts • Large-scale resettlement In other Category A, and as appropriate Category B, Project-Related Corporate Loans, the EPFI may determine whether an Independent Review is appropriate or if internal review by the EPFI is sufficient. This may consider the due diligence performed by a multilateral or bilateral financial institution or an OECD Export Credit Agency, if relevant.
Principle 8	**Covenants** An important strength of the Equator Principles is the incorporation of covenants linked to compliance. For all Projects, the client will covenant in the financing documentation to comply with all relevant host country environmental and social laws, regulations and permits in all material respects. Furthermore, for all Category A and Category B Projects, the client will covenant the financial documentation: a) To comply with the ESMPs and Equator Principles AP (where applicable) during the construction and operation of the Project in all material respects; and b) To provide periodic reports in a format agreed with the EPFI (with the frequency of these reports proportionate to the severity of impacts, or as required by law, but not less than annually), prepared by in-house staff or third-party experts, that i) document compliance with the

Equator Principle	Details
	ESMPs and Equator Principles AP (where applicable), and ii) provide representation of compliance with relevant local, state and host country environmental and social laws, regulations and permits; and c) To decommission the facilities, where applicable and appropriate, in accordance with an agreed decommissioning plan. Where a client is not in compliance with its environmental and social covenants, the EPFI will work with the client on remedial actions to bring the Project back into compliance to the extent feasible. If the client fails to re-establish compliance within an agreed grace period, the EPFI reserves the right to exercise remedies, as considered appropriate.
Principle 9	**Independent Monitoring and Reporting** ***Project Finance*** To assess Project compliance with the Equator Principles and ensure on-going monitoring and reporting after Financial Close and over the life of the loan, the EPFI will, for all Category A and, as appropriate, Category B Projects, require the appointment of an Independent Environmental and Social Consultant, or require that the client retain qualified and experienced external experts to verify its monitoring information which would be shared with the EPFI. ***Project-Related Corporate Loans*** For Projects where an Independent Review is required under Principle 7, the EPFI will require the appointment of an Independent Environmental and Social Consultant after Financial Close, or require that the client retain qualified and experienced external experts to verify its monitoring information which would be shared with the EPFI.
Principle 10	**EPFIs Reporting** ***Client Reporting Requirements*** The following client reporting requirements are in addition to the disclosure requirements in Principle 5. For all Category A and, as appropriate, Category B Projects: • The client will ensure that, at a minimum, a summary of the ESIA is accessible and available online. • The client will publicly report GHG emission levels (combined Scope 1 and Scope 2 Emissions) during the operational phase for Projects emitting over 100,000 tonnes of CO2 equivalent annually. Refer to Annex A for detailed requirements on GHG emissions reporting. ***EPFI Reporting Requirements*** The EPFI will report publicly, at least annually, on transactions that have reached Financial Close and on its Equator Principles implementation processes and experience, taking into account appropriate confidentiality considerations. The EPFI will report according to the minimum reporting requirements detailed in Annex B.

Based on the project type and surrounding environment of the proposed development, the 150 MIGD SWRO project may be classified under Category B project according to Equator Principle 1, as there is a potential for limited adverse social or environmental risks and /or impacts that are few in number., generally site-specific, largely reversible and readily addressed through the implementation of mitigation measures.

3.5 Environmental Regulations and Standards

The environmental standards specified by UAE Federal Laws and FEWA in the project RfP that are applicable to the proposed project with respect to air, noise and vibration, marine, soils and groundwater etc. are presented under the respective section for each environmental aspect.

4 PROJECT INFORMATION

4.1 Project Location

The proposed Project will be located in the northern most extent of the Emirate of Umm Al Quwain in the United Arab Emirates. The specific plot of land has been allocated by FEWA and is immediately south of the Umm Al Quwain border with the Emirate of Ras Al Khaimah, approximately 20 km north of the city of Umm Al Quwain.

The Project will primarily be located on land with intake and outfall facilities extending into the marine environment. The land-based section of the project will be approximately 23.5 hectares in area in two plots of land adjacent to E11 carriageways. The smaller project site (Project site 1) which is located between the north and south flowing E11 carriageways will be approximately 6.9 hectares whereas the larger project site (project site 2) which is located east of the north flowing E11 carriageway will be approximately 16.6 hectares.

The location of the project site 1 & 2 is shown in the figures below.

Figure 4-1 Location of the Proposed Project

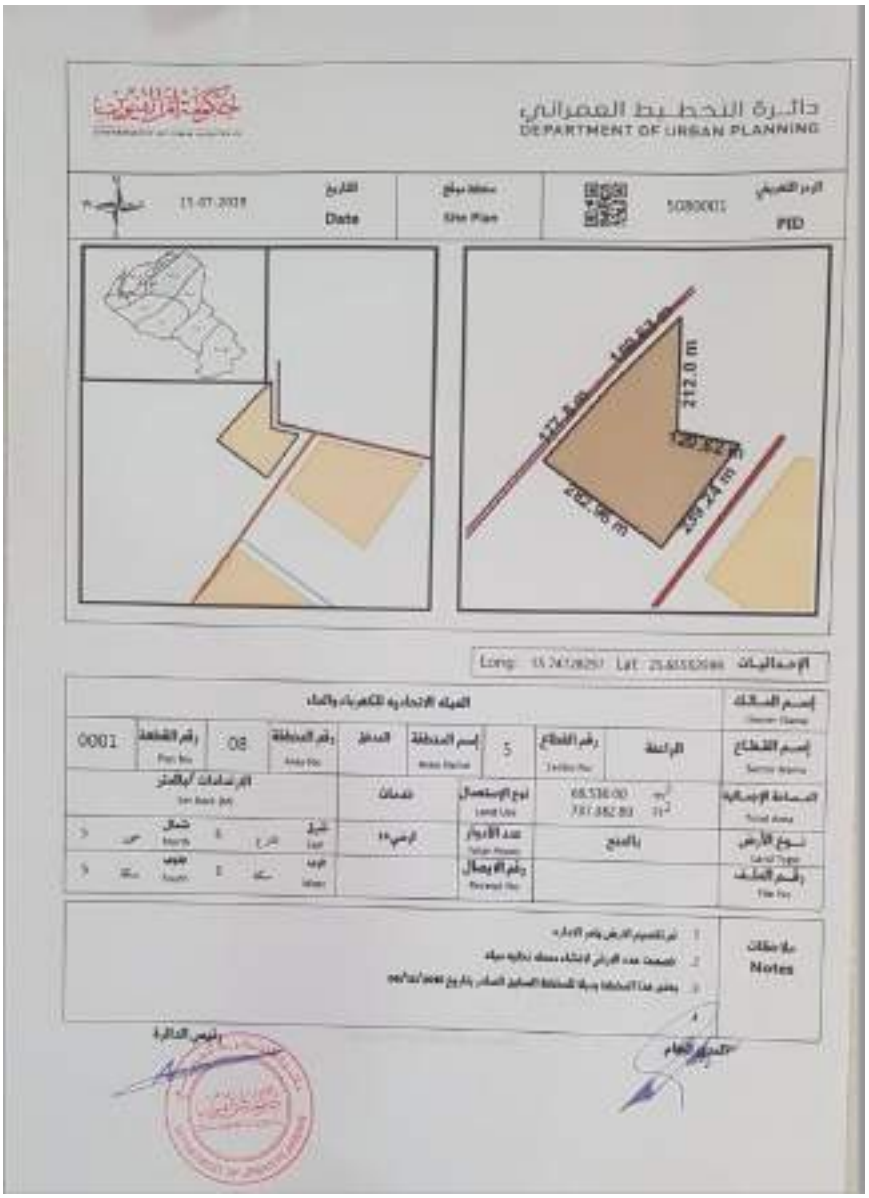

Outfall End
Outfall start
Intake
Project Site-1
Project Site-2

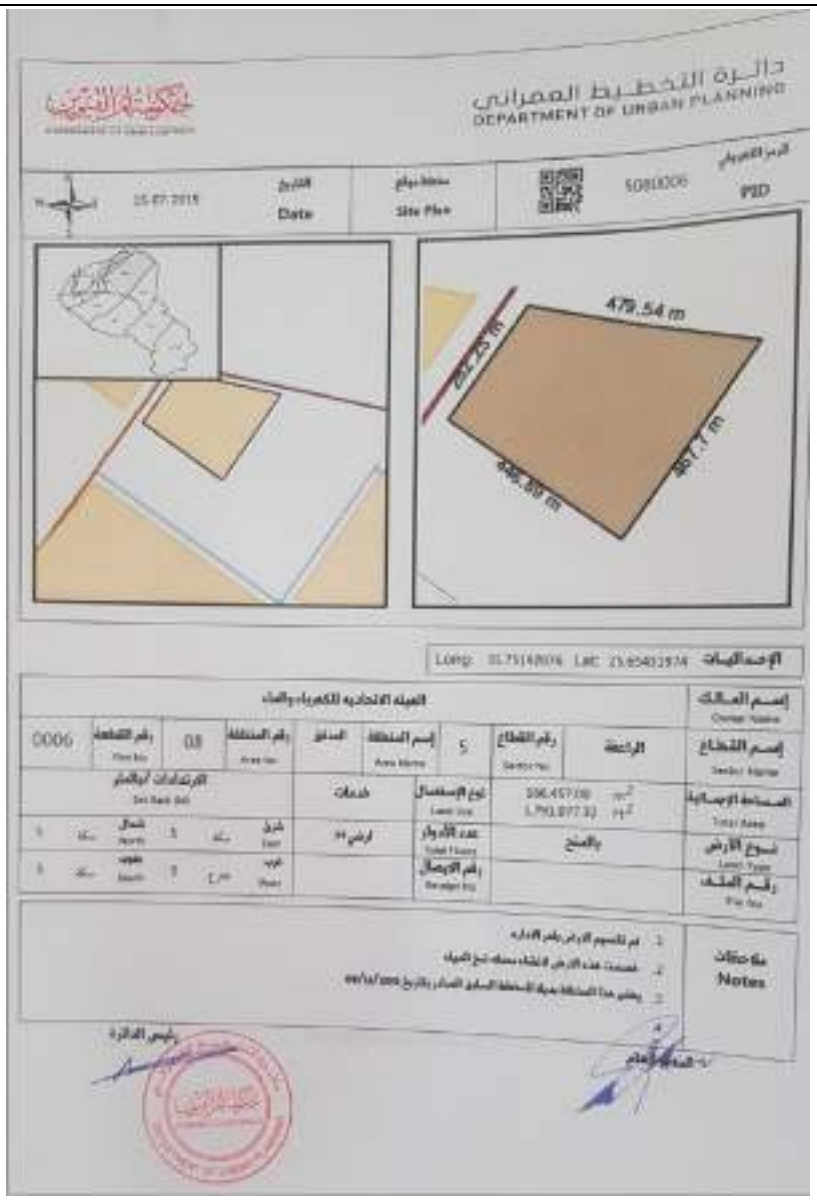
4.2 Land Use and Land Condition

4.2.1 Land Ownership

The land ownership for the proposed project site will be governed by a Land Lease Agreement (LLA) which will set the terms of use and enjoyment of the site. The land ownership has been transferred by the Emir of Umm Al Quwain to FEWA which allows FEWA to grant lease over the site to the Project Company. The LLA will initially be set at 28 years covering the 25 years Water Purchase Agreement (WPA) after which the Project Company will be required to return the site to FEWA at the end of this term.

Figure 4-2 Project Affection Plan for Site 1 & 2 Respectively





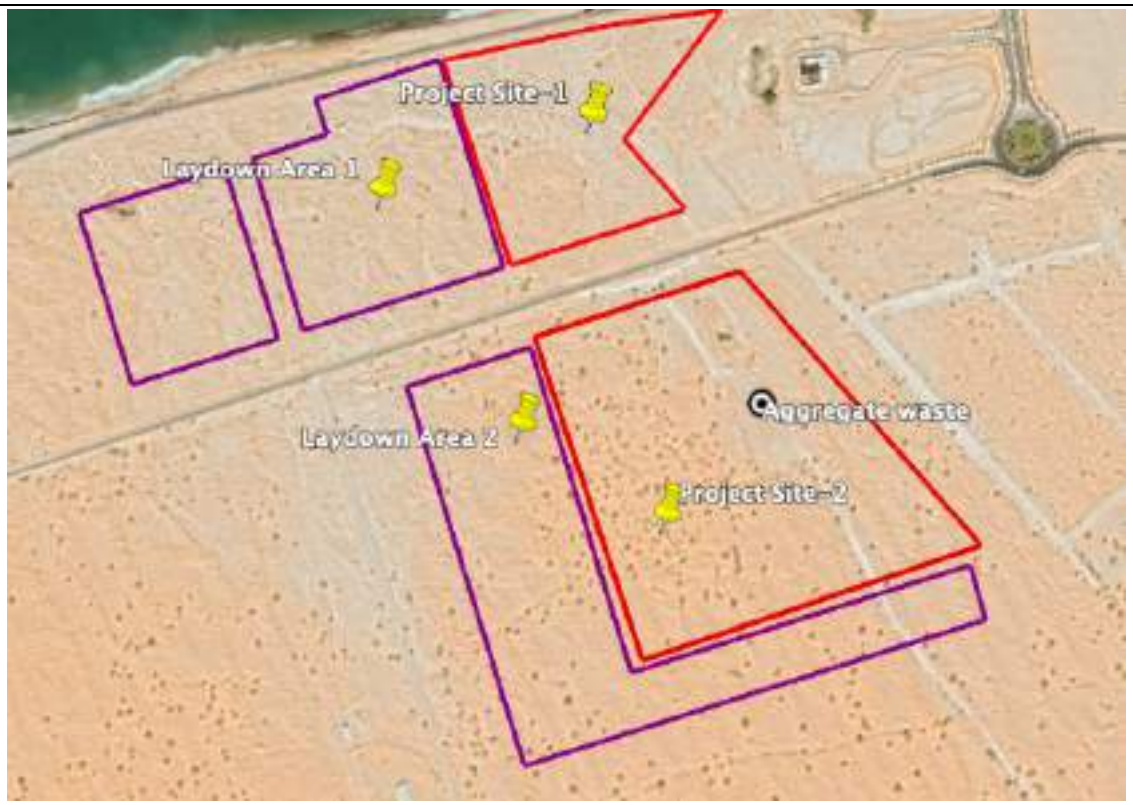
4.2.2 Land Use

The proposed project site (1 & 2) is undeveloped and there is no evidence of any historical use apart from a small section of project site 2 which have been used as an undesignated dumping ground for construction and general waste. The aggregate waste disposed on the project site 2 can be traced back using the Google Maps time series to 2011. Project site 1 & 2 have an undulating topography with scattered vegetation and shrubs amongst the sandy soils. During site visits, it was observed that majority of the vegetation on project site 2 has been eaten back by camels from the camel holding area which is 128m south of the project site.

Plates 4-1 View of the Proposed Project Site 1

Plates 4-2 View of the Proposed Project Site 2

Figure 4-3 Time Series of Aggregate Waste dumped at the Project Site 2 (2011, 2013 & 2016 respectively)



Plates 4-3 Illegal dumping of Waste at Project Site 2 (2019)

A pond of water was observed at project site 2, which is believed to be groundwater since the groundwater levels in the area is known to range between 1 to 4 m. Pipes were also observed nearby which may be used to draw water from the pond.

Plates 4-4 Pond water at Project Site 2

Plates 4-5 View of the Coastal Project Area (Marjan Development to the north of site)

During the site visit, evidence of vehicle tracks were identified on and off the project site 1 used by vehicles connecting to the E11 highway located at the eastern and western extents of the project site 1.

Plates 4-6 Vehicle Tracks Connecting E11 to the Eastern and Western Extents of the Project Site 1 (on and off the site)

During the site reconnaissance, occasional animal droppings were observed which were identified as camel waste based on the hoof prints on the sand. There was also evidence of fire pits and scattered general waste such as bottles and plastic bags at both the project sites 1 & 2 and on the proposed laydown areas.

Plates 4-7 Fire Pit and Camel waste observed during the site visit (project site 1)

A wastewater treatment plant was also identified approximately 106m north east of the proposed project site 1. At the time of the initial site visit a wind mast and a boundary marker between Umm Al Quwain and Ras Al-Khaimah were also identified close to the project site 1 boundary, but off-site as shown in the photos below.

Plates 4-8 Wastewater Treatment Plant, wind mast and boundary marker off site (north of project site 1)


Subsequent site visits also revealed that there is a wind mast north of the project site 2 and a boundary marker that is approximately 175 m north east of project site 2. Power transmission lines belonging to FEWA were also observed parallel to the north bound E11 carriageway west of project site 2 but offsite. In addition, the Ras Al Khaimah industrial area is partially visible in the distance from project site 2 to the north and north east as shown in the images below.

Plates 4-9 Wind mast, boundary marker and Ras Al Khaimah industrial area, electricity power lines off site (project site 2)



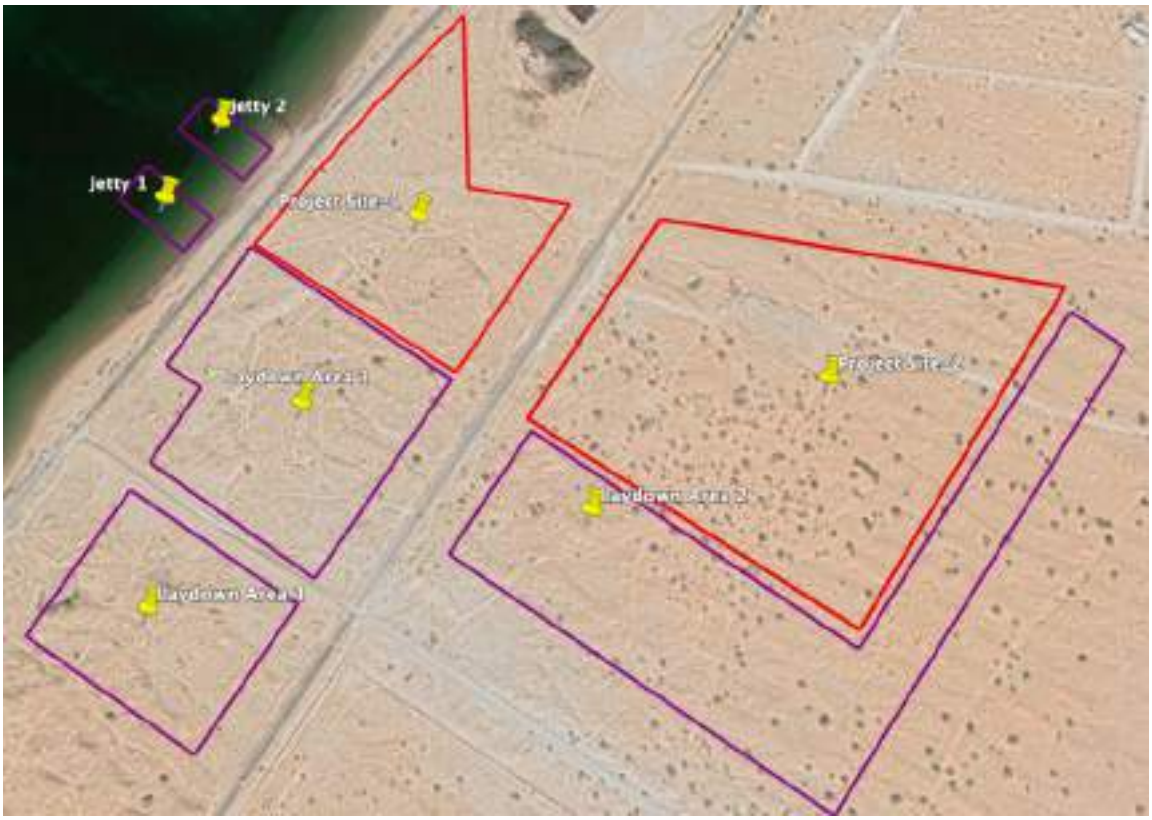

The coastal zone of the project is characterized by a gently sloping sandy beach from the E11 highway which is built on made ground above the high tide level and includes some boulders with dune vegetation that has remained on the highest point of the beach. During the site visit, there was evidence of an isolated man-made rock armour which is presumed to protect a drainage system though this has not been officially confirmed. There was no evidence of human activity on the beach apart from human and dog footprints. However, the Umm Al Quwain Municipality has put up a sign board which prohibits swimming and fishing in this area.

Plates 4-10 The Coastal Zone of the Proposed Project Site

Laydown Areas

There will be two construction laydown areas located to the south of the project site 1 & 2 and a narrow section east of project site 2. The proposed laydown areas will be located in undeveloped land with no evidence of any historical use apart from a pit located west of laydown area 2 with an elevation of -1m compared to surrounding dunes which have an elevation of 6m. The topography of the laydown area is similar to that of the project sites 1 & 2 with undulating topography, scattered vegetating and shrubs amongst the sandy soils. Similar to project site 2, majority of vegetation on laydown area 2 has been eaten back by camels from the camel holding area. In addition, there will be two temporary jetties located along the project shoreline as shown in the figure below.

Figure 4-4 Location of the laydown areas



Plates 4-11 View of the Laydown Area 1

Plates 4-12 View of the Pit in Laydown Area 1

Plates 4-13 View of the Laydown Area 2

Plates 4-14 Camel Holding Area South of Laydown Area 2 (offsite)

Plates 4-15 A Camel Grazing near Laydown Area 2

During the visit to the project site laydown areas, a semi-tarmacked road connecting the south bound E11 highway to the north bound carriageway was observed to cut through the laydown area 1. In addition, an untarmacked road was also observed south of laydown area 2 connecting the north bound E11 carriageway to a Construction & Demolition Waste Plant and a Waste Water Treatment Plant (UAQ) 3.3 km east of laydown area 2 as shown below. During the site visit, approximately 50 trucks and waste water tankers were observed using these roads to and from the waste plants. These vehicles were being driven at speeds of approximately 20kph which generated clouds of dust.

Plates 4-16 Murram (gravel) roads south of the laydown areas 1 & 2 respectively

4.3 Sensitive Receptors

Satellite imagery and site visits undertaken at the project sites one (1) & two (2) and the laydown areas 1 and 2 identified commercial, residential and industrial receptors external to the SWRO project within a 5 km radius to the project sites.

The closest residential receptor is located approximately 780 m south east and an agricultural receptor at 128 m south of the laydown area 2 while the closest commercial and industrial receptors are located approximately 430 m north (RAK Tourism Development Authority), 106 m north east (wastewater treatment plant) respectively from the project site one (1) boundary.

Even though the satellite imagery showed that there are recreational receptors along the beach close to the project site (fishing point, camping site, barbeque beach and open beach) site visits observed that UAQ Municipality has put up sign boards which prohibit swimming and fishing in this area. In addition, consultation meetings were held with UAQ PHED regarding human activity along the project beach on 20th June 2019 and they confirmed that camping, fishing and swimming is prohibited in this area. As a result, any human activity along the beach close to the project site is a violation against the existing municipality regulations and hence these receptors have not been considered in this ESIA.

Plates 4-17 Prohibition of Fishing, Swimming and Camping on the beach near the project site

The figure and table below show the receptors within a 5 km radius from project site 1 & 2. The proximity of the receptors to the project site has been determined by measuring the distance between the closest project site boundary (1 or 2), and laydown areas (1 & 2) to the receptor.

Figure 4-5 Potential Local Receptors Within 5km Radius of the Project Site

Table 4-1 Potential Local Receptors

Receptor	Receptor Type	Distance from the Project Site
Waldorf Astoria Ras Al Khaimah (RAK)	Commercial	Approximately 4 km north east of the project site 1
Al Hamra Village Townhouses (RAK)	Residential	Approximately 3.9 km north east of the project site 1
Smartline Bin Majid Beach Resort (RAK)	Commercial	Approximately 1.6 km north west of the project site 2
Ras Al Khaimah Industrial Zone (RAK)	Industrial	Approximately 1.2 km north east of the project site 2
Park Inn by Radisson Resort Ras Al Khaimah (RAK)	Commercial	Approximately 2.5 km north of the project site 1
Rakystay Marjan Island (RAK)	Commercial	Approximately 2.8 north west of the project site 1
Pacific Development (RAK)	Commercial	Approximately 3.6 km north west of the project site 1
DIC Hotel Resort Project (RAK)	Commercial	Approximately 4km north west of the project site 1
Double Tree by Hilton Resort and SPA (RAK)	Commercial	Approximately 1.4 km north west of the project site 1
Ras Al Khaimah Convention Centre (RAK)	Commercial	Approximately 1.4 km north west of the project site 1
Brasserie (RAK)	Commercial	Approximately 1.2 km north west of the project site 1
Ras Al Khaimah Tourism Development Authority (RAK)	Commercial	Approximately 431 m north of the project site 1
Rixos Bab Al Bahr Resort (RAK)	Commercial	Approximately 475.9 m north west of the project site 1
Wastewater Treatment Plant (RAK)	Industrial	Approximately 106.3 m north east of the project site 1
Al Sinniyah Island (north) (UAQ)	Commercial/Recreational	Approximately 2.4 km south west of laydown area 1
Commercial Compounds 1 (UAQ)	Commercial	Approximately 1.2 km south west of laydown area 1.
Commercial Compound 2 (RAK)	Commercial	Approximately 474 m north east of the project site 2
Commercial Compound 3 (UAQ)	Commercial	Approximately 3.5 km south west of laydown area 1
Commercial Compounds 4 (RAK)	Commercial	Approximately 2.4 km south east of laydown area 1
Residential Compounds 1 (UAQ)	Residential	Approximately 2 km south east of laydown area 1
Residential Compound 2 (RAK)	Residential	Approximately 2.1 km north west of the project site 2
Residential Compound 3 (UAQ)	Residential	Approximately 3.4 km south west of laydown area 1

Receptor	Receptor Type	Distance from the Project Site
Residential Compound 4 (UAQ)	Residential	Approximately 779 m south east of laydown area 2
Residential Compound 5 (UAQ)	Residential	Approximately 5 km south west of the laydown area 1
Residential Compound 6 (UAQ)	Residential	Approximately 3.9 km south west of laydown area 1
Residential Compound 7 (UAQ)	Residential	Approximately 2.7 km south east of laydown area 2
Rocky Intertidal Habitat (UAQ)	Ecological	Approximately 45 m west of the project site 1
Camel Holding Area (UAQ)	Agricultural	Approximately 128 m south of laydown area 2
Construction & Demolition Waste Plant / Waste water Treatment Plant (UAQ)	Industrial	Approximately 3.3 km east of laydown area 2

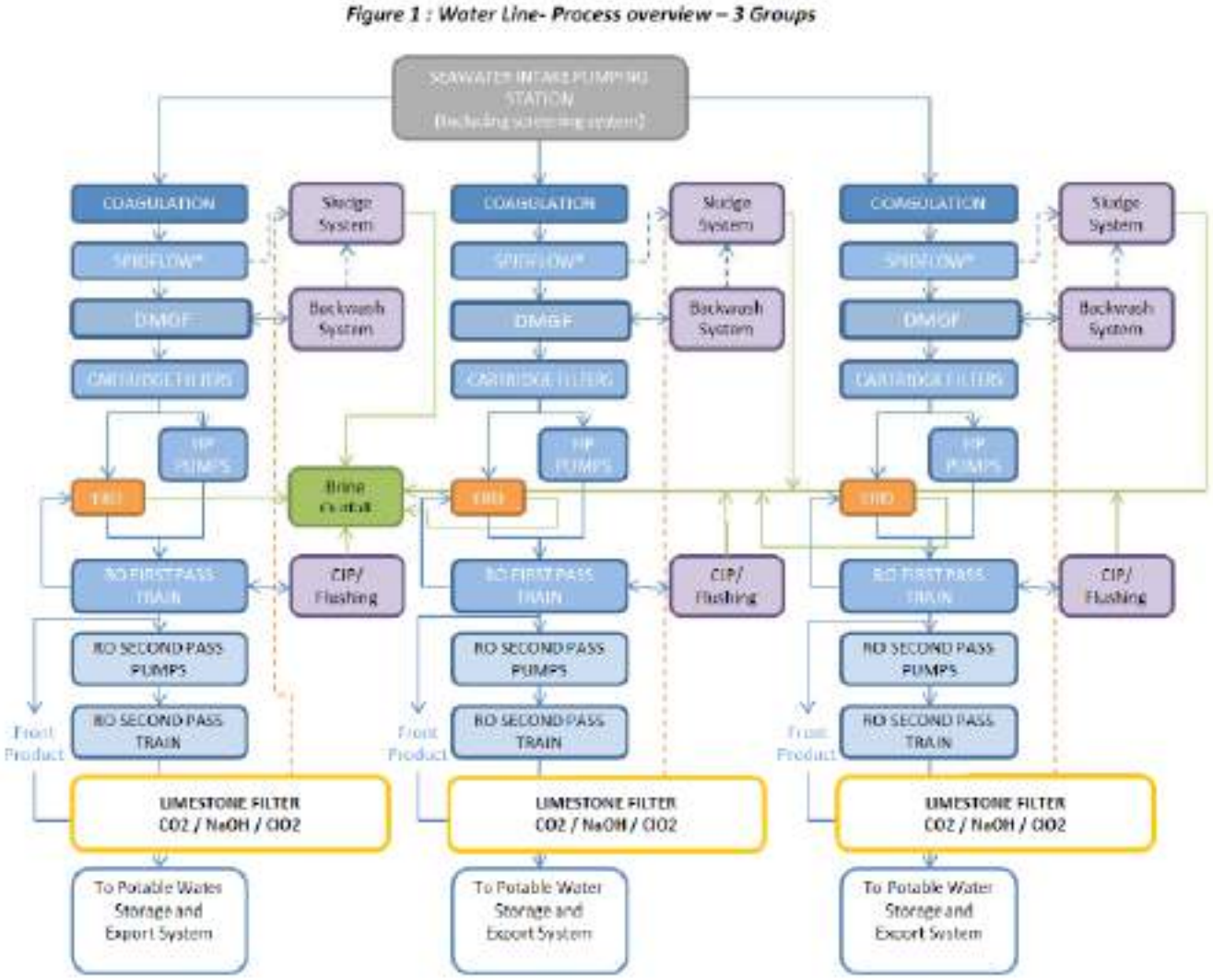
4.4 Project Description

The SWRO desalination plan will consist of the following main stages:

- Seawater intake installations including screening system;
- Pre-treatment: coagulation, floatation and filtration;
- Cartridge filters;
- RO system: 2 pass of reverse osmosis with partial permeate split;
- Flushing/CIP and neutralization system;
- Post-treatment: Limestone filters system with partial carbon dioxide and chloride dioxide injection;
- Sludge thickening systems;
- Sludge dewatering systems; and
- Export system.

A brief description of each of the following components is provided below.

Figure 4-6 SWRO Implementation Phases



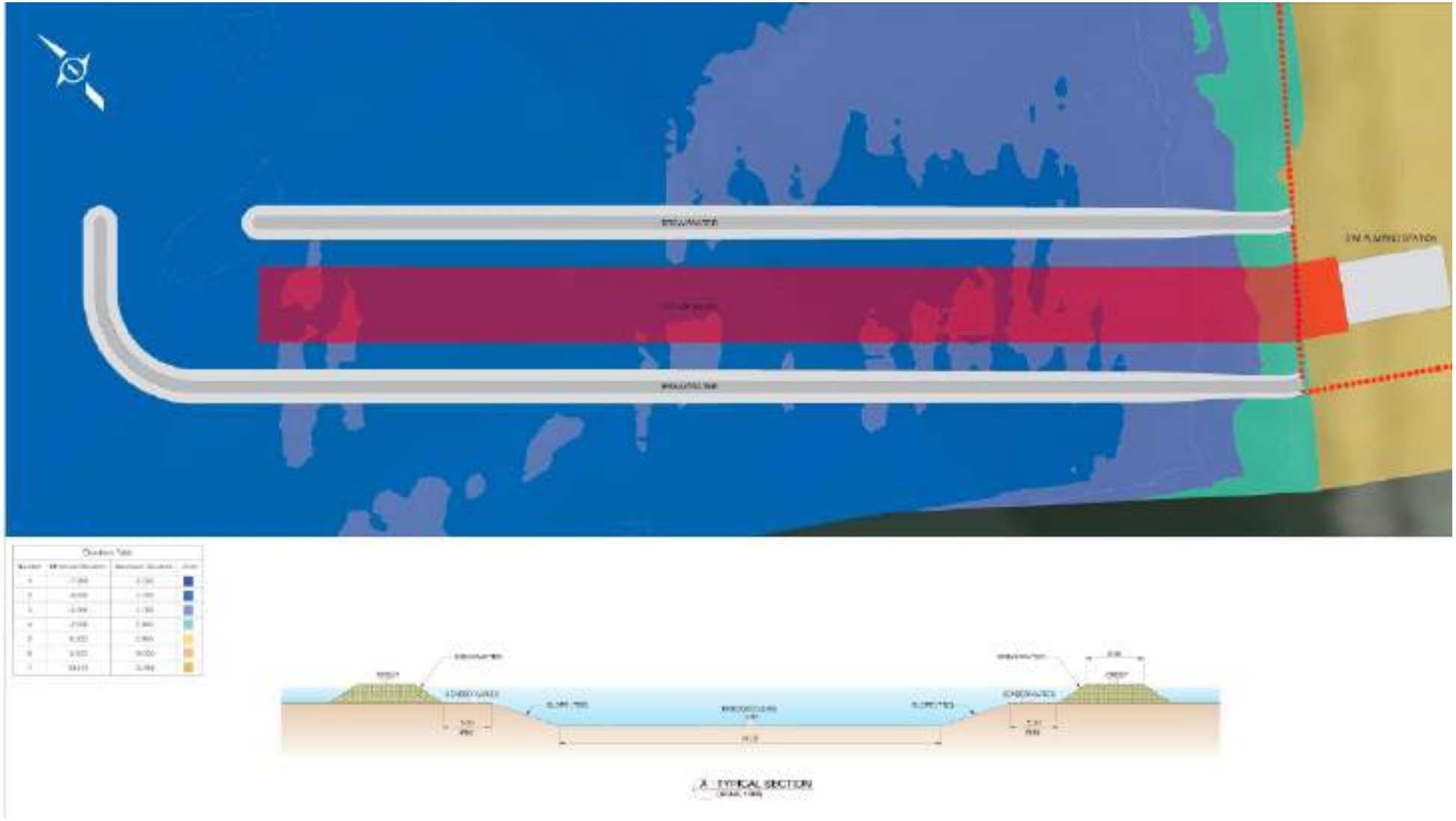
4.4.1 Seawater System

Intake System

The project will include a pipeline intake or an open channel intake. The intake will be located around 600m from the shoreline. According to the bathymetric surveys, the bed elevation 600 m offshore results in a minimum water depth of approximately 4 m.

The open channel intake will comprise of breakwaters as shown in the figures below. The intake velocity as per the project design specifications will be 0.15 m/s (as per IFC Guideline) up to a maximum of 0.2 m/s (ACWA Power 2019).

Figure 4-7 Open intake and breakwaters layout (ACWA Power & HR Wallingford)




OUTFALL
DIFFUSERS

Pumping Station

The pump stations will comprise 3 pumps in duty and 1 pump in stand-by. The screens and seawater pumps will be designed to allow particular pipes and associated pumps to be operated independently from each other. In addition, the seawater pumps will be designed to accommodate required flow, while operating on a 3 × 33% basis.

A screening system, capable of screening solids (e.g. floating matter, algae, mussels, fish or jellyfish) down to at least 5 mm in size will be provided. The bar screens and travelling band screens, drum screens or high-performance debris filters (as applicable) will be of seawater resistant material with an automatic cleaning system.

Table 4-2 Intake Pumps

Intake Pumps	Unit	Values
Number of pumps	U	3+1
Type	-	Vertical pump
Approx. flow rate per pump	m^3/h	25 667
Approx. Design head	mWC	20
VSD	Y/N	Partial 2 out of 4 (minimum flow line provided)

Shock Chlorination

Seawater will be shock chlorinated with hypochlorite solution on the intake basin upstream the screens, to control biological growth within the intake and pre-treatment pipes and structures. The chlorine dosing rates as well as dosing frequency will be defined to ensure a minimum residual chlorine concentration of 0.2 ppm.

Outfall System

The end of the outfall will be located 3600 m from the shoreline where the water depths are approximately 6 m. The outfall consists of a 1500 m long diffuser, with 40 single-port risers equally spaced along the pipe. The end point of the 1,500 m diffuser section will be located 3.6 km offshore (with the first, shoreward, port discharges starting at 2.1 km offshore). Port diameters will be 0.4 m at approximately 1 m above the seabed with exit velocities of approximately 2.6 m/s. The ports will make an angle of 30° with the seabed, and the port on each riser will be oriented normal to the diffuser pipe axis with neighbouring risers discharging in opposite directions.

4.4.2 Pre-treatment Process

Dissolved Air Floatation (DAF)-SPIDFLOW®

The SPIDFLOW® technology will successfully protect the plant from algal blooms, hydrocarbon contamination and high solids concentrations in the incoming raw seawater.

The technical advantage of Spidflow® include:

- The floatation step will allow the plant to successfully deals with raw water quality upsets such as turbidity peaks, algal blooms, or hydrocarbon contamination. It will provide long-term reliability to the plant performance, ensuring full production capacity at all times regardless of the evolution of algal bloom frequency over the next 30 years. On a more regular basis, the floatation system will absorb incoming suspended solids peaks, feeding the subsequent filtration step with consistent water quality. This will allow the filtration step to always operate at the best efficiency point.
- The floatation step also minimizes pre-treatment water losses and thus reduces the water to be withdrawn from the ocean. The floated sludge extraction system included in the design achieves a minimum solids concentration of 15 g/L, as opposed to 0.3 g/L in typical DMF backwash water. Therefore, this decreases the volume of water loss in the pretreatment to evacuate incoming raw water suspended solids by a factor of 50 and allows decreasing drastically the number of equipment dedicated to sludge treatment. Indeed, no thickeners dedicated to DAF sludge are necessary.

Coagulation and Flocculation

Ferric Chloride will be used as a coagulant in order to stabilise the natural particles causing turbidity. The Ferric Chloride will be mixed such that the coefficient of variation (CoV) is <0.05 at a distance no greater than three pipe diameters downstream of the rapid mixing device.

Flocculation tanks will generally comprise 2 or 3 separate stages utilizing mechanical agitation (utilizing variable speed motor drives), ensuring that subsequent shear forces within the 2nd and 3rd stage flocculation stages will not exceed the intensity of agitation within the upstream flocculation stage.

Figure 4-8 Example of Cartridge Filters

4.4.3 Reverse Osmosis System

The main components of the RO system will include the following:

- High pressure pumps;
- Energy recovery devices;
- Energy recovery booster pumps;
- Two pass RO trains with a partial 2nd pass;
- Cleaning in place System; and
- Flushing system.

Full and complete interchangeability of RO membranes between a minimum of three RO membrane suppliers will be provided. This interchangeability will ensure that the required permeate flows and quality can be achieved under the range of seawater temperatures and salinity conditions prevalent when utilising RO membranes from a minimum of three different RO membrane suppliers.

A minimum straight pipe length of 5 times the pipe diameter will be provided feeding the suction of RO high pressure feed pumps. The number of pressure vessels and membranes has been selected in order to limit the flux:

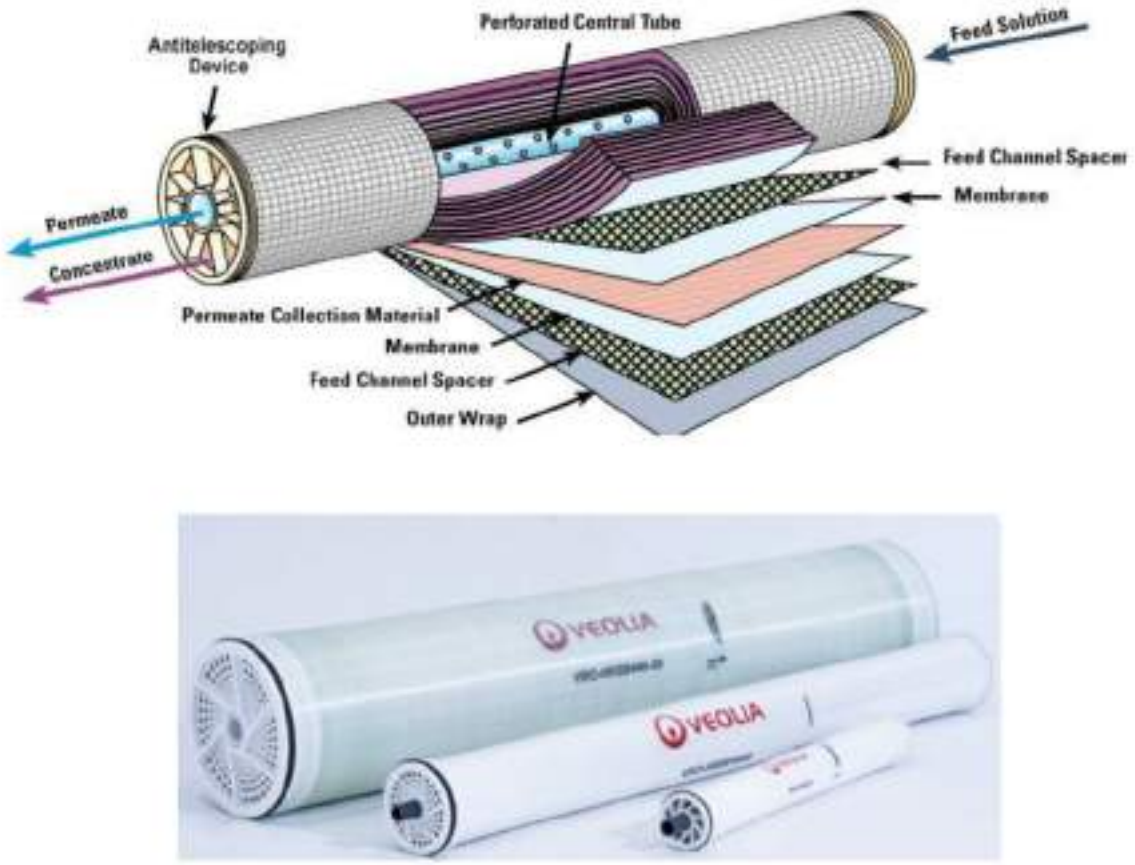
- 13.5 lmh on the first pass RO.
- 35 lmh on the second pass RO.

The first RO system will consist of 24 separate trains (8 per group) with one stage and the trains are designed to operate at a recovery yield of 41% and include:

- One high pressure pump;
- One steel rack arranged with pressure vessels, headers for feed water, brine and permeate; and
- One energy recovery unit of the isobaric type with its recirculation pump.

The pressure feed water is distributed to the individual pressure vessels by multiport pressure vessels arranged on the skid. There will be approximately 380 pressure vessels installed per skid, plus 20% spare space for installation of additional vessels if required. Each pressure vessel can contain 7 spiral wound membrane modules, which are mechanically interchangeable.

Figure 4-9 Example of Spiral Would Membrane



Rear permeate from the first RO skids will flow directly towards the second pass skids. Antiscalants and sodium hydroxide will be injected in the 2nd RO feed header if required to achieve the boron target (<2.4 mg/L in mineralized water).

The 2nd Pass RO system will consist of a two stage RO design where concentrate from the first stage is the feed to the second stage and comprises 12 trains in duty. The two stages will be designed to operate at an overall recovery yield of approximately 90 % and include:

- One booster pump.
- One steel rack arranged with pressure vessels, headers for feed water, brine and permeate.

Energy Recovery Device

To optimize the plant energy consumption, the first RO will include an efficient energy recovery system (ERD). An ERD system (isobaric device) will be installed for each SWRO train. The features of the design include:

- Increase in plant availability and reliability. Each ERD system will be equipped with an ERD booster pump connected to the feed line, each equipped with a variable frequency drive that provides full control over the recovery in the system.

- High operational efficiency (>95%) of the ERD results in low energy consumption.

4.4.4 Flushing/CIP and Neutralization System

Cleaning

Periodic chemical cleaning will be conducted to recover permeate flow rate and permeate quality. A chemical clean in place (CIP) will be conducted on a regular basis to remove any fouling and deposits accumulated on the membrane's surface, thus restoring permeability. The CIP system will be designed for a cleaning flow rate of approximately 8.1 m^3/h per pressure vessel.

Figure 4-10 Cleaning Procedure

Chemical	Dose as 100%	Frequency
Citric acid	10 g/l	2 time per year per train
Caustic soda	1 g/l	3 times per year per train
Biocide	25 mg/l	3 times per year per train

Flushing

Flushing of RO trains will be initiated after the CIP procedure is complete. The flushing system will be designed for flow rate of approximately 4 m^3/h per pressure vessel for 1st Pass and 2nd Pass, both during approximately 5 to 6 minutes, the duration required to completely turn over the volume of the seawater in the RO Skid.

4.4.5 Post-Treatment

This stage will include:

- Remineralization (carbon dioxide and limestone filters).
- Wash water recovery system.
- Final disinfection

The remineralization system will be done with CO_2 and limestone filters designed to achieve a total hardness of 40 gm/L as $CaCO_3$ and a pH value below around 8.5. 50% of the total permeate production will be treated with CO_2 before being introduced in the limestone filters, with water flowing from bottom to top. Excess CO_2 will be removed in counter-flow air/water degasser.

The 50% remaining total permeate will by-pass the limestone filters. This water will be treated with caustic soda and mixed with the degasified stream before feeding the potable water tanks.

Limestone filters water will be sent to the wash water recovery system to be treated and recycled into the main water production stream. During the backwash, injections of Polymer and Ferric Chloride will be operated on the water obtained from the limestone filter system.

The final disinfection will be carried out before the plant outlet by injection of chlorine dioxide prepared with a mixture of hydrochloric acid (HCl) and sodium chlorite ($NaClO_2$).

4.4.6 Product Water Export

Prior to being sent to the potable water tanks and export system, the product water quality will be continuously monitored for the parameters:

- Potable water flowrate;
- Free chlorine;
- pH;
- Conductivity/temperature;
- Turbidity;
- Hardness; and
- Alkalinity.

4.4.7 Sludge Treatment

Sludge treatment facilities will be provided to treat the DAF sludge, DMGF backwash water and wash water from limestone filters, in order to be compliant with the discharge regulations. The sludge treatment system will be designed to minimise the quantity of solid discharge and comply with applicable regulations.

Two systems will be provided one for the pre-treatment and one for the post treatment.

Pre-treatment will include:

- 3 backwash wastewater tank(s)- dependent on the detailed design.
- 6+2 sludge thickeners;
- 1 sludge storage tank; and
- 1+1 centrifuges for sludge dewatering.

Post-treatment will include:

- 1 wash water tank-depending on the detailed design;
- 2+1 sludge thickeners;
- 1 sludge storage tanks; and
- 1+1 centrifuges for sludge dewatering.

4.4.8 Chemical Dosing and Storage System

The location of the chemical dosing and storage facilities will centralise chemical unloading from trucks and minimize pipework distance between storage tanks and the injection points for each group.

The proposed design will be driven by the following key principles:

- 2x50% storage tanks. Storage tank volume for chemicals delivered in liquid form will be designed for 27 days at average chemical consumption.
- Bags and big bags equivalent to 14 days consumption at average dosing will be stored on site for chemical supplied in solid powder form, when the dosing is required continuously.
- At least one stand-by pump is provided for each dosing unit of chemicals.

4.4.9 Utilities

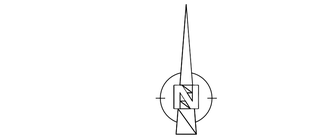
The project utilities will include:

- Process service water: Process service for the plant will be supplied by a pressure booster system with multiple pump sets and a pressure accumulator. The water will be sourced from the permeate water tank. Process service water will be conveyed around the site via a process service water reticulation system to service:
  - Washdown hoses.
  - Process requirements where process service water is required (i.e. chemical dilution if necessary).
- Firefighting system: A system with a fire water ring main with hydrants and fire water sprinkler will be installed around the site. The fire water main will be supplied by firefighting pumps (one electric and one diesel jockey pump) connected t the permeate water tank. The system will comply with the codes of the NFPA and will include all necessary fire alarm and detection systems to ensure a high level of fire protection in all areas of the plant.
- Compressed air system: Compressed air for pneumatic valves will be supplied by a set of air compressors (1 duty/ 1 stand by) per group.
  - Dryers (1 duty/ 1 stand by) will be supplied to reach a suitable dew point for valves.
  - Compressed air will be conveyed around the building in an air compressed reticulation system.

Figure 4-11 Overall Project Layout

1. Coordinates are according to UTM coordinate system.
2. Official Coordinates yet to be identified and demarcated jointly by WAE-EP, Municipality, FEWA & Topographic subcontractor.
3. The coast area shall foresee shore protection system as required.

LEGEND:



LEGEND

	FENCE
	ROAD
	CABLE TRENCH

ZONE	DESCRIPTION
AZZ	INTAKE SYSTEM
ACZ	INTAKE CHEMICALS GENERAL
DZZ	DAF GENERAL
EAZ	ELECTRICAL BUILDING
FKZ	DMGF
FBZ	BACKWASH SYSTEM GENERAL
FWZ	WASTEWATER SYSTEM GENERAL
FZZ	CARTRIDGE FILTERS SYSTEM
GAZ	ADMINISTRATION BUILDING
GGZ	GATE HOUSES
GPZ	CAR PARK
GWZ	WORKSHOP & WAREHOUSE
PLZ1	LIMESTONE FILTERS
PLZ2	LIMESTONE FILTERS AUXILIARIES
PAZ	STORAGE LIMESTONE FILTERS
PFZ	CO2 SYSTEM
PGZ	PLANT CO2 SYSTEM
RZZ	RO GENERAL
RBZ	RO FLUSHING-CIP-NEUTRALISATION SYSTEMS
RCZ	RO CIP / NEUTRALISATION CHEMICALS SYSTEMS GENERAL
STZ	SLUDGE THICKENING SYSTEM
SZZ	SLUDGE TREATMENT GENERAL
WKZ	POTABLE WATER TANKS
WPZ	POTABLE WATER PUMPING STATION
WVZ	SURGE SYSTEM
FPS	FIRE PUMP STATION
SWC	STORM WATER COLLEXTION PIT
SWT	SEWAGE WASTEWATER TREATMENT
ACR	AIR COMPRESSOR ROOM
EDGB	EMERGENCY DIESEL GENERATOR BUILDING
GIS	132 kV GIS
FG	FIRE GARAGE
LB	LABORATORY BUILDING

NORTH GRID
PLANT NORTH
36°

(ETIHAD ROAD)

N=374345
E=2838336

N=374568
E=2838074

POTABLE WATER INTERFACE

132kV cable channel

POWER INTERFACE

N=374463
E=2838099

MAIN ENTRANCE

N=374345
E=2838124

N=374237
E=2838234

N=374209
E=2838200

SECOND ENTRANCE

N=374111
E=2838090

INTAKE PIPE
OUTFALL PIPE
OVERFLOW PIPE

N=374345
E=2838336

N=374340
E=2837929

N=374323
E=2837905

100.0

HOLD ON

SWC FG ACR SZZ STZ EDGB EAZ GGZ DZZ FKZ FBZ FZZ ACZ AZZ GIS GWZ SWT LB GAZ GPZ PGZ PFZ WVZ WPZ WKE RZZ RBZ FPS PLZ1 PLZ2 PAZ

CERTIFICATE OF OFFICIAL EXPLORATION A133007169 B133007169 E107200000

SIZE A0

CHINA ENERGY ENGINEERING GROUP ZHEJIANG ELECTRIC POWER DESGIN INSTITUTE CO., LTD.

中国葛洲坝集团国际工程有限公司 CHINA GEZHOUBA GROUP INTERNATIONAL ENGINEERING CO.,LTD.

TITLE: GENERAL PLAN OF SWRO DESALINATION PLANT

APP'D BY		DSN'D BY			
REV'D BY		SCALE			
CHK'D BY		DATE	2019.04.12	DWG NO	Z-01

REV 0

4.5 Associated Facilities

4.5.1 Electrical System

The SWRO power supply will be supplied from FEWA's substations. The 132KV switchgear will be designed as the main station for FEWA network and it will be used for future interconnections to 132 Kv as well as 400 kV network. The power will be received from four (4) 132KVcable feeders (each of 100% rated power capacity) from FEWA's substations. In addition, there will be two (2) spare feeders (with switchgear) and two (2) reserved feeders as per FEWA's requirements.

FEWA will supply, install, connect, construct, test and commission the power supply 132kV cables (including cable termination of remote FEWA substations) and the EPC Contractor will construct the cable termination at the desalination plant 123kV-end breaker & the 132kV switchgear. In addition, the EPC Contractor will design, procure, install, construct, test and commission the 132kV switchgear as per FEWA specifications.

4.5.2 Potable Water Tanks

During operation, there will be five (5) potable water storage tanks located to the south east of the project site 2. The specifications of the tanks are as follows:

- Total capacity of the 5 tanks:136,400 m^3
- Diameter: 90 m
- Height: 22.12 m

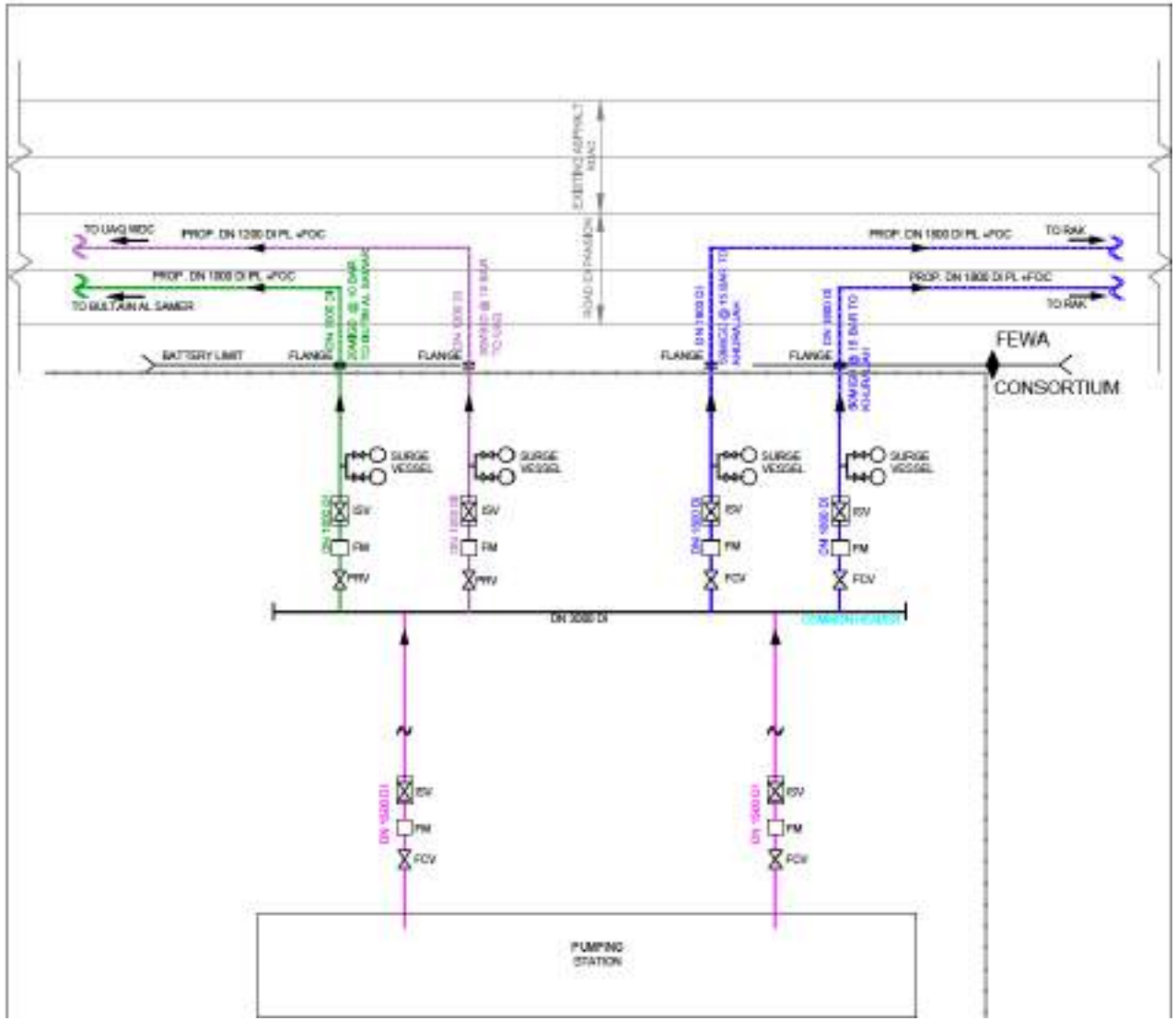
4.5.3 Export of Potable Water

The export of potable water outside of the project site will be the responsibility of FEWA. There will be four (4) potable water pipelines with two (2) connecting to storage tanks located in the Emirate of Ras Al Khaimah, one (1) connecting to Bultan Al Samar distribution network and the other connecting to Umm Al Quwain water distribution center. The distribution of potable water to these three networks will be as follows:

- 50 MIGD at 15 bar to Khuraijah (Ras Al Khaimah);
- 50 MIGD at 15 bar to Khuraijah (Ras Al Khaimah);
- 20 MIGD at 10 bar to Butin Al Samar; and
- 30 MIGD at 10 bar to Umm Al Quwain.

This is as shown in the figure below.

Figure 4-12 Export of Potable Water from the Project Site



4.5.4 Pipeline Works

The pipeline works will include but not limited to the following;

- Supply installation of GRP pipeline from permeate/flushing tank to storage water tank;
- Right of way construction;
- Pipeline crossing protection for powerline, road;
- Protection of pipeline; and
- Pipping support.

4.5.5 Access Roads

The proposed project sites will be accessed from the E11 highway which is along a north/south route. However, the Project Contractor will be required to construct access roads into and within the site. The roads will be designed of sufficient width and load as well as with regard to the frequency of traffic (such as heavy load transportation).

The access roads to the plant area will be an asphalt road with a width of 10 m (3.5 m of each lane) and 1.5 m for the verge of each side. It will have a lateral slope of 2% on both sides, in order to ensure water drainage.

4.5.6 Sewage Drainage, Storm Water and Other Waste Water Drainage Systems

Sewage wastewater will be treated by means of biological contact oxidation process and water obtained from the treatment process will be filtered to meet the relevant standards. Sewage wastewater treatment station will consist of regulating basin, sewage wastewater treatment equipment, clean water tank, supply device, disinfecting device and control cabinet.

Rainwater in the plant will be collected by rainwater pipeline through roadside rainwater drop inlets, then flow by gravity along the pipeline to the rainwater pump station. Storm water will be stored in the storm water collection pit and will be discharged according to local regulations.

4.6 Project Construction Requirements

4.6.1 Construction Facilities

Temporary Construction Facilities

The proposed two laydown areas will be located south of project site 1 & 2 with an additional strip east of project site 2 (Appendix C). However, this is subject to the approval of FEWA who is the Project Proponent. The laydown area is expected to include temporary construction facilities required to enable works (materials storage, staging areas etc), as well as construction administration facilities.

Manpower Requirements

It is estimated that there will be approximately 80 management staff members and 1200 workers during construction phase peak time. The workers will be housed in existing labour camps within a 10km radius from the project site.

Vehicles, Equipment and Heavy Machinery Requirements

During the construction phase of the project the Contractor/ sub-contractors will use different kinds of vehicles, equipment and heavy machinery. The specific details of equipment to be used on site during the construction phase of the project is provided under Section 8.4.1 of this ESIA.

Chemical and Hazardous Materials Storage

Storage of chemicals and hazardous materials during the construction phase of the project will be undertaken by relevant Contractors/sub-contractors. The requirements for the storage of such materials will be set out in the site-specific Construction Environmental and Social Management Plan (CESMP) by the EPC Contractor together with specific procedures for storage required for implementation by the relevant sub-contractors.

Worker Accommodation and Facilities

The workers accommodation facilities will be located off the project site at established labour camps in the project area within a 10km radius from the project site. The worker accommodation will be according to the standards specified by the Project Company and with relevant worker accommodation regulations and guidelines as set out in the respective section of this ESIA.

Electricity Supply

During the construction phase of the project, power supply for the project is expected to be from FEWA's power grid or through the use of generators.

Sanitary Facilities

The site will require on site sanitation facilities for the construction workers (expected to be toilets with collection septic tanks). Sanitary waste will be stored in bunded septic tanks on-site, prior to removal by a licensed contractor.

Water Supply

During the construction phase of the project, it is expected that the EPC Contractor will apply for the necessary permits in order to be able to use the groundwater for construction purposes. In addition, water for use by the workers (i.e. for drinking) will be supplied to the project site by authorised water supply companies.

4.7 Project Schedule

An outline delivery schedule highlighting important milestones for the project is provided in the table below.

Table 4-3 Outline of the Project Schedule

Implementation Milestone	Tentative Date*
Effective Date (Limited Notice to Proceed)	LNTP
Financial Closing Date (Full Notice to Proceed)	FNTP (LNTP+2.5 M)
Start pf site mobilization	LNTP+ 2 M
Site Preparation	LNTP+2 M
Mechanical Completion Date of Plant	
Completion of seawater intake structure (onshore civil works)	FNTP+13 M
Completion of outfall structure (marine works)	FNTP +17 M
Completion of sea water pumps installations	FNTP+16 M
Completion of pre-treatment	FNTP+29 M
Completion of RO trains	FNTP+29 M
Completion of Desalination Units 50 MIGD	FNTP+22 M
Completion of Desalination Units 150 MIGD	FNTP+29 M
Completion of Connection to related Facilities	
Electrical substation	FNTP+15 M
Potable Water Facilities	FNTP+22 M
Seawater Pumping Station	FNTP+17 M
Commissioning of Desalination Units	
Desalination Unit 50 MIGD	
First seawater feed to RO system available	FNTP+21 M
First permeate production	FNTP+22 M
Performance test	FNTP+23.5 M
Reliability test run	FNTP+24.5 M
Net Dependable Capacity Test	FNTP+25.5 M

Early Water 50 MIGD	FNTP+25.5 M
Desalination Unit 150 MIGD	
First seawater feed to RO system available	FNTP+21 M
First permeate production	FNTP+22 M
Performance test	FNTP+31 M
Reliability test run	FNTP+32 M
Net Dependable Capacity Test	FNTP+33 M
Scheduled Commercial Operation Date	Fntp+33 M
Commissioning of the Entire Plant	
Start of Reliability Test Run	FNTP+32 M
Net Dependable Capacity Tests	FNTP+33 M
Scheduled Project Commercial Operation Date	FNTP+33 M

4.8 Project Operation and Maintenance Requirements

The company responsible for operation and maintenance of the project is not unknown at this stage. Based on the project's RfP, the minimum lifespan for the project is envisioned as:

- 25 years for all the mechanical components with minimum maintenance;
- 25 years for all the electrical components with minimum maintenance; and
- 50 years for civil buildings.

During operation, preventative and corrective maintenance activities that will be carried out during the operational life of the RO plant are expected to include daily, weekly, monthly, quarterly and annual visual inspections, scheduled regular replacements of faulty parts and any other components that may affect the optimal operation of the plant. Regular replacement of different parts of the plant will be scheduled when the plant is not operational in order to prevent decrease in plant's productivity. Unscheduled repairs and maintenance will likely occur as a result of breakdowns and emergency situations.

4.9 Project Decommissioning Requirements

This ESIA does not provide specific requirements for the decommissioning of the project which is not expected until after at least 25 years from the Commercial Operation Date. Therefore, it is not considered practical or of value to speculate on future environmental and social conditions including the sensitivity of current or future receptors at this time, or facilities that may or may not be present to handle wastes etc., or the extent of environmental and social regulation that may exist.

Hence, all impacts relating to decommissioning stage will be planned to be approached and mitigated via a specific decommissioning plan and updated baseline surveys prepared closer to the time of decommissioning as it would be able to account for changes in regulation, improvements in technology and requirements for re-use and recycling of components and

materials. The decommissioning plan would be developed at least 18 months prior to decommissioning and would be based on the project's ESMS.

5 MARINE ENVIRONMENT

This chapter describes the potential impacts upon the marine environment (i.e. marine flora, marine fauna and ambient water quality) as a result of the construction and operational phases of the proposed 150 MIGD.

5.1 Standards and Regulatory Requirements

5.1.1 National Standards

In the absence of UAE and Umm Al Quwain Municipality marine discharge standards the Environment Agency Abu Dhabi Technical Guidance Document TG-003R-*Standards and Limits for Pollution to Air and Marine Environments Occupational Exposure, pesticides and chemical use*, as shown in the table below, as a reference to a local benchmark standard for marine discharges to the Arabian Gulf and ambient water quality in the Arabian Gulf (table below).

Table 5-1 EAD Marine Industrial Discharge Standards

Parameter	Symbol	Unit	Suggested Limits
Physical Properties			
Total Suspended Solids	TSS	mg/l	50
Total Dissolved Solids	TDS	mg/l	1500
Ph		pH Units	6 - 9
Floating Particles		mg/m2	None
Temperature	T	˚C	5
Turbidity		NTU	75
Inorganic Chemical Properties			
Ammonia Total as N	NH_4^+	mg/l	2
Nitrate	$NO3^{-N}$	mg/l	40
Chlorine Residual	Cl^-	mg/l	1
Cyanide	CN^-	mg/l	0.05
Dissolved Oxygen	DO	mg/l	>3
Fluoride	F^-	mg/l	20
Sulphide	S^{-2}	mg/l	0.1
Biochemical Oxygen Demand	BOD_{5-20}	mg/l	50
Total Kjeldahl Nitrogen as N	PO_4^{-3}	mg/l	10
Total Phosphorus as P	PO_4^{-3}	mg/l	2

Parameter	Symbol	Unit	Suggested Limits
Chemical Oxygen Demand	COD	mg/l	100
Trace Metals			
Aluminium	Al	mg/l	20
Antimony	Sb	mg/l	0.1
Arsenic	As	mg/l	00.5
Barium	Ba	mg/l	2
Beryllium	Be	mg/l	0.05
Cadmium	Cd	mg/l	0.05
Chromium, total	Cr	mg/l	0.2
Chromium VI	Cr^{+6}	mg/l	0.15
Cobalt	Co	mg/l	0.2
Copper	Cu	mg/l	0.5
Iron	Fe	mg/l	2
Lead	Pb	mg/l	0.1
Manganese	Md	mg/l	0.2
Mercury	Hg	mg/l	0.001
Nickel	Ni	mg/l	0.1
Selenium	Se	mg/l	0.02
Silver	Ag	mg/l	0.005
Zinc	Zn	mg/l	0.5
Organic Chemical Properties			
Haloginated Hydrocarbons & Pesticides		mg/l	Nil
Hydrocarbons	HC	mg/l	15
Oil & Grease		mg/l	10
Phenols		mg/l	0.1
Solvent		mg/l	None
Total Organic Carbon	TOC	mg/l	75
Biological Properties			
Total Coliforms		MPN/100ml	1000
Faecal Coliforms		No. /100 ml	1000
Egg Parasites			None
Warm Parasites			None

Table 5-2 Recommended Ambient Marine Water Quality Objectives (AMWQO's) for Abu Dhabi Emirate

Parameter	Unit of Measurement	Proposed maximum Concentration
Physical Indicators		
Floating Particles	mg/m_2	Nil
Temperature	Delta °C of background concentration	±3
Turbidity	NTU	10
Transparency/Clarity	Meter of Secchi Depth	>=10
Salinity	% of background concentration	<5
BOD_5	Mg/l (5 day at 20°C Annual Average)	5
Odour	Not objectionable	Not objectionable
Colour	No change from background	No change from background
Chemical Indicators		
Ammonia (Free as N) or Ammonia NH_3-N	mg/l	0.004
Arsenic	mg/l	0.005
Cadmium	mg/l	0.001
Chlorine Residual (Cl_2)	mg/l	0.01
Chromium (Cr)	mg/l	0.01
Copper (Cu)	mg/l	0.01
Cyanide (CN)	mg/l	0.004
Lead (Pb)	mg/l	0.001
Mercury (Hg)	-	-
Oil and Grease	mg/l	Not visible
Petroleum Hydrocarbons	Ppm or mg/l	5
Dissolved Oxygen (DO)	mg/l	>4
Total Suspended Solids (TSS)	mg/l	<33
Si-SiO_3	µg/l	890
pH		6.5-8.5
Phenols	mg/l	0.001
Phosphorous Total as (P)	mg/l	0.001
Phosphate (PO_4)	µg/l	34
Sulphide (s)	mg/l	0.004
Total Organic Carbon (TOC)	mg/l	2.5
Zinc	mg/l	0.01
Nickel	µg/l	20
Iron	mg/l	0.3
Vanadium	µg/l	9.4
Nitrate (NO_3-N)	µg/l	95

Parameter	Unit of Measurement	Proposed maximum Concentration
NO_2	µg/l	34
Biological Indicators (Bacteriological)		
Total Coliform	MPN/100ml	70

5.1.2 FEWA RfP Requirements

VOLUME III: MINIMAL FUNCTIONAL SPECIFICATION

In accordance with several clauses in Volume III of the FEWA RfP, the discharge at the outfall will be in compliance with Iran environmental discharge requirements.

'All industrial complexes which produce waste water with higher quantities of pollutants than those above the National Standard of Environmental Protection Agency of Islamic Republic of Iran should have waste water treatment facilities before the final release to the environment. The effluent standards for direct discharge are reported in the table below. The table below lists the limit values for wastewater characteristics prior to be discharged.

Dilution of a wastewater discharge shall not be used to meet effluent discharge limitations.

The use of pond for untreated wastewater is allowed only by the permission of National Environmental Protection Agency of Iran.'

Table 5-3 Iranian Effluent Discharge Standards

Substance	Surface water (mg/l)	Agriculture and Irrigation Use	Soakaway Well (mg/l)
Al	5	5	0.1
Ag	1	0.1	5
As	0.1	0.1	0.1
Bo	2	1	1
Ba	5	1	1
Be	0.1	0.5	1
Ca	75	-	-
Cd	0.1	0.05	0.1
Cl	1	0.2	1
Cl^-	(1) 600	600	600(6)
CH_2O	1	1	1
C_6H_5OH	1	1	Petty (trace)
CN	0.5	0.1	0.1
Co	1	0.05	1
Cr VI	0.5	1	1
Cr III	2	2	2

Substance	Surface water (mg/l)	Agriculture and Irrigation Use	Soakaway Well (mg/l)
Cu	1	0.2	1
F	2.5	2	2
Fe	3	3	3
Hg	Under limit	Under limit	Negligible
Li	2.5	2.5	2.5
Mg	100	100	100
Mn	1	1	1
Mo	0.01	0.01	0.01
Ni	2	2	2
NH_4	2.5	1	1
NO_2	10	10	10
NO_3	50	10	10
Phosphates/phosphorous	6	-	6
Pb	1	1	1
Se	1	0.1	0.1
H_2S	3	3	3
SO_3	1	1	1
SO_4	(1) 400	500	400(6)
V	0.1	0.1	0.1
ZN	2	2	2
Oil and Grease	10	10	10
Detergent (ABS)	1.5	0.5	0.5
BOD 5	30 (50) (*)	100	30 (momentarily (100))
COD	60 (100) (*)	200	60 (momentarily (100))
DO	2	2	-
TDS	(1)	-	(6)
TSS	40 (90) (*)	100	-
Soluble Salt	0	0	-
pH	6.5 – 8.5	6.0 - 8.5	5 - 9
Radioactivity	0	0	-
Turbidity	50	50	-
Colour	85	85	75
Temperature	(3)	-	-

Substance	Surface water (mg/l)	Agriculture and Irrigation Use	Soakaway Well (mg/l)
Faecal Coliforms (/10ml)	400	-	400
Nematodes	-	4	-
Total Coliforms	1000	1000	1000

Notes

(*): The concentration in () is the value accepted for peak;

(1): Concentration < 10% after 200 m of the discharge point;

(2): Concentration < 10% of their standards;

(3): The temperature increase of the water must be less than 3°C after 200 m from the discharge point;

(4): The number of nematodes for the ultimate purpose of irrigation of products which are used in the raw form, should not be more than 1 nematode per lit.

(5): Not more than 1 of potable water.

(6): Not more than 10% of potable water.

The above limits have been obtained from "*Extract of rules and regulations for the protection of the environment practice and standards applicable for Oil industry*" prepared by the Ministry of Petroleum Department of Environmental Protection – 1997.

The reference waste water concentration limits to be applied to the project are those referred to the direct discharge to surface waters (e.g. river, channel, sea).

Further requirements for discharges to the Environment are set by FEWA in Volume III, Form Sheet 6: Performance Guarantees as shown in the table below.

Table 5-4 FEWA Performance Guarantees in Regards to the Liquid Discharges into the Environment

Description	Unit	Data
Ammoniacal nitrogen	mg/l	≤ 0.5
Arsenic (As)	mg/l	≤ 0.1
Bio-chemical oxygen demand (BOD)	mg/l	≤ 30
Cadmium (Cd)	mg/l	≤ 0.1
Chlorine (residual)	mg/l	≤ 0.15
Chromium, total (Cr)	mg/l	≤ 0.5
Copper (Cu)	mg/l	≤ 0.5

Description	Unit	Data
COD	mg/l	≤ 100
Cyanide (CN)	mg/l	≤ 0.1
Oil	mg/l	≤ 10
Iron, total (Fe)	mg/l	≤ 1
Lead (Pb)	mg/l	≤ 0.1
Manganese (Mn)	mg/l	≤ 1
Mercury (Hg)	mg/l	≤0.001
Nickel (Ni)	mg/l	≤0.5
pH		6.5 – 8.5
Phenols	mg/l	≤ 0.1
Phosphate (total as P)	mg/l	≤ 3
Selenium (Se)	mg/l	≤ 0.05
Silver (Ag)	mg/l	≤ 0.1
Sulphide	mg/l	≤ 0.2
Suspended solids	mg/l	≤ 30
Vanadium	mg/l	≤ 1.0
Zinc (Zn)	mg/l	≤ 1.0
TDS	mg/l	Not more than 5% above receiving water at the boundary of the mixing
Max. cooling seawater temperature rise	°C	5

5.1.3 Lenders Requirements

In addition to compliance with the Equator Principles, associated IFC Performance Standards (2012) and World Bank Group EHS Guidelines, the Project has also been considered against sector-specific guidance published by IFC including EHS Guidelines for Water and Sanitation (2007).

The EHS Guidelines for Water and Sanitation include information relevant to the operation and maintenance of potable water treatment and distribution systems. This chapter details the mitigation measures which the project will implement to prevent, minimise, and control environmental impacts associated with water withdrawal and to protect water quality during the construction (Table 5-32) and operational phases (Table 5-36).

5.2 Observations and Baseline Conditions

The Arabian Gulf is a shallow and almost land-locked sea that is 1000 km long by 230 - 250 km wide, with a 60 km wide entrance from the Gulf of Oman at the Strait of Hormuz. The average depth is 35 meters with a maximum of 100m on the Iranian side. There is no continental shelf and 18 % of the area of the Gulf is less than 5m deep (27.2 % of the Gulf is less than 10 m deep, Marine Environment Protection Association, 1987).

The physico-chemical properties of the Arabian Gulf reflect an extreme environment, which limits the ecological biodiversity. Water temperatures experience extreme fluctuations between summer and winter, with maximum highs reaching 34 °C and lows 17 °C, although the average fluctuation is approximately 10 °C between summer and winter. The Gulf's salinity is uncharacteristically high, and this is due to the high evaporation rate and minimal input of fresh water. The average salinity in the UAE is 39 ppt, however summer salinities are slightly higher at 40 - 42 ppt. It should be noted that in shallow intertidal areas, where flushing is limited, salinity can be substantially higher. For example, in the bays around Qatar and Kuwait, naturally occurring salinity levels have been recorded as high as 48 - 52 ppt. Notwithstanding this extreme marine environment, the Arabian Gulf supports a variety of ecosystems and a healthy diversity and density of fauna and flora.

The characteristics of the Arabian Gulf coastline, particularly along Dubai emirate has been significantly developed and altered. Commercial fishing harbour and marinas, industrials ports and power/desalination plants share the coastline with commercial, hospitality and residential developments. This heavy and intense interface with the coastal environment has resulted in changes to the bathymetry, currents, water quality and ecology of the Arabian Gulf.

Previous surveys of the area

- The marine environment encompassing the area under assessment was described by a marine ecological assessment at six (6) locations following a sampling route from the coastline to offshore (SGS Gulf Limited, October 2017).

5.2.1 Physical Environment

Bathymetry

The bathymetry of the project area from the high-tide line to 10 km off-shore is naturally characterised by a relatively simple seafloor topography, with a shallow sloping seabed and without any major three-dimensional features of natural origin. The bathymetry at the site gently slopes to 5 m at 3.2 km offshore. Water depths of over 10m are reached beyond 8 km offshore. Recent developments along the coastline and into the neighbouring emirate of Ras al Khaimah such as the Al Marjan Island project and Al Hamra development have introduced significant topographical variability in the vicinity of the project site, the majority of which is found within 3.6 from the shoreline parallel to the project area.

The near-shore zone of the Umm al Quwain Emirate supports most of the epibenthic biodiversity that is found such as macro-algae, seagrass meadows and sparse non-frame building coral reefs (i.e. the reef does not form sedimentary structures that reach the sea surface). Figure 5-1 below shows the general bathymetry of the coastline within the project area. The project site is approximately indicated by the red circle. While the bathymetry will have been modified in the localised area of these offshore developments, the overall

characteristics of slope profile remain the same in the undeveloped areas and at the project site.

Figure 5-1 General Bathymetry of the Project Area within Umm Al Quwain Emirate

Coastal Processes

Currents are controlled by three components: tides, winds and water density. The kinetic energy of the water velocity associated with the three current driving mechanisms is partitioned at approximately 100 : 10 : 1.

Following deployment of an ACDP at site in October 2017, the current speeds and flow direction along the project site coast are noted to have the following characteristics:

- Speeds as low as <0.1m/s;
- Tidal currents at the site flow approximately towards 30°N during the ebbing (falling tide) and approximately towards 210 °N on the flooding (rising) tide; and
- The current is relatively weak and observed speeds and directions are often highly variable, being affected by local wind and wave variations. The variations are more noticeable on neap tides, as the tidal currents are weaker than those on spring tides.

It should be noted that the current flow is mostly tidal driven, with very little wind influence. Therefore, the direction of the current flows to the north during ebb tides, and reverts to the south during flood tides.

Arabian Gulf tides are mixed, mainly semi-diurnal, reflecting the nature of the connected Gulf of Oman. The tidal range in the Gulf is small, approximately 0.5 m. A typical mean low tide is 0.6 m mean sea level (MSL) whilst mean high tide will be 1.2 m MSL. The culmination of the tidal currents working in concert with wind-driven currents and waves is perceived to result in a year-round north-easterly long-shore surface current in the Jebel Ali area. Winter, with strong

winds and in particular 'Shamals', will lead to a persistent, stronger mixing of the water body than summer.

Storm Events

Storm events occur occasionally between November and April, and can include storm surges along the shallow coast of Umm Al Quwain. These storm surges can last for several days, and result with high waves overtopping breakwaters or walls of newly built structures. Typically, a project involving coastal remediation should factor in a 1:100-year storm event, in order to ensure that the height and width of shoreline structures such as the walls of the shoreline intake channel are suitable to prevent flooding of roads and facilities along the shoreline near to the project area.

Storm events can cause significant turbulence throughout the water column which greatly assists in the mixing of stratified layers.

5.2.2 Water and Sediment Quality Survey Program

The water and sediment quality baseline of this EIA has been informed from the following sources;

1. A marine survey conducted by SGS Gulf Limited on behalf of FEWA to determine the baseline conditions in October 2017. The marine sediment samples were collected from six (6) different locations on 17th October 2017, marine water samples were collected from the same 6 locations and in-situ readings taken from 11 locations on a weekly basis (17th & 24th October and 1st November 2017) with one sample in the morning and one sample in the evening. The marine water sampling was carried out at depths of 0 m, 1.5 m and 3 m for all the 6 sampling locations.
2. Project-specific marine monitoring undertaken by 5 Capitals to validate the SGS Gulf Limited supplied data and investigate additional areas specifically with regard to the project. Marine sediment and water samples were collected from six (6) different locations on 29th November 2018.

The project-specific data also serves to provide a reference point for subsequent marine modelling which will be discussed in the following sub-sections.

The full set of marine water and sediment analysis results from the laboratory are presented in Volume 4, Appendix D.

Water Quality

Water quality was obtained from twelve (12) locations throughout the project area, the locations of which are indicated in Figure 5-2. Water quality testing results from 2017 provided in Volume 4, Appendix D and 2018 results are shown in Table 5-6, with lab sheets provided in Volume 4, Appendix D.

Marine water and sediment sampling locations were considered based on several factors:

- Evidence from the earlier marine survey recently carried out in 2017;
- Alignment with the expected route of the pipelines based on current design knowledge; and,
- Consideration of the spatial area of the predicted discharge plume from the diffusers to provide representative coverage.

Figure 5-2 Water and Sediment Quality Locations (October 2017 and November 2018)

Legend:

Marine Locations (sampled October 2017) MW-1

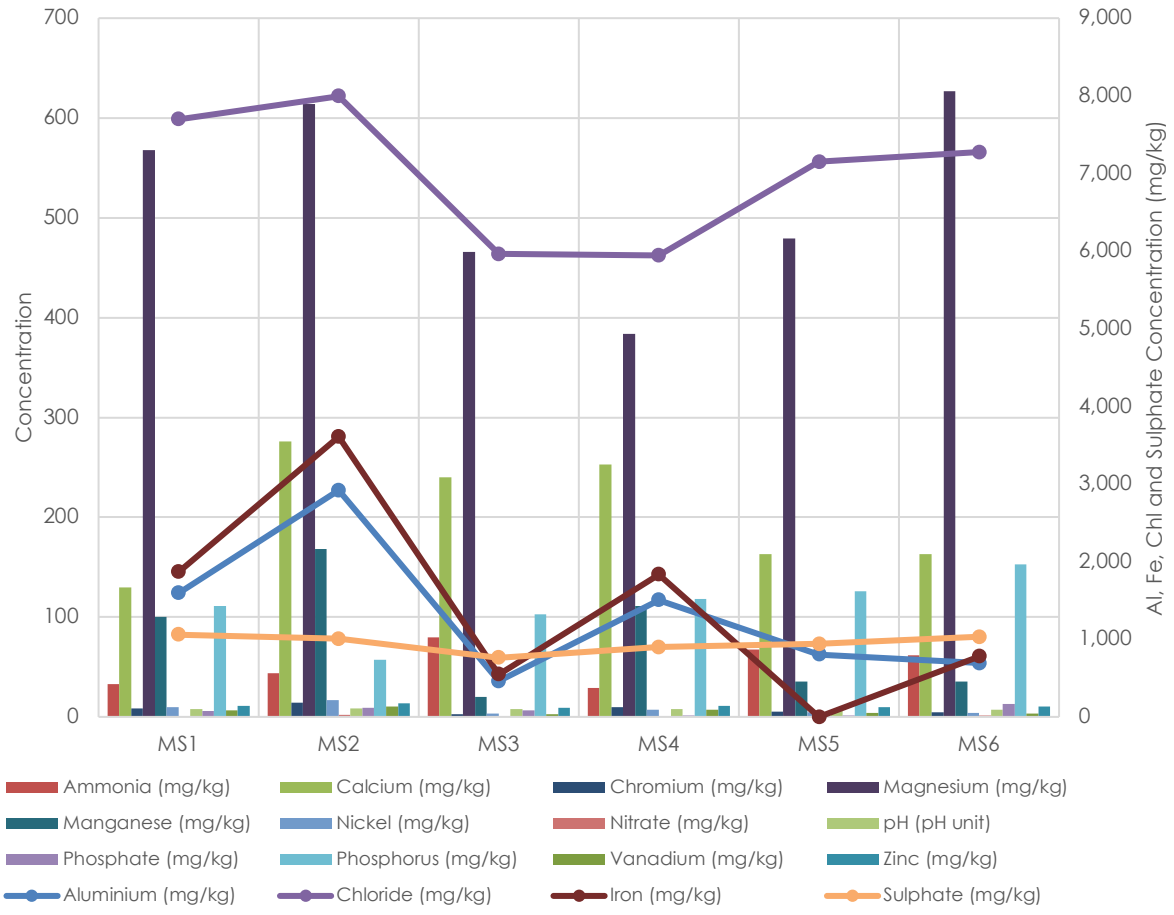
Marine Locations (sampled November 2018) UAQ WQ-1

To distinguish from parameters which are below laboratory limits of detection (LOD), concentrations above laboratory LODs have been highlighted in **bold** for ease of reference. Parameters which exceed respective standards have been marked red.

Table 5-5 Preliminary EIA Sediment Quality Sample Results (October 2017)

Parameter	Unit	Results						Dutch 'Target' Sediment standards (mg/kg)
		MS1	MS2	MS3	MS4	MS5	MS6	
pH	-	**8.1**	**8.3**	**7.8**	**8.1**	**7.7**	**7.4**	-
Aluminium	mg/kg	**1,594**	**2,919**	**461.3**	**1503**	**802.4**	**691.9**	-
Cadmium	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0.8
Chromium	mg/kg	**8.4**	**14.3**	**2.6**	**9.7**	**5.4**	**4.7**	100
Cobalt	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	9
Copper	mg/kg	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	36
Iron	mg/kg	**1,868**	**3,608**	**546.9**	**1,835**	**8,78.8**	**778.7**	-
Lead	mg/kg	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	85
Manganese	mg/kg	**100.5**	**168.5**	**20.2**	**111.1**	**35.3**	**35.2**	-
Nickel	mg/kg	**9.5**	**17.1**	**3.2**	**7.3**	**4.5**	**4.2**	35
Vanadium	mg/kg	**6.5**	**10.6**	**2.5**	**7**	**4**	**3.3**	-
Zinc	mg/kg	**11.2**	**13.9**	**8.9**	**11.1**	**9.7**	**10.5**	140
Mercury	mg/kg	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0.3
Chloride	mg/kg	**7,698**	**7,994**	**5,963**	**5,944**	**7,148**	**7,274**	-
Nitrate	mg/kg	**0.6**	**2.3**	**1**	**<0.2**	**<0.2**	**1.2**	-
Phosphate	mg/kg	**5.6**	**9.4**	**6.7**	**1.3**	**1.4**	**13.2**	-
Sulphate	mg/kg	**1058**	**1005**	**761**	**900**	**939**	**1031**	-
Total Petroleum Hydrocarbon	mg/kg	<20	<20	<20	<20	<20	<20	-
Magnesium	mg/kg	**568**	**614**	**466**	**384**	**479**	**627**	-
Calcium	mg/kg	**130**	**276**	**240**	**253**	**163**	**163**	-
Phosphorus	mg/kg	**111**	**57**	**103**	**118**	**126**	**153**	-
Total PHC (Oil and Grease)	mg/kg	<5	<5	<5	<5	<5	<5	-
Ammonia	mg/kg	32.9	43.9	79.8	29.2	67.5	61.4	-
TOC	% weight	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	-

Figure 5-3 Preliminary EIA Sediment Quality Sample Results (October 2017)



Project Specific Water and Sediment Quality Sampling (November 2018)

Six (6) project-specific water and sediment sample locations (Figure 5-2) were chosen throughout the project area to validate water and sediment quality throughout a wider area of the site and areas expected to be most impacted by the marine discharges. The results are shown below in Table 5-6.

To distinguish from parameters which are below laboratory limits of detection (LOD), concentrations above laboratory LODs have been highlighted in **bold** for ease of reference. Parameters which exceed respective standards have been marked red.

Table 5-6 Project-Specific Water Quality Sample Results (November 2018)

Parameter Name	EAD Standard (mg/L)	WQ - 01	WQ - 02	WQ - 03	WQ - 04	WQ - 05	WQ - 06
Aluminium (Al) (mg/L)		<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Ammonia (mg/L)	0.004	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Ammonium (mg/L)	0.004	<0.064	<0.064	<0.064	<0.064	<0.064	<0.064
Antimony (Sb) (mg/L)		**0.009**	<0.005	<0.005	<0.005	**0.014**	**0.008**
Arsenic (As) (mg/L)	0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Barium (Ba) (mg/L)		**0.01**	**0.011**	**0.011**	**0.012**	**0.013**	**0.013**

Parameter Name	EAD Standard (mg/L)	WQ - 01	WQ - 02	WQ - 03	WQ - 04	WQ - 05	WQ - 06
Beryllium (Be) (mg/L)		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bicarbonate (mg/L)		**146**	**149**	**151**	**149**	**151**	**151**
Biochemical Oxygen Demand (mg/L)		<2	<2	<2	<2	<2	<2
Boron (B) (mg/L)		**5.15**	**5.37**	**5.29**	**5.28**	**5.28**	**5.3**
Cadmium (Cd) (mg/L)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Carbonate (mg/L)		**5**	**5**	**5**	**5**	**5**	**5**
Chemical Oxygen Demand (mg/L)		<5	<5	<5	<5	<5	<5
Chloride (mg/L)		**22,300**	**22,700**	**22,300**	**22,300**	**22,700**	**22,300**
Chromium (Cr) (mg/L)	0.01	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Chromium (VI) (mg/L)		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cobalt (Co) (mg/L)		<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Copper (Cu) (mg/L)	0.01	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Iron (Fe) (mg/L)		<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Lead (Pb) (mg/L)	0.01	**0.01**	<0.01	<0.01	<0.01	<0.01	<0.01
Manganese (Mn) (mg/L)		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mercury (µg/L)		<0.300	<0.300	<0.300	<0.300	<0.300	<0.300
Nickel (Ni) (mg/L)	0.02	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Nitrate (mg/L)	0.095	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Nitrite (mg/L)		<0.016	<0.016	<0.016	<0.016	<0.016	<0.016
Nitrogen (Ammonia) (mg/L)		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrogen Kjeldhal (mg/L)		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
pH Value (pH units)		**8.2**	**8.2**	**8.2**	**8.2**	**8.2**	**8.2**
Phosphorus (P) (mg/L)		<0.030	0.058	<0.030	<0.030	0.039	0.038
Residual Chlorine (mg/L)		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Salinity (ppt)		**42**	**42.7**	**42.1**	**42.2**	**42.4**	**42.3**
Selenium (Se) (mg/L)		<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Silver (Ag) (mg/L)		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sodium (Na) (mg/L)		**11,900**	**12,200**	**12,100**	**12,100**	**11,900**	**11,900**
Sulphate (mg/L)		**2,930**	**2,970**	**2,930**	**2,930**	**2,970**	**2,950**
Sulphide (mg/L)	0.004	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Alkalinity (mg/L)		**128**	**130**	**132**	**130**	**132**	**132**
Total Organic Carbon (mg/L)	2.5	**1.4**	**1.6**	**1.5**	**1.5**	**1.6**	**1.4**
Total Suspended Solids (mg/L)	<33	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Turbidity (NTU)	10	**1.2**	**1**	**1.3**	**1.3**	**1.1**	**0.7**
Vanadium (V) (mg/L)	0.0094	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc (Zn) (mg/L)	0.01	<0.010	<0.010	0.072	<0.010	0.013	<0.010

Figure 5-4 Project-Specific Water Quality Sample Results (November 2018)

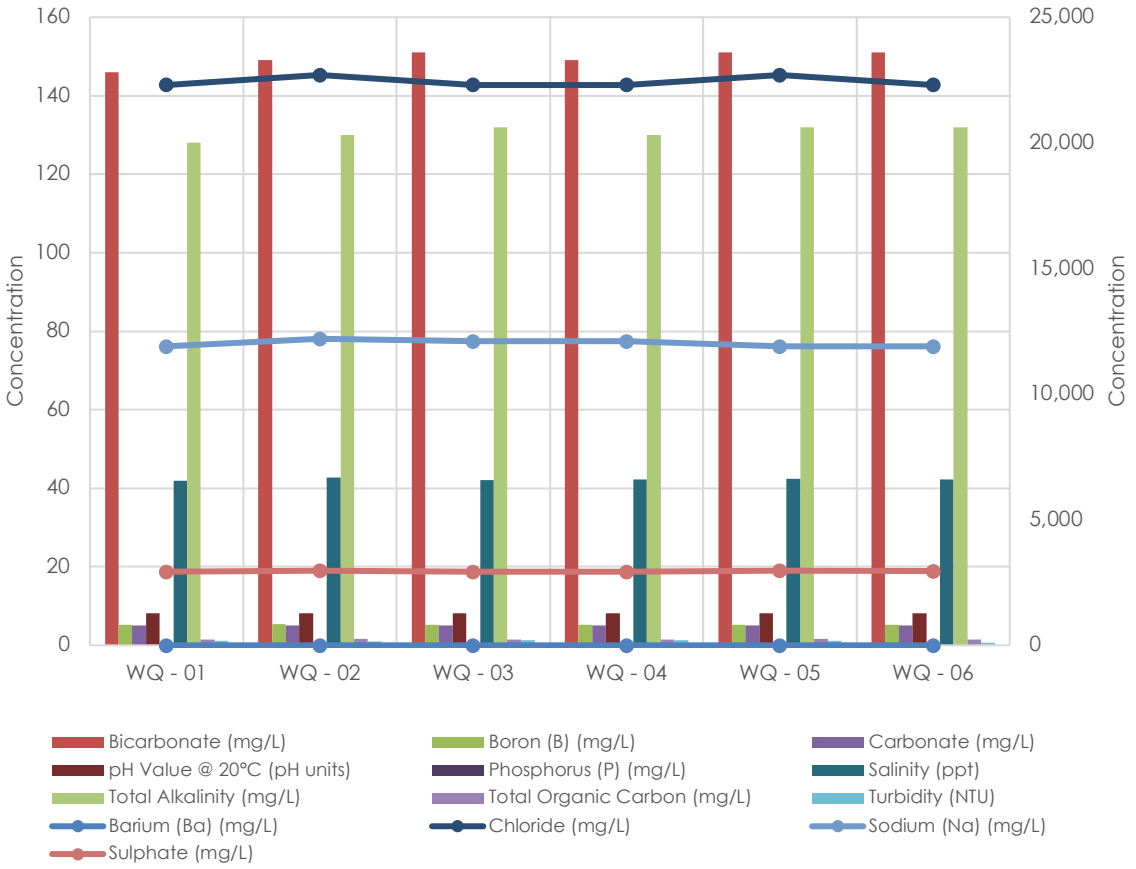
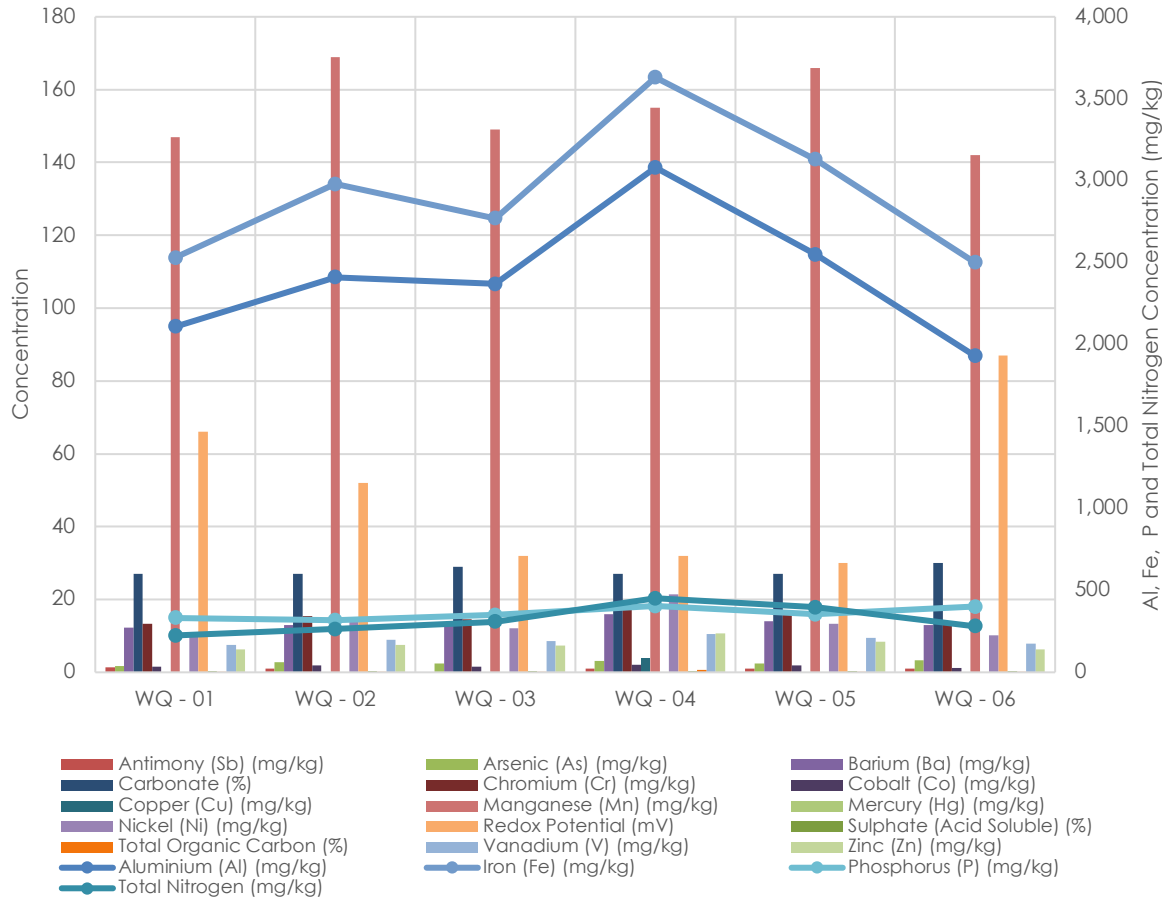


Table 5-7 Project-Specific Sediment Quality Sample Results (November 2018)

Parameter Name	WQ - 01	WQ - 02	WQ - 03	WQ - 04	WQ - 05	WQ - 06	Dutch 'Target' Sediment Standards (mg/kg)
Aluminium (Al) (mg/kg)	**2,110**	**2,410**	**2,370**	**3,080**	**2,550**	**1,930**	-
Antimony (Sb) (mg/kg)	**1.3**	**1**	<1.0	**1.1**	**1.1**	**1**	-
Arsenic (As) (mg/kg)	**1.7**	**2.7**	**2.5**	**3.1**	**2.5**	**3.3**	29
Barium (Ba) (mg/kg)	**12.2**	**12.9**	**13.1**	**15.9**	**14.1**	**13**	160
Beryllium (Be) (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	-
Cadmium (Cd) (mg/kg)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.8
Carbonate (%)	**27**	**27**	**29**	**27**	**27**	**30**	-
Chromium (Cr) (mg/kg)	**13.4**	**15.5**	**14.5**	**18.3**	**15.9**	**13.8**	100
Chromium (VI) (mg/kg)	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	100
Cobalt (Co) (mg/kg)	**1.5**	**1.9**	**1.5**	**2.1**	**1.9**	**1.2**	-
Copper (Cu) (mg/kg)	<3.0	<3.0	<3.0	3.9	<3.0	<3.0	36
EPH C10-C40 (mg/kg)	<50	<50	<50	<50	<50	<50	-
Iron (Fe) (mg/kg)	**2,530**	**2,980**	**2,770**	**3,630**	**3,130**	**2,500**	-
Manganese (Mn) (mg/kg)	**147**	**169**	**149**	**155**	**166**	**142**	-
Mercury (Hg) (mg/kg)	<0.010	<0.010	<0.010	<0.010	0.011	<0.010	-
Nickel (Ni) (mg/kg)	**11**	**14.8**	**12.1**	**21.5**	**13.4**	**10.1**	35

Parameter Name	WQ - 01	WQ - 02	WQ - 03	WQ - 04	WQ - 05	WQ - 06	Dutch 'Target' Sediment Standards (mg/kg)
Phosphorus (P) (mg/kg)	**333**	**318**	**349**	**405**	**353**	**400**	-
Redox Potential (mV)	**66**	**52**	**32**	**32**	**30**	**87**	-
Selenium (Se) (mg/kg)	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	-
Silver (Ag) (mg/kg)	<10	<10	<10	<10	<10	<10	-
Sulphate (%)	**0.24**	**0.23**	**0.26**	**0.3**	**0.25**	**0.33**	-
Sulphide (mg/kg)	<5	<5	<5	<5	<5	<5	-
Total Nitrogen (mg/kg)	**225**	**264**	**308**	**452**	**396**	**281**	-
Total Organic Carbon (%)	**0.2**	**0.2**	**0.2**	**0.6**	**0.2**	**0.2**	-
Vanadium (V) (mg/kg)	**7.5**	**8.9**	**8.6**	**10.5**	**9.5**	**7.9**	42
VPH C5-C10 (mg/kg)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-
Zinc (Zn) (mg/kg)	**6.3**	**7.5**	**7.4**	**10.7**	**8.4**	**6.3**	140

Figure 5-5 Project-Specific Sediment Quality Sample Results (November 2018)



Water and Sediment Quality Analysis Results Discussion

The waters of the Arabian Gulf are characterised by high seasonal temperature variability, high salinity content, low clarity, and low nutrient content. Seasonal upwelling of nutrients in the waters have been known on occasion to cause significant algal blooms (GHD, 2004).

As suggested by the very low (below laboratory LOD) concentrations of metals reported from baseline water quality analysis from both the preliminary EIA and project-specific sampling indicates that overall concentrations are within the expected range of seasonal variability and compliant with the Abu Dhabi Ambient Water Quality Objectives. In all of the samples analysed, except for antimony barium, boron, and one instance of lead, concentrations of heavy metals were below detectable levels in water. Levels of hydrocarbons and inorganics were within the expected range for ambient seawater quality characteristics in the Arabian Gulf (Table 5-6), lab reports presented in Volume 4, Appendix D.

The concentration of parameters analysed for sediment quality results (Table 5-5 and Table 5-7) were either non-detectable or within the Dutch Sediment target range. Heavy metal analysis indicated that all metals tested, were below LOD or were lower than the Dutch Sediment target range.

5.2.3 Biological Environment

The marine ecological baseline of this EIA has been informed from the following sources;

1. A marine survey conducted by SGS Gulf Limited on behalf of FEWA to determine the baseline conditions in October 2017. The marine ecological assessment was performed at six (6) different locations on 24th October 2017.
2. Project-specific marine monitoring undertaken by 5 Capitals to validate the SGS Gulf Limited supplied data and investigate additional areas specifically with regard to the project. The project-specific marine ecological assessment was performed at seventeen (17) different locations on 29th November 2018.

Preliminary EIA Marine Ecological Assessment (October 2017)

A marine ecological assessment was performed at six (6) locations throughout the project area. The locations of which are indicated in Figure 5-6. The alignment of the assessment locations reflects early design stage alignment of the outfall pipeline route. The results of the assessment are shown in Figure 5-7.

Figure 5-6 Marine Ecological Assessment Survey Locations (October 2017)

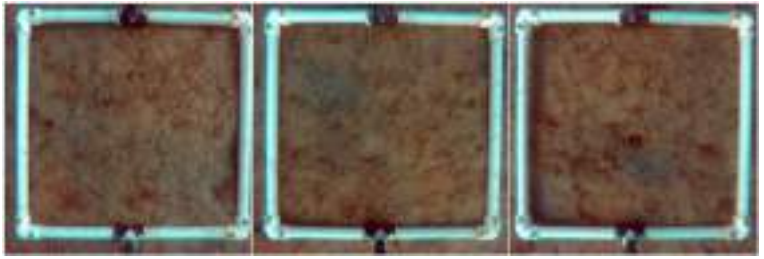
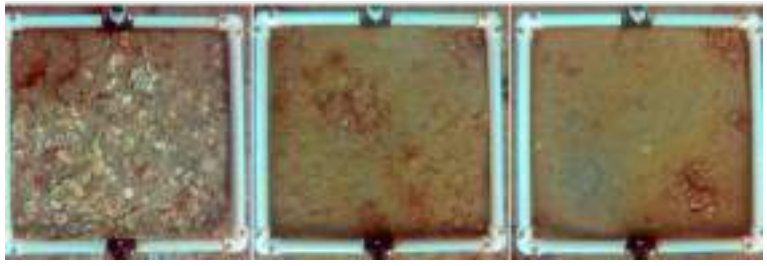
Legend:

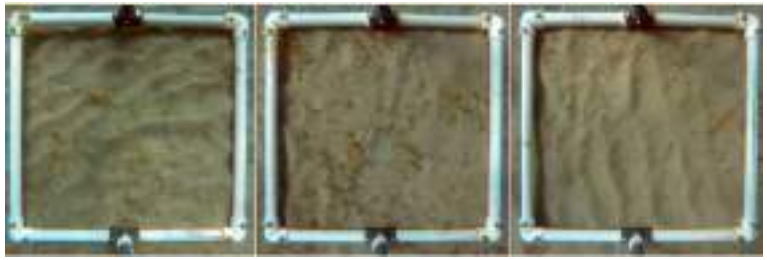
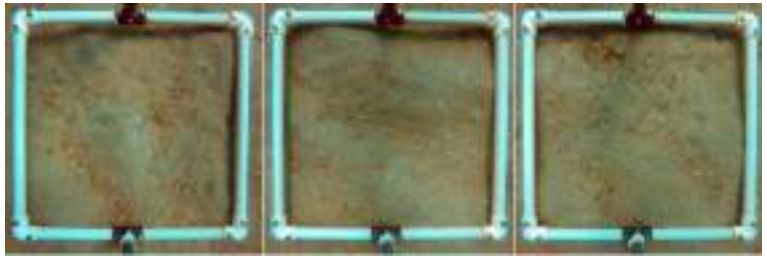
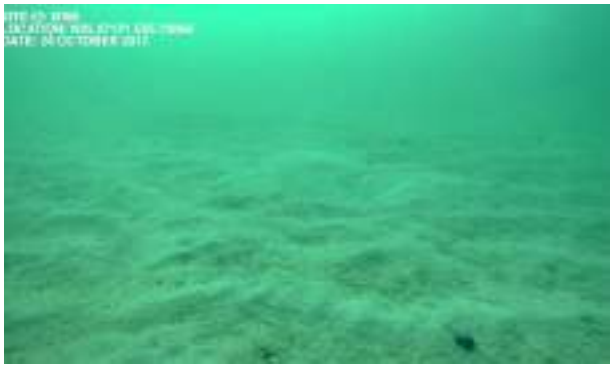
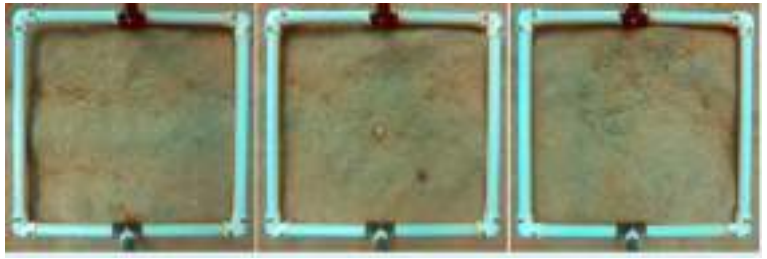
Marine Locations (sampled October 2017)

Intake Channel Route – current design

Outfall Pipeline Route – current design

Figure 5-7 Marine Ecological Habitat Summary (October 2017)

Site	Lateral View Over Seabed	Photo-quadrat Images	Site information
MW1			Depth: 3.8 m Visibility: Poor Habitat type: Unconsolidated Sediment type: Medium to fine Epiflora: Very low-density seagrass with turf algae over rubble surfaces; Epifauna: Occasional small cerithids Fish/MMR: few fish, no MMR, Status; Impacted/not sensitive
MW2			Depth: 4.8m; Visibility: Poor; Habitat Type: Unconsolidated; Sediment Type: Medium to fine; Rugosity/Slope: 0/0; Flora: V. low density seagrass; Fauna: None recorded; Fish/MMR: Few fish; no MMR sightings; Status: Impacted/not sensitive;
MW3			Depth: 6.1 m Visibility: Poor Habitat type: Unconsolidated Sediment type: coarse to fine Rugosity/slope:0/0; Flora: none recorded Fish/MMR: few fish, no MMR, Status; Impacted/low sensitive

Site	Lateral View Over Seabed	Photo-quadrat Images	Site information
MW4			Depth: 4.0m; Visibility: Poor; Habitat Type: Unconsolidated; Sediment Type: Medium to fine; Rugosity/Slope: 0/0; Flora: V. low density seagrass; Fauna: None recorded; Fish/MMR: Few fish; no MMR sightings; Status: Impacted/low sensitivity;
MW5			Depth: 5.5m; Visibility: Poor; Habitat Type: Unconsolidated; Sediment Type: Medium to fine; Rugosity/Slope: 0/0; Flora: None recorded; Fauna: None recorded; Fish/MMR: Few fish; no MMR sightings; Status: Impacted/low sensitivity;
MW6			Depth: 5.4 m Visibility: Poor Habitat type: Unconsolidated Sediment type: Medium to fine Rugosity/slope:0/0; Flora: none recorded Fish/MMR: few fish, no MMR, Status; Impacted/low sensitive

Project-Specific Marine Ecological Assessment (November 2018)

Project-specific marine monitoring was undertaken by 5 Capitals in 2018 to complement the earlier supplied marine habitat data by investigating additional project-specific areas. A drop-down video (DDV) was placed on the seafloor at seventeen (17) locations chosen to provide a representative indication of the areas likely to be within the project's area of influence. Surveyed locations are shown in Figure 5-8 below with the results (and coordinate locations) presented in Table 5-8 to Table 5-24. Any observed species observed at each site are listed along with a description of the seafloor habitat.

Marine habitat survey locations were considered based on several factors:

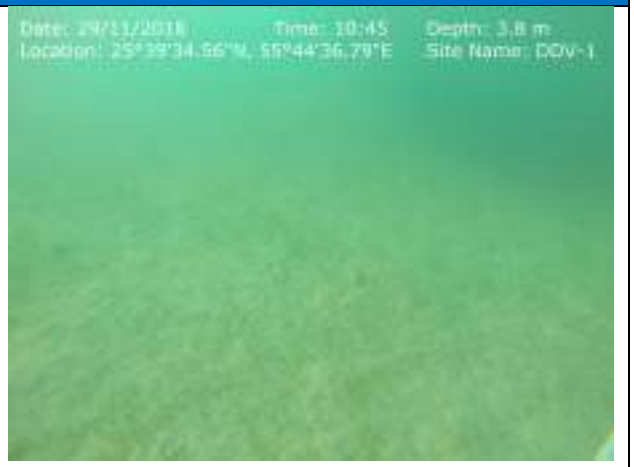
- Evidence from the earlier marine survey recently carried out in 2017;
- Alignment with the expected route of the pipelines based on current design knowledge; and,
- Consideration of the spatial area of the predicted discharge plume from the diffusers to provide representative coverage.

Figure 5-8 Project-Specific Marine Ecological Assessment Survey Locations (November 2018)

Legend:
Marine Locations (sampled November 2018) DDV-16
Intake Pipeline Route – current design
Outfall Pipeline Route – current design

Additionally, a 1:5,000 scale seafloor classification survey derived from Sentinel-2 satellite imagery was commissioned (Figure 5-9) to provide a understanding of the benthic habitat across a wider area where the brine plume is predicted to disperse.

Table 5-8 Site Views and Ecological Status – Site: DDV-1

Location Map	Photo-quadrat	Lateral view over Seabed
		

Site Description	
Site Condition (dominant floral and faunal communities)	500 m from shoreline and 1.6 km from proposed project brine discharge location. 100% cover of unconsolidated sediment with limited benthic development. Sparse seagrass coverage (*Halodule uninervis*), occasional gastropod activity (tracks).
Site Information	Depth: 3.8 m Visibility: Poor Habitat Type: Unconsolidated particulate sediment Sediment Type: Medium to fine sand Rugosity/Slope: 0/0 Flora: Low density seagrass (*H. uninervis*) Fauna: None recorded Fish/MMR: None recorded Status: Impacted/Low sensitivity

Table 5-9 Site Views and Ecological Status – Site: DDV-2

Location Map	Photo-quadrat	Lateral view over Seabed
		

Site Description	
Site Condition (dominant floral and faunal communities)	1 km from shoreline and 1 km from proposed project brine discharge location 100% cover of unconsolidated sediment with limited benthic development. Sparse seagrass coverage (*Halodule uninervis* dominant, but with *Halodule stipulacea* and *Halophila ovalis*), occasional gastropod activity (tracks).
Site Information	Depth: 4.8 m Visibility: Poor Habitat Type: Unconsolidated particulate sediment Sediment Type: Medium to fine sand Rugosity/Slope: 0/0 Flora: Low density seagrass (*H. uninervis, H. stipulacea, H. ovalis*) Fauna: None recorded Fish/MMR: None recorded Status: Impacted/Low sensitivity

Table 5-10 Site Views and Ecological Status – Site: DDV-3

Location Map	Photo-quadrat	Lateral view over Seabed
		

Site Description	
Site Condition (dominant floral and faunal communities)	500 m from shoreline and 1.6 km from proposed project brine discharge location. 100% cover of unconsolidated sediment with limited benthic development. Sparse seagrass coverage (*Halodule uninervis*), occasional gastropod activity (tracks).
Site Information	Depth: 3.8 m Visibility: Poor Habitat Type: Unconsolidated particulate sediment Sediment Type: Medium to fine sand Rugosity/Slope: 0/0 Flora: Low density seagrass (*H. uninervis*) Fauna: None recorded Fish/MMR: None recorded Status: Impacted/Low sensitivity

Table 5-11 Site Views and Ecological Status – Site: DDV-4

Location Map	Photo-quadrat	Lateral view over Seabed
		

Site Description	
Site Condition (dominant floral and faunal communities)	2.1 km from shoreline and 360 m from proposed project brine discharge location 100% cover of bare rippled sediment and few instances of seagrass (*Halodule uninervis*) recorded.
Site Information	Depth: 4.0 m Visibility: Poor Habitat Type: Unconsolidated particulate sediment Sediment Type: Fine sand Rugosity/Slope: 0/0 Flora: Very low density seagrass (*H. uninervis*) Fauna: None recorded Fish/MMR: None recorded Status: Impacted/Low sensitivity

Table 5-12 Site Views and Ecological Status – Site: DDV-5

Location Map	Photo-quadrat	Lateral view over Seabed
		

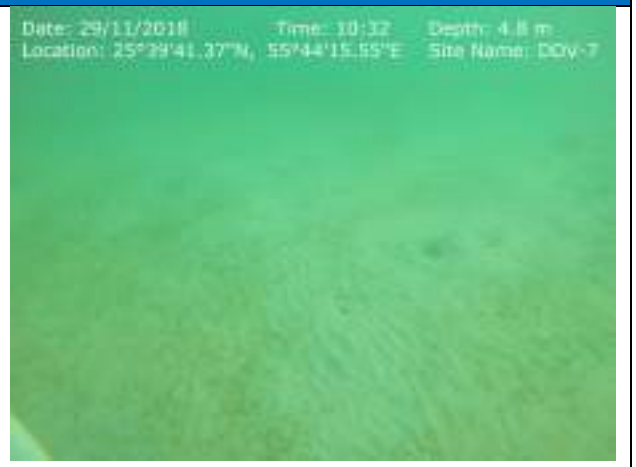
Site Description	
Site Condition (dominant floral and faunal communities)	500 m from shoreline and 1.6 km from proposed project brine discharge location. 100% cover of rippled sediment and few instances of seagrass (*Halodule uninervis*) recorded.
Site Information	Depth: 3.8 m Visibility: Poor Habitat Type: Unconsolidated particulate sediment Sediment Type: Medium to fine sand Rugosity/Slope: 0/0 Flora: Very low density seagrass (*H. uninervis*) Fauna: None recorded Fish/MMR: None recorded Status: Impacted/Low sensitivity

Table 5-13 Site Views and Ecological Status – Site: DDV-6

Location Map	Photo-quadrat	Lateral view over Seabed
		

Site Description	
Site Condition (dominant floral and faunal communities)	625 m from shoreline and 1.5 km from proposed project brine discharge location. 100% cover of unconsolidated sediment with limited benthic development. Sparse seagrass coverage (*H. uninervis, H. stipulacea, H. ovalis)*, occasional gastropod activity (tracks).
Site Information	Depth: 3.8 m Visibility: Poor Habitat Type: Unconsolidated particulate sediment Sediment Type: Medium to fine sand Rugosity/Slope: 0/0 Flora: Low density seagrass (*H. uninervis, H. stipulacea, H. ovalis*) Fauna: Occasional gastropod (sp. unid.) Fish/MMR: None recorded Status: Impacted/Low sensitivity

Table 5-14 Site Views and Ecological Status – Site: DDV-7

Location Map	Photo-quadrat	Lateral view over Seabed
		

Site Description	
Site Condition (dominant floral and faunal communities)	1 km from shoreline and 1 km from proposed project brine discharge location. 100% cover of unconsolidated sediment with limited benthic development. Sparse seagrass coverage (*Halodule uninervis*), occasional gastropod activity (tracks).
Site Information	Depth: 4.8 m Visibility: Poor Habitat Type: Unconsolidated medium to fine particulate sediment Sediment Type: Sand Rugosity/Slope: 0/0 Flora: Low density seagrass (*H. uninervis*) Fauna: Occasional gastropod (sp. unid.) Fish/MMR: None recorded Status: Impacted/Low sensitivity

Table 5-15 Site Views and Ecological Status – Site: DDV-8

Location Map	Photo-quadrat	Lateral view over Seabed
		

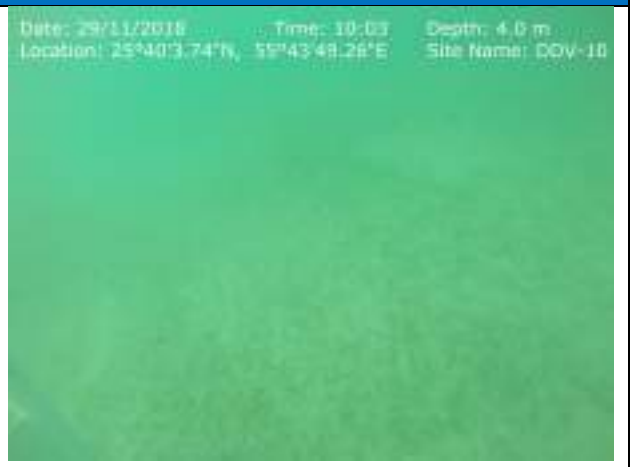
Site Description	
Site Condition (dominant floral and faunal communities)	1 km from shoreline and 1 km from proposed project brine discharge location. 100% cover of unconsolidated sediment with shell debris mix and no benthic development recorded.
Site Information	Depth: 4.8 m Visibility: Poor Habitat Type: Unconsolidated particulate sediment Sediment Type: Medium to fine sand with shell fragments Rugosity/Slope: 0/0 Flora: Non recorded Fauna: None recorded Fish/MMR: None recorded Status: Impacted/Low sensitivity

Table 5-16 Site Views and Ecological Status – Site: DDV-9

Location Map	Photo-quadrat	Lateral view over Seabed
		

Site Description	
Site Condition (dominant floral and faunal communities)	2.1 km from shoreline and 460 m from proposed project brine discharge location 100 % cover of bare rippled sediment and no benthic species recorded
Site Information	Depth: 4.0 m Visibility: Poor Habitat Type: Unconsolidated particulate sediment Sediment Type: Fine sand Rugosity/Slope: 0/0 Flora: None recorded Fauna: None recorded Fish/MMR: None recorded Status: Impacted/Low sensitivity

Table 5-17 Site Views and Ecological Status – Site: DDV-10

Location Map	Photo-quadrat	Lateral view over Seabed
		

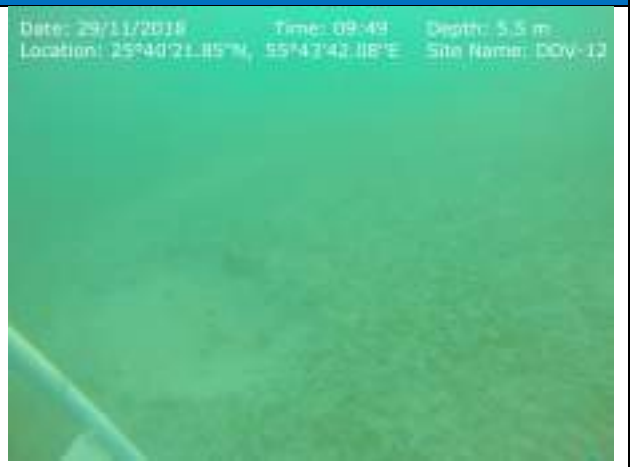
Site Description	
Site Condition (dominant floral and faunal communities)	2.1 km from shoreline and 260 m from proposed project brine discharge location 100% cover of unconsolidated sediment with limited benthic development. Sparse seagrass coverage (*Halodule uninervis*),
Site Information	Depth: 4.0 m Visibility: Poor Habitat Type: Unconsolidated particulate sediment Sediment Type: Medium to fine sand Rugosity/Slope: 0/0 Flora: Very low density seagrass (*H. uninervis*) Fauna: None recorded Fish/MMR: None recorded Status: Impacted/Low sensitivity

Table 5-18 Site Views and Ecological Status – Site: DDV-11

Location Map	Photo-quadrat	Lateral view over Seabed
		

Site Description	
Site Condition (dominant floral and faunal communities)	2.1 km from shoreline and at the proposed project brine discharge location. 100% cover of unconsolidated sediment and no benthic development recorded.
Site Information	Depth: 4.0 m Visibility: Poor Habitat Type: Unconsolidated particulate sediment Sediment Type: Medium to fine sand Rugosity/Slope: 0/0 Flora: None recorded Fauna: None recorded Fish/MMR: None recorded Status: Impacted/Low sensitivity

Table 5-19 Site Views and Ecological Status – Site: DDV-12

Location Map	Photo-quadrat	Lateral view over Seabed
		

Site Description	
Site Condition (dominant floral and faunal communities)	2.6 km from shoreline and at the proposed project brine discharge location. 100% cover of unconsolidated sediment with limited benthic development. Sparse seagrass coverage (*Halodule uninervis* dominant, but with *Halodule stipulacea* and *Halophila ovalis*), occasional gastropod activity (tracks).
Site Information	Depth: 5.5 m Visibility: Poor Habitat Type: Unconsolidated particulate sediment Sediment Type: Medium to fine sand Rugosity/Slope: 0/0 Flora: Low density seagrass (*H. uninervis, H. stipulacea, H. ovalis*) Fauna: Occasional gastropod (sp. unid.) Fish/MMR: None recorded Status: Impacted/Low sensitivity

Table 5-20 Site Views and Ecological Status – Site: DDV-13

Location Map	Photo-quadrat	Lateral view over Seabed
		

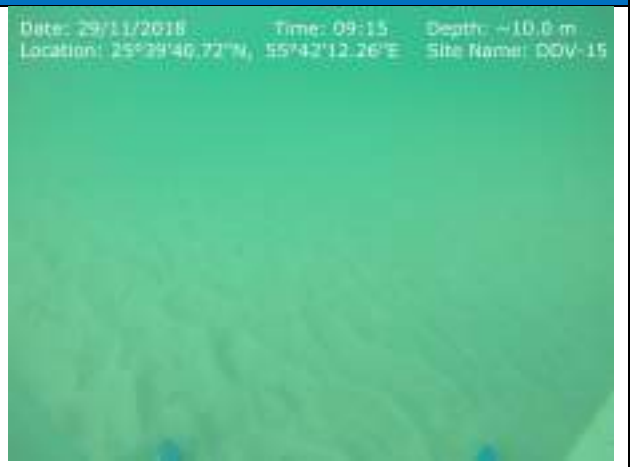
Site Description	
Site Condition (dominant floral and faunal communities)	1.46 km from shoreline and 575 m from proposed project brine discharge location 100 % cover of bare rippled sediment with no benthic development recorded.
Site Information	Depth: 6.1 m Visibility: Poor Habitat Type: Unconsolidated particulate sediment Sediment Type: Medium to fine sand Rugosity/Slope: 0/0 Flora: None recorded Fauna: None recorded Fish/MMR: None recorded Status: Impacted/Low sensitivity

Table 5-21 Site Views and Ecological Status – Site: DDV-14

Location Map	Photo-quadrat	Lateral view over Seabed
		

Site Description	
Site Condition (dominant floral and faunal communities)	1.5 km from shoreline and 1.4 km from proposed project brine discharge location. 100% cover of unconsolidated sediment with limited benthic development. Sparse seagrass coverage (*Halodule uninervis*), occasional gastropod activity (tracks).
Site Information	Depth: ~10.0 m Visibility: Poor Habitat Type: Unconsolidated particulate sediment Sediment Type: Medium to fine sand Rugosity/Slope: 0/0 Flora: Low density seagrass (*H. uninervis*) Fauna: Occasional gastropod (sp. unid.) Fish/MMR: None recorded Status: Impacted/Low sensitivity

Table 5-22 Site Views and Ecological Status – Site: DDV-15

Location Map	Photo-quadrat	Lateral view over Seabed
		

Site Description	
Site Condition (dominant floral and faunal communities)	3.2 km from main shoreline, 840 m from the nearest peninsula and 3 km from proposed project brine discharge location. 100 % cover of bare rippled sediment with no clear benthic development with the exception of few gastropod tracks visible.
Site Information	Depth: ~10.0 m Visibility: Poor Habitat Type: Unconsolidated particulate sediment Sediment Type: Fine sand Rugosity/Slope: 0/0 Flora: None recorded Fauna: None recorded Fish/MMR: None recorded Status: Impacted/Low sensitivity

Table 5-23 Site Views and Ecological Status – Site: DDV-16

Location Map	Photo-quadrat	Lateral view over Seabed
		

Site Description	
Site Condition (dominant floral and faunal communities)	4.5 km from shoreline and 2.7 km from proposed project brine discharge location. 100 % cover of bare rippled sediment with no clear benthic development recorded. Few mounds throughout, likely *Clypeasteroida sp.*
Site Information	Depth: ~10.0 m Visibility: Poor Habitat Type: Unconsolidated particulate sediment Sediment Type: Medium to fine sand Rugosity/Slope: 0/0 Flora: None recorded Fauna: Unid *Clypeasteroida sp.* Fish/MMR: None recorded Status: Impacted/Low sensitivity

Table 5-24 Site Views and Ecological Status – Site: DDV-17

Location Map	Photo-quadrat	Lateral view over Seabed
		

Site Description	
Site Condition (dominant floral and faunal communities)	4.2 km from shoreline and 2.2 km from proposed project brine discharge location. 100 % cover of bare rippled sediment with no clear benthic development recorded. Few mounds throughout, likely *Clypeasteroida sp* and 1 sea anemone.
Site Information	Depth: ~10.0 m Visibility: Poor Habitat Type: Unconsolidated particulate sediment Sediment Type: Medium to fine sand Rugosity/Slope: 0/0 Flora: None recorded Fauna: Unid *Clypeasteroida sp.* and sea anemone (sp. unid) Fish/MMR: None recorded Status: Impacted/Low sensitivity

Figure 5-9 Project-Specific Marine Ecological Assessment by Remote Sensing (February 2018)

Classification Legend:	
Sand	
Sparse vegetation (seagrass/ benthic algae)	
Dense vegetation (seagrass/ benthic algae)	

Intertidal Survey

An intertidal survey was carried out by 5 Capitals in September 2018 within the project site. The intertidal walkover was undertaken by two members of the survey team to assess the biodiversity of flora and fauna within the intertidal habitat. During the survey three (3) species of flora (*Tetraena qatarense, Suaeda vermiculata and Salsola Sp.)* typical of coastal dune habitat were identified scattered on the upper side of the beach between rocky made ground near the E11 highway. Small quantities of sea grass and filamentous algae were also identified after being washed up onto the beach by the tide. The intertidal area has a rocky outcrop which supports around twenty different species of gastropods (see Table 5-25)

Plates 5-1 Rocky Outcrop at the Proposed Project Site

The flora and fauna species identified during the intertidal survey are listed in the table below.

Table 5-25 Image Summary of the Intertidal Survey- 25th September 2018

Photo	Photo
 *Padina pavonica*	 *Halodule uninervis*
 *Ulva lactuca*	 *Tetraena qatarense*

Photo	Photo
 *Salsola Sp.*	 *Suaeda vermiculata*
 Tube worms on the intertidal rocks	 Sand bubbler crab burrow
 Mollusc sp. Indet.	 *Planaxis sulcatus*

Photo	Photo
 *Nerita Sp.*	 *Saccostreea cucullata*
 *Planaxis sulcatus, Littorina littorea, Nerita Sp.*	 Mollusc sp. Indet.
 Solitary Tube Worms in intertidal sand habitat	 *Medusafissurella salebrosa*

Photo	Photo
 *Cellana rota*	 Mollusc sp. Indet.
 *Cardites bicolor*	 *Conus ardisiaceus*
 *Oliva bulbosa*	 *Dosinia sp.*

An additional dusk intertidal survey was carried out by 5 Capitals in November 2018. The survey was carried out to assess the flora and fauna present within the intertidal habitat at dusk. The tide was in, therefore obscuring the rocky intertidal habitat where any intertidal flora and fauna might have been. However, a dead green sea turtle was observed near the project site with what appeared to be deep parallel cuts on the shell potentially caused by a prey attack or

boat propeller. As a result, 5 Capitals contacted the UAQ PHED to report the dead turtle and were informed that a team would be sent on site to investigate and remove the turtle.

Plates 5-2 A Dead Green Sea Turtle near the project site

Dawn Intertidal Survey June 2019

In June 2019 5 Capitals carried out an additional survey on 20th June 2019 at 6:00 am to assess the flora and fauna within the intertidal habitat at dawn. During the survey one (1) jelly fish and one (1) star fish and one (1) unknown species were identified. Small quantities of seagrass were also identified after being washed up onto the beach by the tide.

Table 5-26 Image Summary of the Dawn Intertidal Survey-20th June 2019

Photo	Name
	*Aurelia aurite*

Photo	Name
	*Asteroidea*
	*Crustacean species*

In addition, 5 Capitals observed plastic waste along the intertidal habitat of the project site as shown in the plate below.

Plates 5-3 Plastic Waste along the Intertidal Habitat at the Project Site

5 Capitals also surveyed a tidal channel at the Al Marjan Island north west of the Double Tree by Hilton Resort and Spa (approximately 1.4 km north west of project site 1). 5 Capitals recorded multiple sightings of jelly fish along the channel. This was immediately reported to ACWA Power for consideration in the project design. The number of jelly fish passing by a single point were counted over a timed period and this indicated approximately 50 jelly fish per 15 minutes, equipment to 200/hour.

Plates 5-4 Tidal Channel Surveyed at Al Marjan Island

Plates 5-5 Jelly Fish Observed Along the Tidal Channel (Al Marjan Island)

Marine Species

Although the floral diversity at all sampled locations was observed to be poor, seagrass was recorded (*Halodule uninervis* dominant) at multiple sites in low densities during both surveys in 2017 and 2018. In addition, gastropods, sponges, ascidians, hydroids and fish species were generally scarce (full results in Appendix E). This could be attributed to the recent coastal developments in the area to the north which may have impacted the local hydrodynamics, resulting in a depositional regime in the location, which has covered any existing near-shore habitat. Most locations consisted of a 100% medium to fine sediment cover, of indeterminate depth, over the substrate.

During the site survey in 2017, one (1) turtle was sighted which given the relatively limited in-field duration, would tend to suggest the species moves within the area, confirmed during the 2018 survey where multiple juvenile turtles were observed along the mangrove channels towards the south of Al Sinniyah Island. Despite these observations, the project area is of low ecological value with minimal seagrass for the turtles to feed on suggesting they may only use the project area as a passage route.

Birds over open water were recorded as infrequent and at a distance which made it difficult to identify the species, however the mangroves towards the south of the island are known to harbour larger populations.

The site is therefore not considered to be of high ecological value based on its low diversity and paucity of species sighted and recorded.

Zooplankton

The zooplankton samples were analysed from six (6) locations during the preliminary EIA survey (Figure 5-6). The samples analysed comprised 33 taxa in 10 phyla although all individuals could be identified to species level. These comprised Ctenophora, Cnidaria, Brachiopoda, Nematoda, Platyhelminthes Chaetognatha, Mollusca, Annelida, Arthropoda and Chordata. The table below provides a representation of the zooplankton encountered for each sample.

Table 5-27 Taxonomic breakdown of Zooplankton Results

Phylum/sub-phylum	No Taxa	Relative abundance (%)
Ctenophora	1	0.1
Cnidaria	2	4.1
Brachiopoda	1	0.07
Nematoda	1	0.07
Platyhelminthes	1	0.06
Chaetognatha	1	0.1
Mollusca	3	1
Annelida	3	0.5
Arthropoda	17	25.8
Chordata	3	68.2
Total	**33**	**100**

Ref: SGS Preliminary ESIA for 2x45 MIGD SWRO Desalination Plant Umm Al Quwain

As shown in the table above, phylum Chordata was the most abundant with three different taxa making up to 68.2% of the total. Here, the taxon, Oikopleuridae, accounted for nearly all the organisms present within the phylum with 99.1%.

Arthropoda accounted for 25.8% with 17 different taxa. Within the phylum the order Copepoda was the most dominant accounting for 59.4% of the phylum. The samples taken contained seven (7) copepod taxa, the majority of which was the order Cyclopoida at 54.9% of the record of copepods while Calanoida followed at 43.8%. Copepods were presented in all the samples analysed.

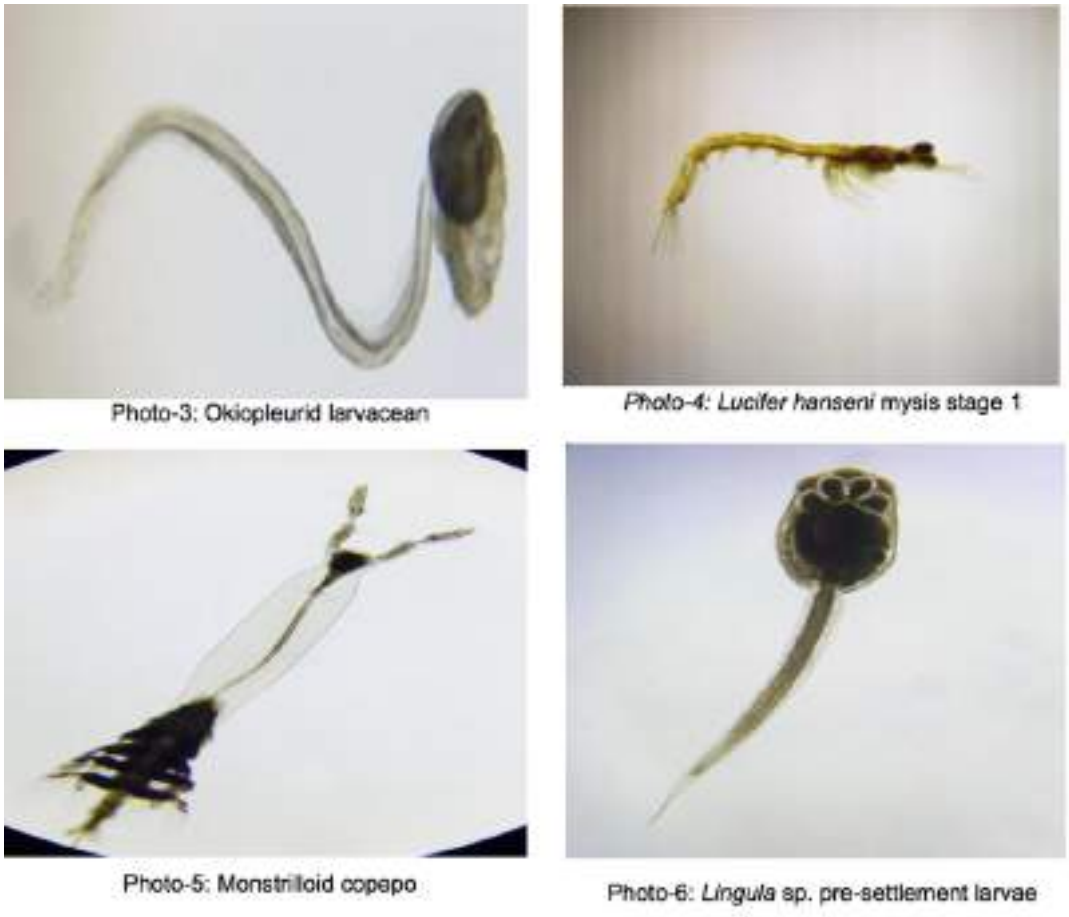
The species *Acarthia fossae* was the second most abundant accounting for 30.8% of all the recorded copepods, followed by *Temora turbinate* at 14.3%. The species *Pontellopsis herdmani* was also identified.

The order Monstrilloida was only encountered in the sample collected at MW 05, with a recorded density of 0.5 organisms m^{-3}. On the other hand, the Brachiopod taxon *Lingula sp.* was recorded in sample MW-1. This phylum is rather rare as a whole within infaunal samples.

Generally, the samples were dominated by Chordata, which was driven by oikopleurid larvaceans. Their nano-pico scale filter feeding strategy is shared by taxon *Oithona sp.*, which

was the most abundant Arthropod taxon. The dominance of these two taxa potentially indicate a healthy bacterioplankton community within the sample area.

Figure 5-10 Example of the Zooplankton Identified during the Taxonomic Analysis



Ref: SGS Preliminary ESIA for 2x45 MIGD SWRO Desalination Plant Umm Al Quwain

Phytoplankton and Harmful Algal Blooms (HABs)

Phytoplankton samples were collected from the same locations as the zooplankton samples (Figure 5-6). Results composed of three (3) phytoplankton classes; Bacillariophyceae, Dinophyceae and Haptophyta. A total of 48 taxa were identified with many of the recorded species classed as non-toxic on the IOC-UNESCO HAB database (IOC-UNESCO HAB, 2017). The species encountered within the samples are listed being potentially harmful and indirectly harmful, although these had a low abundance, typical of a marine ecosystem which is in a healthy state.

Marine Ecology Analysis Results Discussion

The marine area offshore of the project landholding has been surveyed multiple times in recent years using drop down video cameras and sediment sampling. As part of this project a remote sensing study by satellite over an extensive area was commissioned to provided additional information on the surrounding habitats. The earlier monitoring conducted as part of the

preliminary EIA provides an comprehensive overview of the marine area along a corridor from shoreline to the offshore area, while more recent project-specific monitoring locations by 5 Capitals was carried out along the proposed pipeline corridor and throughout the marine area where it is expected that the discharge plume will have the greatest impact. Overall, the benthic ecology investigations did not present any species of significance that would be of concern.

Sensitive Habitats

Preliminary EIA – Marine Benthic Habitat Assessment (2017)

From the 6 sites investigated for the preliminary EIA assessment, very low density observations of seagrass, *Halodule uninervis*, *H. stipulacea* and *Halophila ovalis* were recorded at three locations (MW1, 2 and 4).

No coral reefs were identified at any of the surveyed locations.

Project-Specific Marine Benthic Habitat Assessment (2018)

During the project-specific survey, low density observations of seagrass, *Halodule uninervis*, *H. stipulacea* and *Halophila ovalis* were recorded at a number of the surveyed locations, which were primarily in the near shore area (DDV-1, 2, 3, 4, 5, 6, 7, 10, 12 and 14). Review of the satellite derived habitat classification (Figure 5-9) identifies that along the proposed pipeline corridor, primarily low-density seagrass is observed with patches of sand. Little higher density vegetation is present and this is restricted towards the shoreline area. Towards the north, increased levels of dense vegetation is reported, the same wavelength spectrums used to detect seagrass also detect benthic algae, which based on the reclaimed island development, is very likely to be algae rather than seagrass.

Summary

Seagrass is recognised as a valuable species within the Arabian Gulf, providing grazing fodder for turtles, known to inhabit the wider area. However, the reported seagrass observations are too low in density to be of any meaning ecological value on their own. In time, the area could potentially develop into a denser seagrass habitat if conditions are favourable.

Macro-Benthos

Preliminary EIA – Marine Benthic Habitat Assessment (2017)

The positioning of the survey locations closer or further from shore did not appear to influence the seafloor composition which was reported to comprise medium to fine unconsolidated sediment. Limited benthic fauna was noted at 2 of the locations surveyed, these were occasional small cerithids (MW1), hermit crabs (MW3) and, sea anemone and bivalves at MW6.

Project-Specific Marine Benthic Habitat Assessment (2018)

Observations during the project-specific survey concur with those reported earlier with benthic conditions described as of relatively low value and sensitivity. Little fauna was seen aside from suspected *Clypeasteroida sp.* (DDV-16) and an unidentified sea anemone (DDV-17).

Summary

The marine habitats along the line of the proposed outfall and broader site area can broadly be categorised under one habitat type; that of unconsolidated sediments with a high percentage of sediment cover.

Although macroalgae are often observed affixing to hard substrate through the layer of sediment, soft sediments seen throughout the project area often prevents valuable marine fauna such as coral polyps from colonising the substrate which hinders further development.

Locations closest to the planned construction area and where the discharge plume will be most concentrated is arguably the least significant in terms of ecological significance having likely been impacted by past dredging or reclamation activities taking place within the adjacent area (e.g. Al Marjan Island) wherein finer sediments may have been transported to this location and settled.

Overall, the findings indicate that the benthic habitats identified were generally low in ecological value and do not harbour significant fauna. Areas closest to the shoreline would be unlikely to be negatively affected in any significant way by pipeline and shoreline construction.

Fish, Marine Mammals, Turtles, Dugong and Sharks

Preliminary EIA – Marine Benthic Habitat Assessment (2017)

No fish, marine mammals or reptile observations were made during the survey carried out for the preliminary EIA.

Project-Specific Marine Benthic Habitat Assessment (2018)

During the preliminary EIA survey 1 turtle (unid.) was observed, During the project-specific survey no fish, marine mammals or reptiles were observed at any of the sites surveyed, however while transiting to and from the UAQ port along the mangrove channels, south of Al Sinniyah Island, multiple marine turtle observations (>10) were made. Turtles are well known to transit along the shallow shoreline areas and the closest observation made from the project location was approximately 5 km.

Neither survey reported encounters with any marine mammals, turtles, dugong or sharks directly within the project area.

Summary

Habitats of low complexity, such as those predominant throughout the survey area are typically considered of lower ecological value than those with complex benthic structures such as coral reefs and dense sea grass beds. The local marine ecological community is unlikely to derive significant value from the marine habitat area which falls within the project area.

5.2.4 Sensitive Receptors

Based on the surveys performed, the table below outlines identified receptors in the vicinity of the project site.

Table 5-28 Marine Environment- Receptors

Receptor	Sensitivity	Justification
Local Marine Ecology	**Low**	Impacts to the marine flora and fauna from marine construction works and project brine discharge have the potential to be significant where mitigation and management measures are not adequately incorporated. However, the overall findings from multiple studies described above concluded that no ecologically significant habitats exist in the areas surveyed and that as a result, impacts from construction and operation of an offshore diffuser are expected to have minimal impact from an ecological perspective. Furthermore, studies have shown the site to likely be in an already disturbed state likely due to nearby past construction works and dredging/reclamation works in the vicinity.
Water and Sediment Quality	**Low**	Although water visibility in the Arabian Gulf can become poor during stormy conditions, the physical and chemical characteristic of the water is suitable for marine flora and fauna. However, the site is of low ecological value and supports a low number of flora and fauna species.
Intertidal area	**Medium**	The marine fauna located in the intertidal zone will be relatively vulnerable to construction activities. However, the fauna is expected to re-establish itself once the construction activities are finalised.

5.3 Potential Impacts

5.3.1 Construction Phase

During construction, the main activities that could negatively impact the marine ecology and water quality of the Project area will occur via a range of actions as listed below. Excavation from the shoreline will result in a temporary and short duration of increased noise and vibration levels.

- Dredging marine sediments for footing trench along the length of the proposed outfall pipeline alignment, the outfall diffuser system is expected to be located between 2,100 m to 3,600 m from the shoreline in water depths of around 6 m;
- Disposal of dredge soil;
- Placement and levelling of bedding material in base of footing trench;
- Installation of the GRP outfall pipeline;
- Backfilling footing trench and placement of armour rip rap layers;
- Construction of the rock revetment protecting intersecting pipeline-shoreline section;
- Shoreline intake channel excavation or breakwater channel installation;
- Construction vessel operations;
- Noise and vibrations disturbance to marine fauna; and,
- Groundwater dewatering discharge from the on-shore construction activities.

Dredging and Excavation of the Outfall Pipeline Corridor and Intake Channel

Excavation of the shoreline to align the outfall pipeline route and intake pipeline/channel will permanently alter the shoreline and seabed, including potential temporary loss of associated benthic fauna and localised adverse impacts to water chemistry associated with increases in suspended sediments. Increases in suspended sediments causes turbidity, which will decrease light penetration through the water column and may result in a reduction in photosynthetic activity of marine flora (i.e. seagrass/algae) and epifauna (i.e. coral). Turbid conditions in the water column could have negative impacts on production and growth of existing organisms.

During dredging and shoreline excavation activities, sediments released by excavation will negatively impact the water quality in the surrounding area. Sands and sediments greater than 0.063 mm will fall out of suspension relatively quickly and close to the excavated locations. Very fine sands and silts may remain suspended for longer periods and would consequently settle further from the activity location. Therefore, in the absence of mitigation measures, plumes of fine suspended sediment would be expected to form in the direction of the localised currents and will result with a temporary increase in turbidity within the water column as well as potentially smothering adjacent seabed benthic habitats and disturbing faunal species. Filter feeding organisms and marine flora are very sensitive to water turbidity and silt deposition, and if present could be negatively impacted. Even though multiple marine surveys have shown that there is a low diversity and abundance of species, it will be necessary to plan and control dredging activities carefully. Once dredging and shoreline excavation activities cease, turbidity levels can be expected return to background levels as the settlement of suspended sediments takes place.

Based on baseline habitat and marine ecology investigations previously undertaken throughout the potentially affected area (Figure 5-6 & Figure 5-8) the area of seafloor likely to

be impacted by shoreline excavation primarily comprises of unconsolidated sediments with low density seagrass. The habitats are overall low in ecological value and do not harbour significant fauna. With the majority of the habitat expected to be disturbed not particularly rich in biodiversity compared with other shoreline areas along the Emirate, with the implementation of suitable mitigation measures, it is expected that the affected habitat will be limited to the area of construction only. As such, impacts to adjacent more valuable habitats are expected to be minor in magnitude as there will be some measurable change in the attributes, but not affecting integrity of the marine environment in its present state. Impact from the shoreline and offshore construction works will be limited in size and scope as they are by definition and design restricted to the narrow corridor of the outfall pipeline corridor and intake pipeline/channel at the shoreline. The impacts described are not considered to be permanent, as it is expected that habitats within the dredging corridor will recover as epibenthic organisms resettle returning the habitat to a similar state prior to dredging activities. Furthermore, there is potential for re-growth of marine flora along the shoreline area once installation is complete and experience from previous shoreline infrastructure projects have demonstrated that the rocky revetments, breakwaters and armouring of the shoreline will provide complex substrate for settlement of anchoring species and provide spaces for juvenile fish to hide.

In order to maintain as far as practically possible, a suitable environment for the colonisation and development of marine community once shoreline construction has ended, the construction management strategies should aim to minimise activities that may further damage the physical marine environment or decrease the water quality further than necessary (i.e. increased suspended sediments). This can be practically achieved through not disposing of dredge material into the open water through side casting and the use of effectively deployed silt curtains.

Dredged/Excavated Sediments

Excavated shoreline sediments removed as part of the pipeline route and shoreline intake pipeline/channel construction process may require storage on land. Until ready for reuse as cut/fill balance or removal by licenced contractors to appropriate disposal facilities, excavated sediments will likely be stored within the construction laydown area. This will be at a sufficient distance from the shoreline such that there is no risk of runoff of water to the sea during periods of heavy rainfall. The free draining nature of the project site soils may pose an impact to groundwater quality if excavated material were to contain any residual contaminants. Chemistry analysis on marine sediments presented in Table 5-5 and 5-7 has indicated that marine sediments throughout the site are non-contaminated and would not pose a threat to groundwater resources in the area.

It is expected that at a minimum, construction of the outfall pipeline would be completed using silt curtains deployed to isolate the construction area from the marine environment and

prevent uncontrolled dispersion of suspended sediments in the water column while dredging, pipelaying and building of associated structures. Impacts to the marine system are foreseen to be continuous during the dredging of the route and laying of pipe and diffuser sections.

The baseline habitat and marine ecology investigations (discussed Section 5.2.3, Figure 5-6 and Figure 5-8) indicate that habitat along the pipeline route is likely to comprise a majority sand substrate with some areas of low-density seagrass and no significant features. Although it is likely that there are further locations where seagrass exists, the habitats throughout the affected area are overall low in ecological value and do not harbour significant fauna.

Dredging of the outfall pipeline corridor will be limited to the lowest width possible and the construction corridor will be defined by silt curtain positioning. The construction technique has not been finalised, and is pending confirmation by the EPC Contractor together with specific Method Statements and Management Plans prepared by the specialist appointed Dredging Contractor.

The influence of marine dredging and fill operations extends beyond the construction footprint Three impact zones can be identified that correspond to a varied response of the marine habitats identified by Purkis and Riegl (2007) in relation to distance from the construction area.

- Zone 1: up to 100 m from the dredged channel;
- Zone 2: 100 to 350 m; and,
- Zone 3: 350 to 900 m.

Considering the construction methods and marine habitat type surrounding the project; beyond 900 m, negligible or no impact is expected. The following table summarises the impact and potential for recovery for impacted habitat. The evaluation is based on expert judgment and scientific literature review.

Table 5-29: Impact Evaluation of Dredging on Critical Habitats – Outfall Pipeline

Habitat type	Zone 1	Zone 2	Zone 3
Low Density Seagrass Beds and Macroalgae	**Impact**		
	Complete loss of seagrass and associated flora and fauna	Moderate impact. Stress, reduced growth, moderate loss of biodiversity of associated flora and fauna	Negligible impact
	Potential for Recovery		
	Patches of seagrass may reappear in the area where sandy and medium-fine grained substrates reappear	Marine vegetation will recover once construction activities stop	Marine vegetation will recover once construction activities stop
	Impact		

Habitat type	Zone 1	Zone 2	Zone 3
Subtidal Silt and Sands	Loss of macrobenthos and benthic microalgae production. Significant reduction in biodiversity, community shift towards benthos adapted to mud environments	Minor to moderate deterioration: reduced growth, minor reduction of biodiversity and shift in community associated flora and fauna	Negligible or no impact
	Potential for Recovery		
	Macrobenthic community biomass may partially recover	Benthos may fully recover	Not applicable

Prior to the implementation of mitigation measures, and based on the scale of the marine construction activities, it is predicted that construction activities, in the case of building an offshore outfall, would result in an overall impact of moderate negative significance to the marine ecology of the project site, as a result of direct damage and habitat removal over a larger surface area when compared with the shoreline discharge (Table 5-30 and Table 5-31).

Noise and Vibration Disturbance to Marine Fauna

Marine works may result in a temporary disturbance to marine fauna through underwater noise and vibration originating from dredging and excavation activities. Fish and marine turtles are likely to be the most sensitive receptors to underwater noise and vibration, as they occur along the UAQ coastline primarily towards the south along the mangrove channels.

The main response of the higher level marine motile fauna (such as mammals, reptiles and fish) to elevated underwater noise levels is typically avoidance. Therefore, during noise creating activity it is probable that these fauna would move away from the immediate source of the noise. Spawning and nesting seasons are generally the most sensitive period for fish and turtles in terms of noise disturbance.

It is likely that motile fauna would not approach within range of the project site to be affected by noise and vibratory affecting works due to the lack of ecology at the site which would not be comfortable or attractive to marine organisms. Certain construction processes, particularly those involved with site preparation and civil works, e.g. breaking, levelling and excavations, have the potential to create vibrations within the vicinity of the works at the shoreline.

Piling works can be expected as part of the initial shoreline construction works and vibro-compaction activities may take place later during backfilling at shoreline around the new intake channel and transition zone of the outfall pipeline. Vibrations are anticipated to occur sporadically around the construction site due to the movement of materials and equipment, although these may dissipate rapidly as they spread due to losses of energy radiating 360 degrees from the source. Additionally, the relatively shallow and constricted work area will

reduce the field and distance of noise propagation, therefore restricting the area of potential impact.

Observations made during the preliminary EIA and project-specific benthic habitat survey suggested low value habitat which does not encourage marine fauna to develop or remain in the area. On this basis, the impacts from underwater noise and vibration are considered to have a minor negative effect.

Construction Vessel Operations

Construction vessel traffic may potentially disturb marine reptiles such as the turtles which may pass through the project area. The most likely impact would be behavioral, such as a startle response or avoidance of the area. It is recognised there is a low risk of a vessel striking a sea turtle or marine mammal (Lutcavage *et al*., 1997).

In the absence of mitigation measures, and based on the activity level of marine vessels, it is predicted that the vessel operations could result in an overall impact of moderate negative significance to the marine mammal and reptiles although this is unlikely. Once the construction phase is completed and vessels are demobilised from the site, there is no further risk of marine mammal and turtle impacts from collision with project construction vessels

In order to maintain a suitable environment for the colonisation and development of marine community once construction has ended, the construction management strategies should aim to minimise activities that may damage the physical marine environment or decrease the water quality further than necessary (i.e. increased suspended sediments).

Groundwater Dewatering and Dredged Material Runoff

On-shore excavations for foundation works will encounter groundwater during construction. The groundwater survey (see Section 7 Soil, Geology & Groundwater) encountered groundwater at a shallow depth of between 1.3 to 3 m. Typically, during dewatering processes, the construction team will make use of pumps to continuously remove water which is then percolated through gravel filled tanks or temporary settlement ponds using earth bunds and geotextile liners to reduce the suspended solids and turbidity prior to discharge into the sea in order to comply with Abu Dhabi and Iranian Discharge Standards. Any dredged material that is to be stored on land should be stored more than 100m distance from the shoreline to reduce the risk of runoff into the sea which raises the risk of causing high loads of suspended sediments and a reduction in seawater quality.

It is likely that several silt curtains will be required at the shoreline to reduce the spread of suspended solids from dewatering discharge operations, thereby meeting Abu Dhabi and Iranian Ambient Marine Water Quality standards. Following these control measures, minimal water quality impacts on flora and fauna should result from groundwater discharge to the marine environment.

The magnitude and significance of the impacts resulting from construction activities without implementing any mitigation measures, is summarised in Table 5-30 and Table 5-31.

Table 5-30 Marine Environment – Magnitude of Construction Impacts

Impact	Magnitude	Justification
Shoreline Excavation	Moderate	Impacts will result in moderate change to marine ecology due to permanent loss of habitat and increased turbidity. Moderate and temporary impact to water quality.
Pipeline Route Dredging	Moderate	As above, negative effects of suspended solids in the water column have a higher magnitude, with effects persisting over a more widespread area and longer duration.
Shoreline Remediation	Moderate	Impacts will result in moderate change to marine ecology due to permanent loss of habitat and increased turbidity. Moderate and temporary impact to water quality
Dewatering	Moderate	A temporary and short-term impact resulting from releases of turbid and chemically different properties of the groundwater from the receiving seawater.

Table 5-31 Marine Environment – Significance of Construction Impacts

Impact	Magnitude	Receptor	Sensitivity	Impact Significance
Shoreline Excavation	Moderate	Coastline Ecology	Low	Minor
Pipeline Route Dredging	Moderate			
Shoreline Remediation	Moderate	Coastline Ecology	Low	Minor
Dewatering	Moderate	Water and Sediment Quality	Low	Minor

Table 5-32 Marine Environment- Impact Significance, Mitigation & Management Measures and Residual Impacts- Construction

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
Shoreline Excavation	**Negative**	Intertidal Area	Medium	**Negligible**	• Excavation method statement will be prepared prior to the commencement of excavation activities. The method statement will define all the mitigation and monitoring requirements included in this ESIA and any further mitigation and monitoring measures that may occur as a condition of the ESIA approval from the UAQ Municipality and Lender requirements. • Mitigations in regard to excavated material run off will be required to limit suspended sediment. This will require silt curtain deployment (up to 3 layers may be needed) and settlement pond filtration systems prior to discharge. Monitoring of discharged effluent will be required to confirm compliance with the applicable UAE Federal and IFC standards. • All dredging activities will incorporate the use of silt curtains to protect adjacent waters and marine habitats from suspended sediments. See dredging activities for mitigation and management measures. • Storage of excavated shoreline sediment to be at sufficient distance (at least 100 m) from the shoreline to prevent uncontrolled runoff into the sea, particularly during heavy rainfall.	**Negligible to Minor**
Dredging Activities	**Minor Negative**	Marine Ecology	Low	**Negligible to Minor**	• Dredging Method Statement will be prepared prior to the commencement of dredging activities. The method statement will define all the mitigation and monitoring requirements included in this ESIA and any further mitigation and monitoring measures that may occur as a condition of the ESIA approval from the UAQ Municipality. • Disposal of material from the off-shore dredger will be onto the land and will not be side cast, where possible. Consideration will be given to the re-use of the dredge spoils for the cut/fill balance for the on-shore works.	**Negligible**
	Minor Negative	Water and Sediment Quality	Low	**Negligible to Minor**		**Negligible to Minor**
	Minor Negative	Intertidal Area	Medium	**Minor**		**Negligible to Minor**

					Mitigations in regard to dredged material run off will be required to limit suspended sediment. This may require silt curtain deployment and settlement pond filtration systems prior to discharge. Monitoring of discharged effluent will be required to confirm compliance with the applicable standards. All dredging activities will incorporate the use of silt curtains to protect adjacent waters and marine habitats from suspended sediments. Silt curtains reduce water movement in the area contained by the curtain which then allows suspended sediment within the contained area to settle out of suspension, before water disperses broadly. • Silt curtains will be placed at a suitable distance from the dredging activity to prevent spread of silt as much as practicable without introducing risk to the dredger. Laying out of the silt curtains and distances to be maintained from the dredger will be identified within the dredging activities risk assessment and method statement. • Concrete blocks attached to the bottom of the silt curtains will prevent the screen from floating or dragging along the seabed in windy conditions. • Silt curtains will be left in place after dredging activities are completed to allow for complete settling of sediment. The curtains may only be removed once concentrations of suspended sediments within the silt curtain area are reduced to levels in compliance with the applicable standards. • Timing of the dredging activities will consider the current direction, tide levels and wind/wave energy in order to maximise the efficiency of the silt screen and minimise potential for transport of the sediment plume over long distances. • During marine dredging works, the use of explosives to clear any area is prohibited. • The propellers on the dredgers will be fitted with propeller guards to prevent mortality of marine species.	

					• Storage of dredged sediment to be at sufficient distance (at least 100 m) from the shoreline to prevent runoff into the sea during heavy rainfall.	
Temporary removal of the intertidal area	**Negative**	Intertidal Area	Medium	**Minor**	• Removal of existing intertidal/rocky habitat to be performed only where necessary and within the footprint of the pipeline/channel route. • Restoration of the marine rocky habitat within the construction footprint after completion of works to facilitate the re-establishment of intertidal biodiversity where possible.	**Negligible to Minor**
Disturbance of marine fauna	**Minor Negative**	Marine Ecology	Low	**Negligible to Minor**	• Vessel masters and crew members to be trained on the identification of marine fauna species. • Marine vessel movement related to the project should remain in the project area to reduce disturbance to the sensitive marine areas near to Al Sinniyah Island (south-west of the project site). • If any sensitive marine species such as turtles are within 100m of the works, construction activities in the vicinity of the sighting will be temporarily suspended until direction of movement is away from the vessel or no further sighting. The sighting must be reported immediately to the HSE Manager and no attempt to capture the animal.	**Negligible to Minor**
Impact on seawater quality due to groundwater dewatering, dredging material runoff, spills and marine vessel activities	**Minor Negative**	Marine Ecology	Low	**Negligible to Minor**	• Provision for the settlement of de-watered effluent will be provided (i.e. settlement ponds) to ensure that discharged de-watered effluent can meet the respective discharge standards. • Continuous and event-based (such as after storms or environmental incidents) monitoring of ambient water quality will be conducted at the dewatering discharge point from the settling pond to the sea and at areas close to sensitive receptors that support feeding turtles to ensure that compliance can be demonstrated with Abu Dhabi, Iranian and Lender requirements for TSS. • Inclusion of a spill management plan in the CESMP to prevent and control the spread of a spill in the marine environment.	**Negligible to Minor**

					• Site drainage controls will include provisions to limit pollution to the marine environment from storm-water runoff, specifically from oily water and sediments. • At no point is bilge or ballast water allowed to be discharged into marine waters. Bilge and ballasts waters must be stored securely on board the vessel, and then discharged into a port/marina treatment facility. • Discharge of untreated effluent is prohibited. • Any hazardous substances on board shall be securely stored in bunds with secondary containment to prevent any leaks or spills. • Spill kits will be provided on vessels and will be easily accessible. Sufficient quantities and distribution of the kit will take into account the size of the vessel and area where the spills are most likely to occur. • Site drainage controls will include provisions to limit pollution to the marine environment from storm-water runoff, specifically from oily water and sediments. • No hazardous substances will be stored within 100 m of the shoreline area. Bunds with secondary containment measures will be provided to prevent any leaks or spills.	

5.3.2 Operational Phase

The main impacts on the marine environment from the operation of the SWRO Desalination Plant are linked to the following operational elements:

- Intake of the seawater resulting with fauna entrainment; and
- Discharge of brine water.

Entrainment of Fauna

Depending on the intake design, seawater drawn in by the intake system for the production of freshwater may contain a variety of aquatic organisms.

Some organisms are small enough to pass through the mesh screens into the intake. This process, called entrainment, may affect plankton and larval stages of benthic organisms such as shellfish (i.e., meroplankton), and fish eggs and larvae (ichthyoplankton). Because of the abundance and short regeneration times of plankton, impacts of entrainment on these organisms have rarely been documented outside the immediate vicinity of the plant and are considered to be of little consequence. Therefore, entrainment impacts to phytoplankton and zooplankton are considered to have a relatively small significance. (Schubel and Marcy 1978; Hesse *et al.* 1982; Kennish *et al*. 1984; MDNR 1988; MRC 1989; EPRI EA-1038).

Aquatic organisms that are drawn into the intake and are too large to pass through the debris screens may be impinged against the screens. Mortality of fish that are impinged is high because they are eventually suffocated by being held against the screen mesh or are abraded, which can result in fatal infection. Depending on the design and location, impingement can affect large numbers of fish and invertebrates (crabs, shrimp, jellyfish, etc.), and is considered a moderate negative impact.

Impingement occurs when the intake through-screen velocity is too high for species, such as crab or fish, to swim away and results in them being retained against the screens. The US EPA has determined that if the intake velocity is lower or equal to 0.15 m/s, the intake facility is deemed to have met impingement mortality performance standards. Therefore, designing intake screening facilities to always operate at or below this velocity would address impingement impacts.

Open channel intakes are also typically equipped with coarse bar screens which typically have openings between the bars of 20 mm to 150 mm followed by smaller-size ("fine") screens with openings of 1 mm to 10 mm, which preclude the majority of the adult and juvenile marine organisms (fish, crabs, etc.) from entering the plant. While coarse screens are always stationary, fine screens could be two types – stationary (passive) and periodically moving (i.e., rotating) screens. Most marine organisms collected with the source seawater are removed by screening and downstream filtration before the seawater enters the RO system.

Discharge of Brine

Hyper-saline water (brine) affects the osmoregulation capability of marine organisms, which consequently may cause acute toxicity due to an excess, or deficiency of specific ions. Hyper-saline water is denser that background seawater, which may result in stratification in the water column, with the denser water settling at lower depth. Hyper-saline water also reduces the entropic ability of water consequently thermal dissipation rates are decreased.

The overall effect of this hyper-saline, warm layer of seawater at depth can be a stressed and restrictive environment, which will limit the ability of organisms to survive and consequently degrade the marine habitat where the undiluted brine persists, resulting in degradation of ecosystem diversity and reduced diversity of fish, flora, crustaceans and other benthic organisms in the surrounding area. A degraded marine environment at depth can have secondary effects on the upper levels of the marine environment as the support structure of the food chain can be compromised.

In order to assess the effect of an ongoing brine discharge to the area once the SWRO plant is operational, predictive modelling of brine dispersion plumes was performed as discussed in the following section.

Thermal and Brine Discharge Modelling

HR Wallingford was appointed by ACWA Power to undertake hydrodynamic and dispersion modelling for the proposed project. Hydrodynamic modelling was used to assess the effects of brine discharge on the water quality and the marine ecology within the coastal zone.

Hydrodynamic Modelling

HR Wallingford have used their established Arabian Gulf regional model to provide time- and space-varying boundary conditions for a detailed local model at UAQ. This procedure, commonly known as nesting, is a well-established technique for modelling hydrodynamics over wide areas with varying resolutions (see full report in Volume 4, Appendix F)

Regional Model

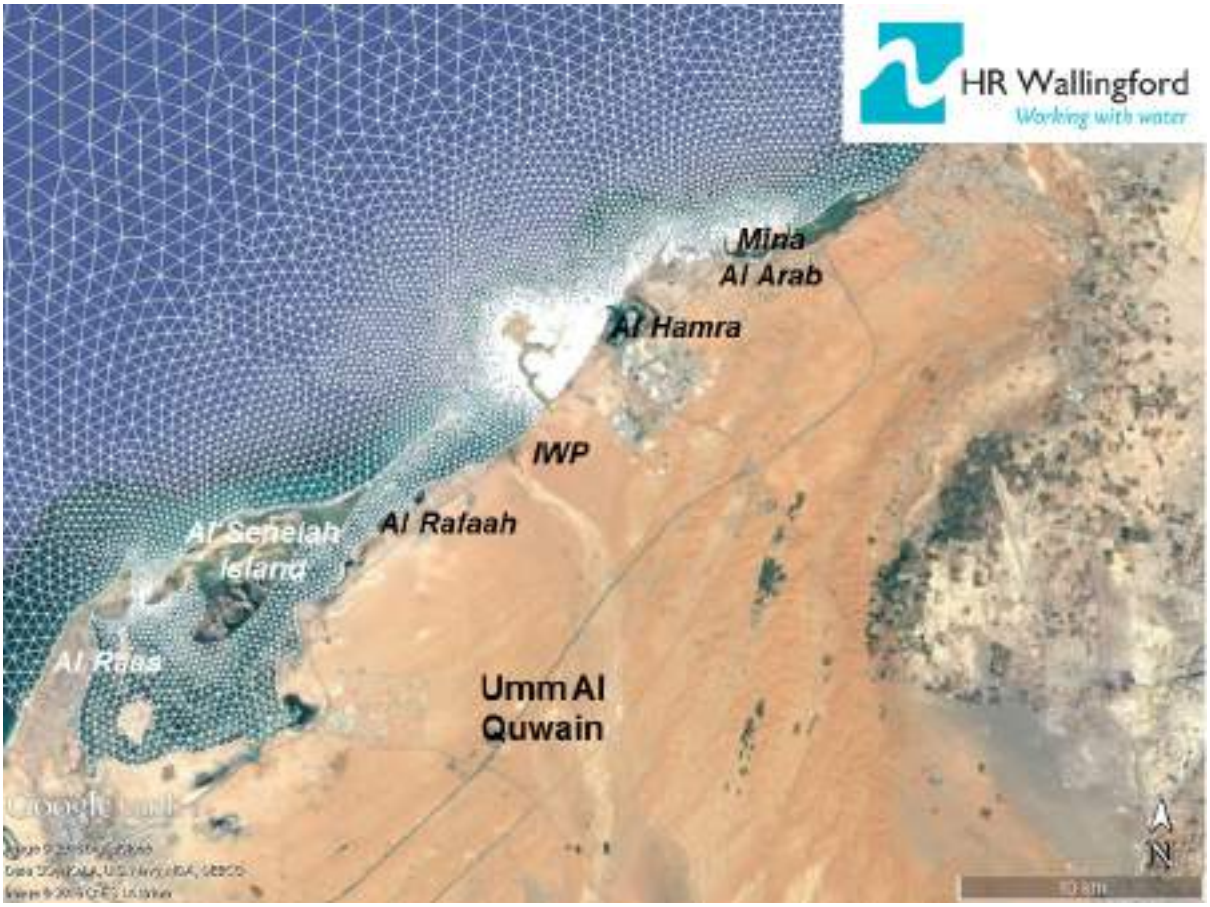
The regional Gulf model is built using TELEMAC, an established state of the art finite element model, which is currently being used by more than 200 professional and research organisations worldwide. The TELEMAC-2D module solves the depth averaged shallow water equations and is used to model various hydraulic phenomena such as tidal and coastal flows, storm surges etc. the TELEMAC system is developed under a quality assured system, which includes the application of stringent validation tests. TELEMAC uses a complex flexible triangular mesh. As meshes are unstructured, they can be easily refined to present coastline and other important structures efficiently and accurately.

Local Flow Modelling

HR Wallingford has an existing UAQ model built using TELEMAC-3D, which solves the equations of motions and transport in multiple layers, and includes the important effects of buoyant spreading, inhibition of vertical mixing associated with sharp density gradients, and sheer of wind-driven currents. Each of these processes is vital for the accurate stimulation of brine discharge dispersion and recirculation.

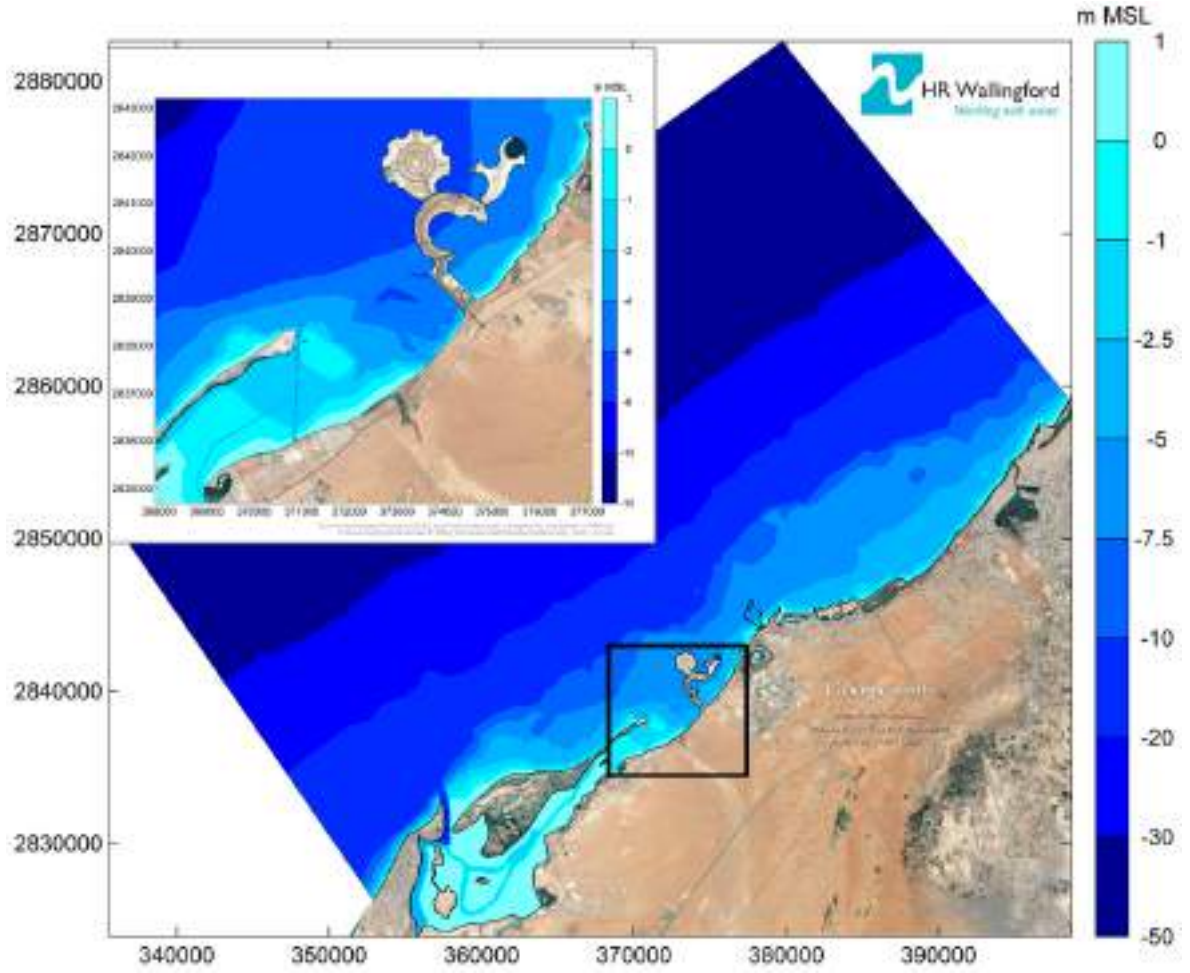
The figure below shows the mesh used for the baseline UAQ model.

Figure 5-11 Local Model Mesh



The model bathymetry is based on data from international hydrographic offices and has been updated to include the survey bathymetry collected by during the preliminary EIA survey (October 2017) as shown below in Figure 5-12.

Figure 5-12 Bathymetry Model Used in the Model



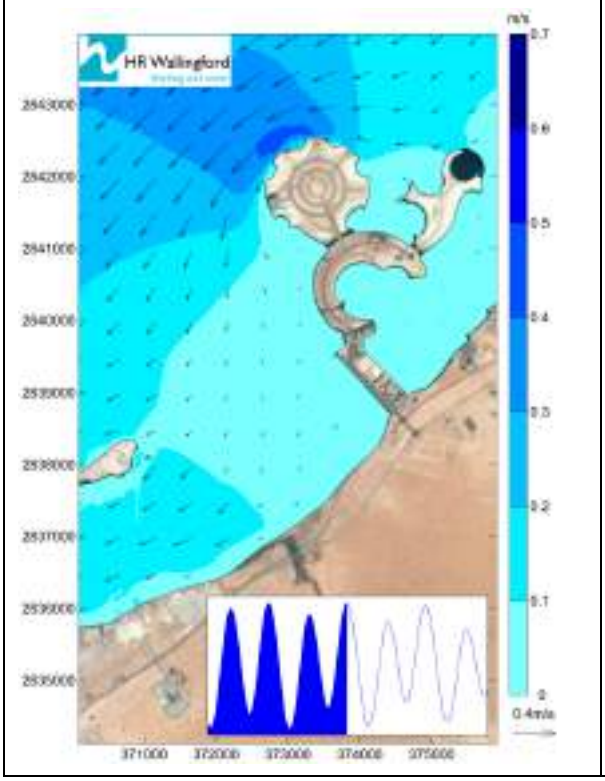
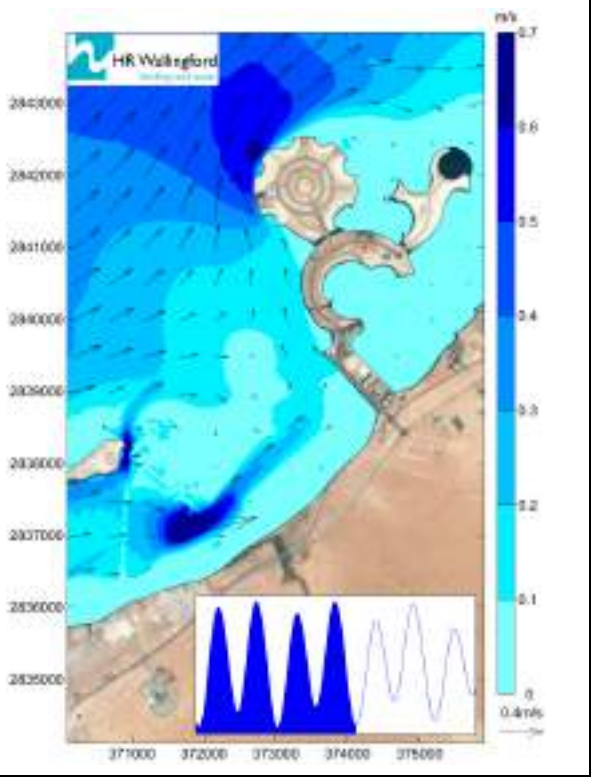
An ADCP was deployed in October 2017 by during the preliminary EIA survey to record currents, waves and water levels. The instrument was located at the initial location for the IWP intakes (25°39'23.30" N, 55°44'39.96" E), which is approximately 180 m from the shoreline.

Due to the ADCP deployment in shallow water and vertical resolution, HR Wallingford applied smoothing to data in order to reduce the noise within the measurements obtained.

The model was validated using the processed ADCP data by adjusting the model parameters to achieve the best possible agreement between the predictions and observations. Wind forcing was applied across the entire model using observed wind data from Dubai International Airport for the period of the ADCP.

The observed currents were slow, with speeds generally below 0.1m/s. in such environments, where the tidal components of the current are relatively weak, observed current speeds and directions are often highly variable, being affected by local wind and wave variations. These variations are more noticeable on neap tides, as the tidal currents are weaker than those on spring tides. An example of predicted currents in the vicinity of the site are shown in Figure 5-13.

Figure 5-13 Predicted Currents Used in the Model

High water, spring tide	Low water, spring tide
	

Modelling Input Data

The SWRO plant will produce 150MIGD (681,900 m³/day). The operational parameters provided by ACWA Power are provided in the table below.

Table 5-33 Modelling Input Data for the SWRO

Parameter	Description
Intake flow	7,1033 m³/hr
Brine effluent flow	42,620 m³/hr
Excess salinity in brine effluent	29 ppt
Effluent temperature	Maximum 1 °C above ambient
Intake length	600 m from the shore
Outfall length	3,600 m from the shore

Water quality sampling was carried out in October 2017 and the key parameters sampled with regards to hydrodynamic and dispersion modelling are:

- Ambient TDS: 42-43 ppt and sea water temperature: 31°C

Based on a background salinity of 42 ppt, the required mixing zones for the discharge are defined as follows:

Table 5-34 Mixing Zone Standards

Standard	Federal Standards	Iranian
Salinity Level	Salinity within 5% (2.1 ppt) of background at the edge of the mixing zone	Salinity within 10% (4.2 ppt) of background at the edge of the mixing zone
Mixing Zone Size	Size of mixing zone is not established	200 m diameter from point of discharge

Outfall Configuration and Near-Field Behaviour

As noted in the table above, the UAE Federal environmental standards require the excess salinity to be below 5 % (2.1 ppt) of the background salinity at the edge of the mixing zone. Therefore, HR Wallingford have proposed a diffuser design that meets the required level of dilution within the near-field area around the diffuser. However, as the seabed along the proposed outfall corridor slopes relatively gradually, water depths at the proposed outfall location (between 2.1 km and 3.6 km offshore) can be as shallow as 5m meaning that the depth of water available for mixing will require sufficient diffusers to achieve good initial dilution.

Brine from an SWRO plant is denser than the receiving water and therefore usually discharged as a series of individual jets from diffuser ports spread along a pipe. The ports are normally angled upwards so that the jets initially rise before sinking back to the seabed under their negative buoyancy. This increases the trajectories of the individual jets before they reach the seabed, maximises the potential for entrainment of ambient seawater, and reduces near-bed concentrations.

The proposed configuration for the proposed outfall has been designed using these principles and consists of a 1,500 m long diffuser, with 40 single-port risers, equally spaced along the pipe. The end point of the 1,500 m diffuser section is located 3.6 km offshore (with the first, shoreward, port discharges starting at 2.1 km offshore). Port diameters are 0.4 m, which produces exit velocities of approximately 2.6 m/s.

The proposed configuration is predicted to reduce excess salinities to within 2.1 ppt of the ambient values within the near-field area which extends about 30-40 m from the outfall. The saline layer that forms at the bed will be around 2-3 m deep at this point, which means that the spreading layer will occupy a significant proportion of the water depth. Dispersion of the brine over the wider area, and its potential for build-up around the diffuser over successive tides are provided in the next section.

Initial Outfall and Intake Layout

The intake (piped or open channel) will be located 600 m from the shoreline as shown in the figure below. According to bathymetric surveys of the area, the bed elevation 600m offshore results in minimum water depths of around 4m. The outfall diffuser will be located from 2.1 km to 3.6 km from the shoreline in water depths of around 6 m.

Figure 5-14 Location of Intake and Outfall Pipelines

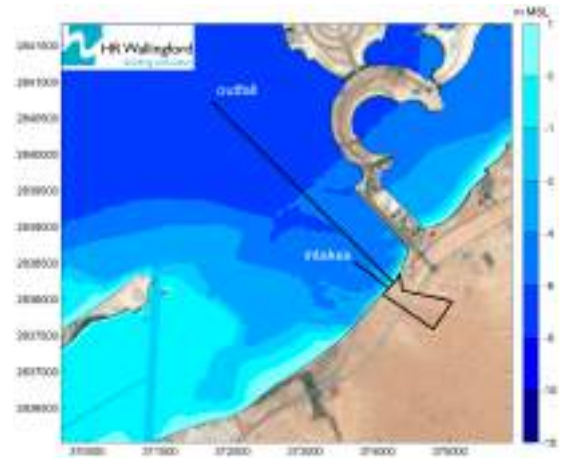
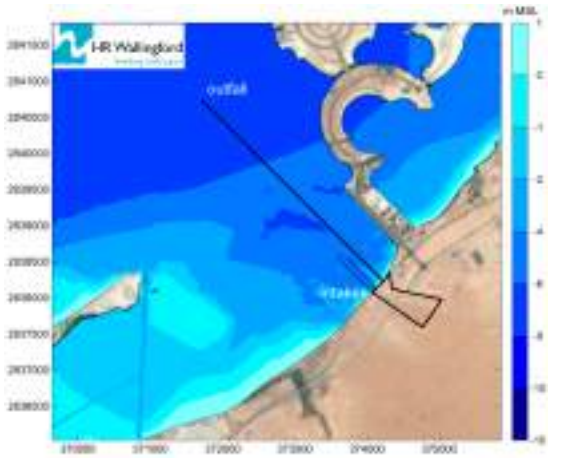
Piped Intake	Open Intake Layout with Breakwaters
	

Figure 5-15 Concept open intake layout with breakwaters layout, general arrangement

Wind Conditions

Wind conditions at the site were stimulated using data from Dubai International Airport accessed through the NOAA NCDC database. For the field dispersion assessment, winds were applied for a 17-day period from 19th October to 5th November 2017 to coincide with the ADCP deployment.

Far-Field Assessment

Brine Dispersion Patterns

Dispersion and recirculation were stimulated for "weak winds" and "strong winds". The strong wind simulations were conducted for 17 days to include a full 15-day spring neap cycle, and allowing two days model spin-up time (for dispersion patterns to reach a dynamic equilibrium). Weak winds simulation was conducted over two spring-neap cycles plus an additional two-day period at the start to allow model spin-up. This extended period was required as the weaker wind simulations took longer for dispersion patterns to reach an approximate dynamic equilibrium. However, it should be noted that such long periods of weak winds are unlikely to occur in reality, and these simulations therefore represent conservative conditions.

Model predictions are presented as:

- Contour plots of average excess salinity at the sea surface and seabed
- Contour plots of maximum excess salinity at the sea surface and seabed.

Predicted salinity dispersion patterns are shown in Figure 5-16 to Figure 5-22 for the periods of weak winds and strong winds respectively. As the brine is denser than the ambient sea water, it forms a layer to the seabed, meaning that excess salinities will be higher at the seabed than at the sea surface.

Depending on the configuration of the intake, the water may be drawn selectively from the lower part of the water column (offshore intake) or may effectively be drawn from the entire water column (open channel with breakwater).

In both scenarios, at the seabed, maximum excess salinities outside the near-field region are below 2 ppt, although excess salinities above 1 ppt are predicted up to around 8 km to the east of the outfall and 3.5 km to the west. On average, excess salinities are predicted to exceed 1 ppt up to 750m west and up to 1.8 km east of the outfall. This demonstrates that the rates of dilution in the spreading layer beyond the near-field are likely to be slow.

Using an offshore intake, excess salinities of up to 0.8 ppt are predicted at the seabed, and are highest around days 3 of the "strong winds" conditions, which largely coincide with stronger Shamal winds. At the sea surface and at the depth average the excess salinity is predicted to be similar which indicates a well-mixed water column at this location. This is to be expected given the shallow water depths at the proposed intake.

The results of using an open channel design were similar to the offshore intake in terms of excess salinity footprints and salinities at sensitive sites. The predicted excess salinities for the open channel intake are largely similar to those of a piped offshore intake apart from a small increase in the area immediately to the north-east of the intake breakwaters, which might be due to the blocking of the weak currents along the coast by the breakwaters. Peak predicted excess salinities at the offshore intake were increased slightly from 0.6 to 0.75 ppt (weaker wind case) and from 0.8 to 0.95 ppt (stronger wind case).

Peak excess salinities at the open intake channel are slightly higher than for the equivalent offshore intake, rising from 0.6 to 0.75 ppt for the weaker wind scenario and from 0.8 to 0.95 for the stronger wind scenarios.

Figure 5-16 Predicted Average Excess Salinity (Weak Winds)

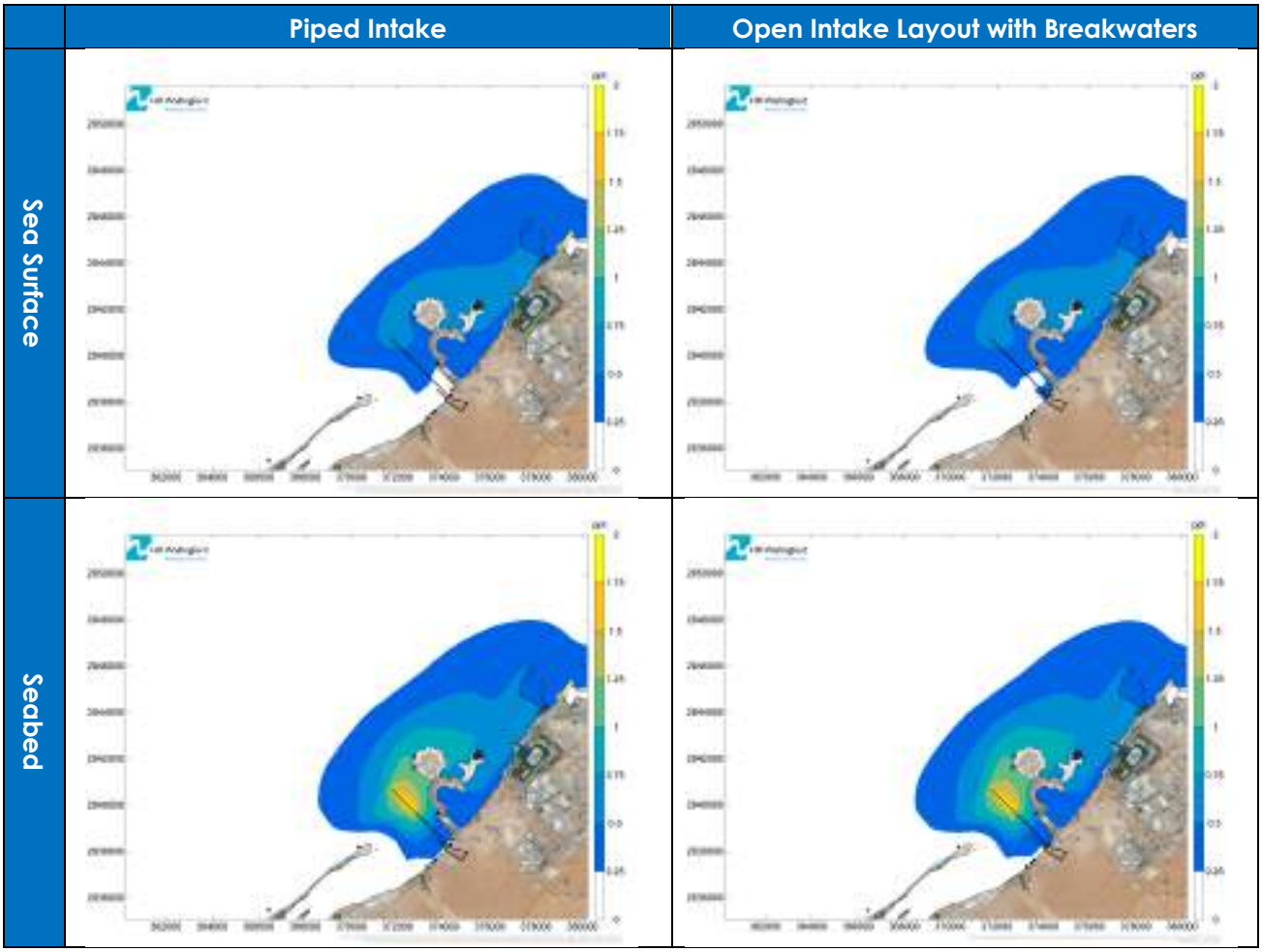


Figure 5-17 Predicted Maximum Excess Salinity (Weak Winds)

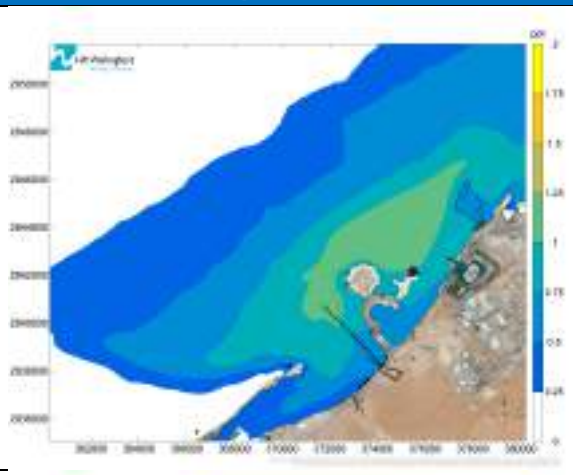
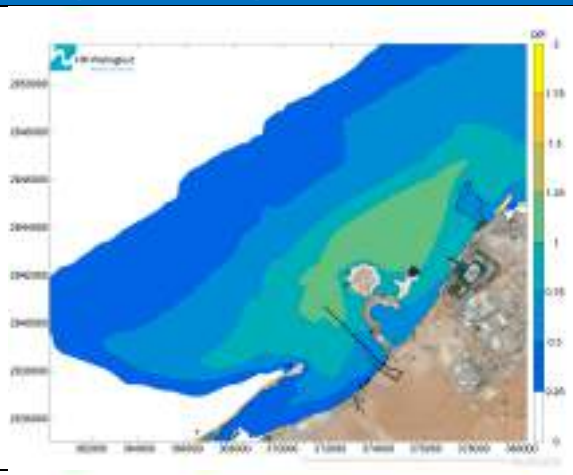
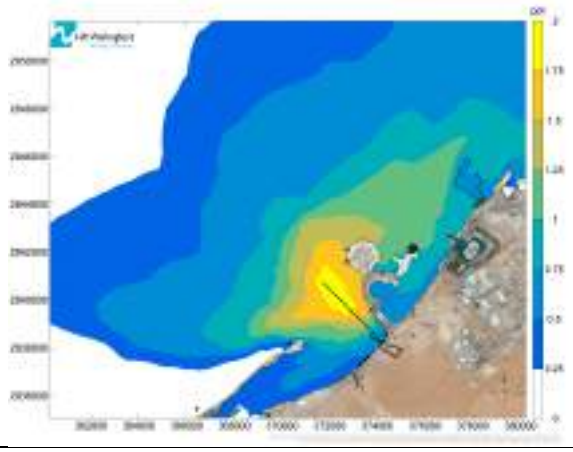
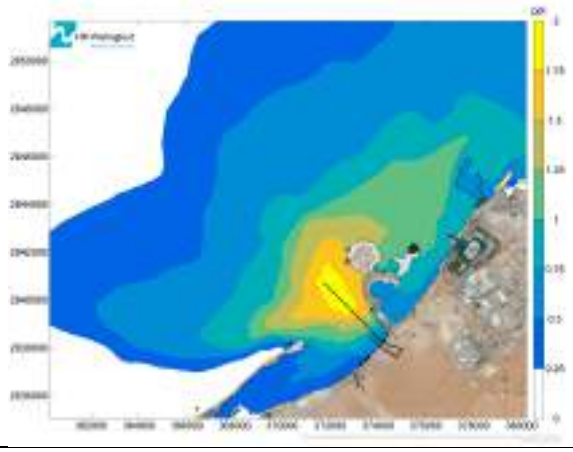
	Piped Intake	Open Intake Layout with Breakwaters
Sea Surface		
Seabed		

Figure 5-18 Predicted Average Excess Salinity (Weak Winds)

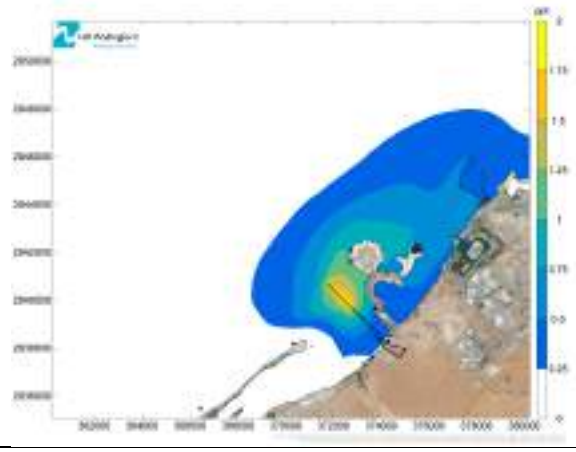
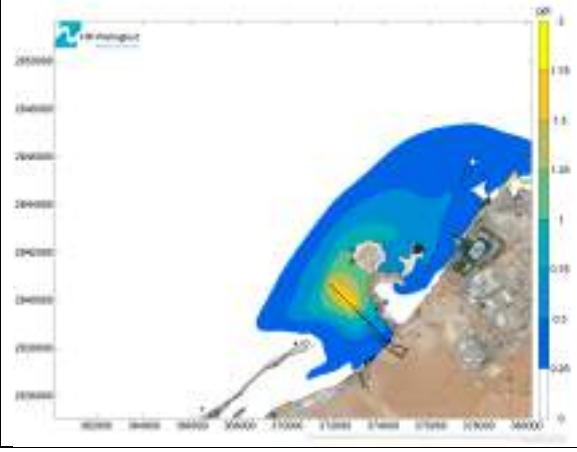
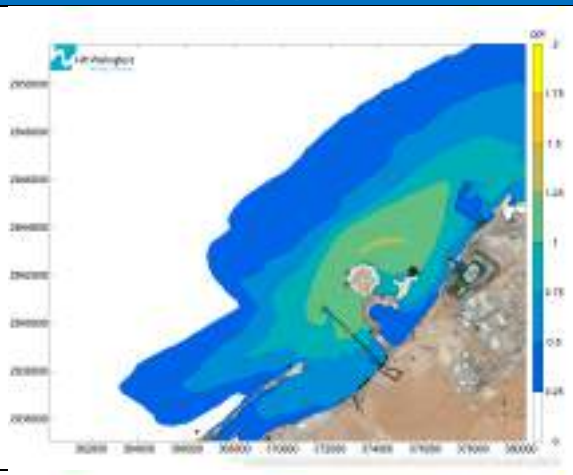
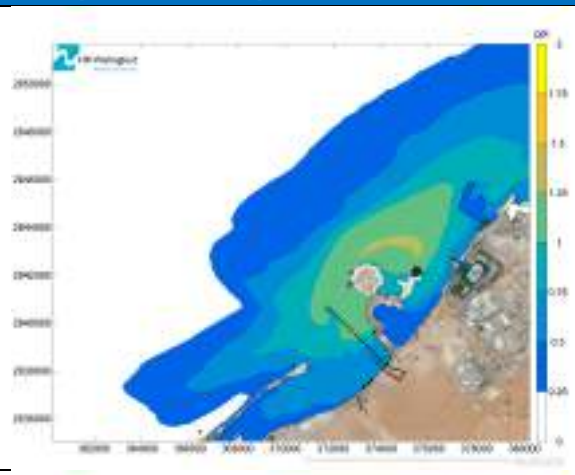
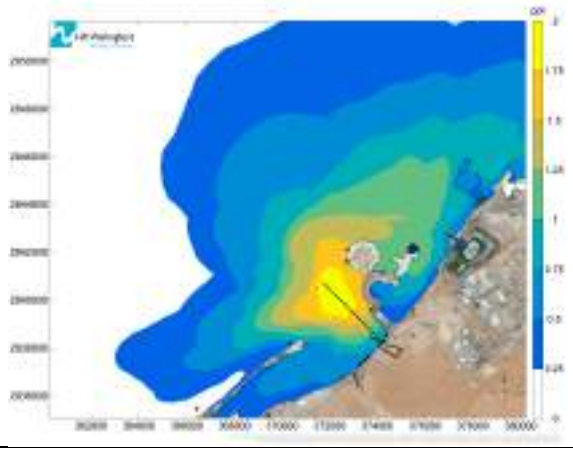
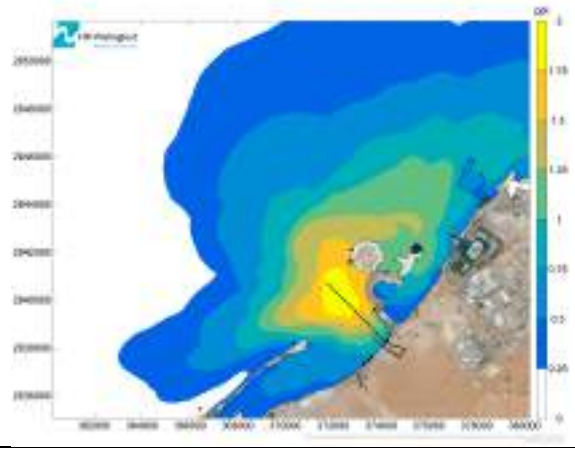
	Piped Intake	Open Intake Layout with Breakwaters
Sea Surface		
Seabed		

Figure 5-19 Predicted Maximum Excess Salinity (Stronger Winds)

	Piped Intake	Open Intake Layout with Breakwaters
Sea Surface		
Seabed		

Assessment at Sensitive Marine Receptors

The locations of sensitive marine receptors (Figure 5-20) was included in the model and times series of excess salinity at each of these locations are shown in the figures below. A summary of the predicted excess salinity at each marine receptor for the piped and open channel intake are provided in Table 5-35 below. The time series show excess salinities at the seabed, surface and as a depth-average.

Figure 5-20 Location of Sensitive Marine Receptors

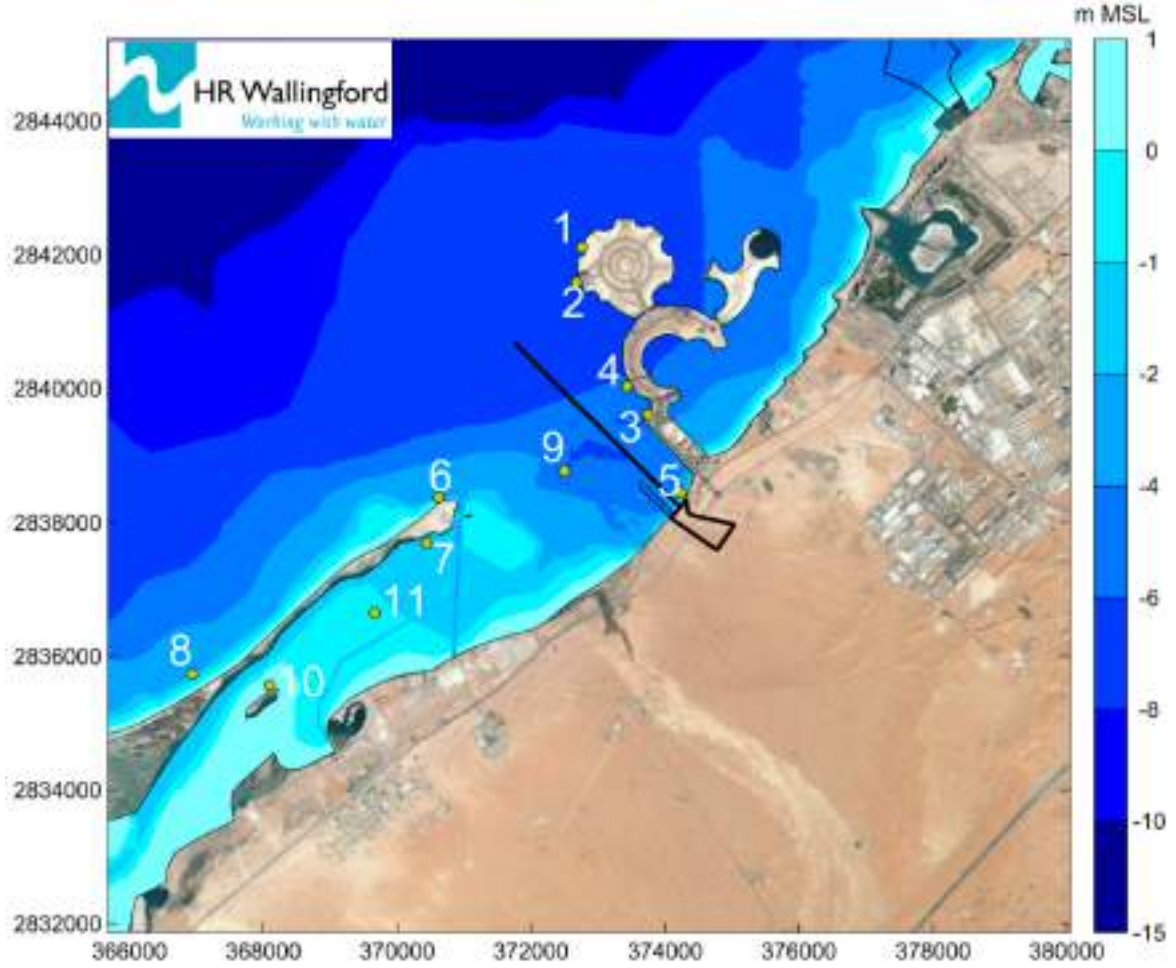


Table 5-35 Summary of Maximum Excess Salinity Predictions at the Marine Receptors

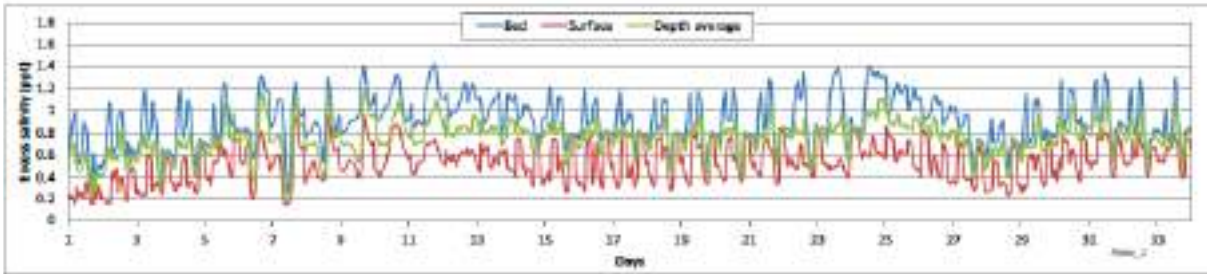
ID	Site	Maximum Predicted Excess Salinity (ppt)	
		Piped Intake	Open Channel
1.	DIC Hotel and Resort	1.5	1.5
2.	Pacific Development	1.6	1.6
3.	Ras Al Khaimah Convention Centre	1.3	1.3
4.	Tidal channel	1.6	1.6
5.	Rocky intertidal habitat	**0.7**	**0.8**
6.	Al Sinniyah island (north)	0.8	0.8
7.	Residential compound 3	0.6	0.6
8.	Al Sinniyah island (south)	0.1	0.1
9.	Sparse seagrass habitat	1.4	1.4
10	Residential compound 5	0.3	0.3
11	Area of observed turtles	0.6	0.6

The time series of excess salinity at DIC Hotel & Resort Project, rocky intertidal habitat(open channel & piped intake), Al Sanniyah island (north), Sparse seagrass habitat and area of

observed turtles are provided in the following figures at the seabed, surface and as a depth average. Time series from the open channel layout at available in the full marine modelling report (Volume 4, Appendix F), not presented here due to the similarities in excess salinity predictions shown in Table 5-35 above.

Figure 5-21 Predicted Excess Salinity at DIC Hotel & Resort

Weak Winds



Strong Winds

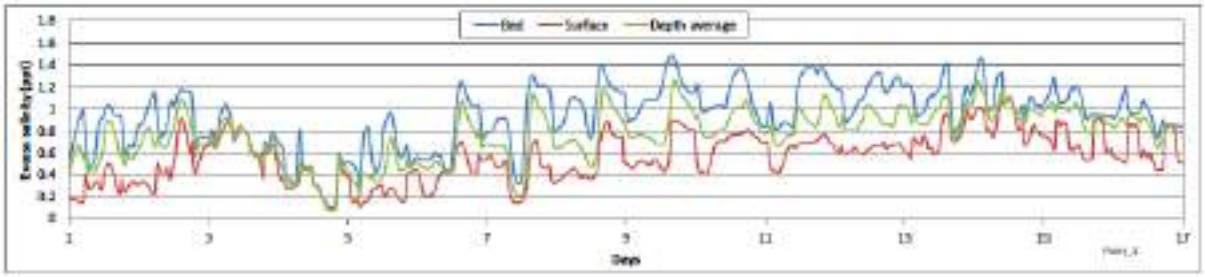
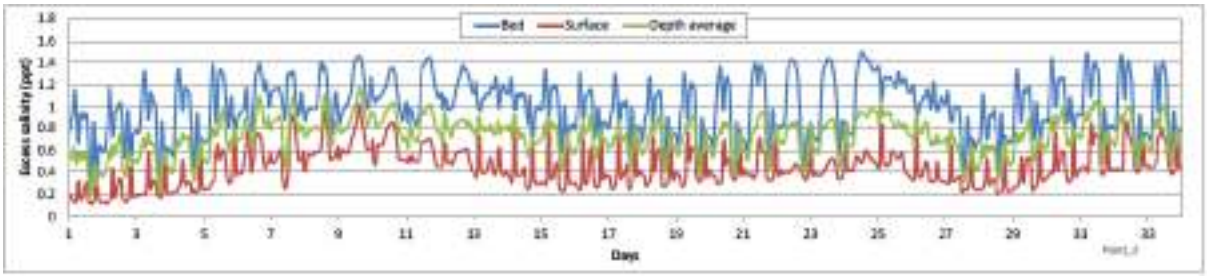


Figure 5-22 Predicted Excess Salinity at Pacific Development

Weak Winds



Strong Winds

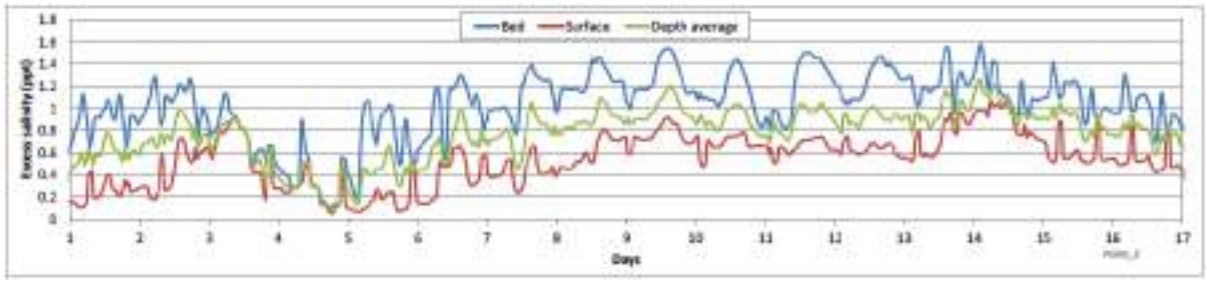
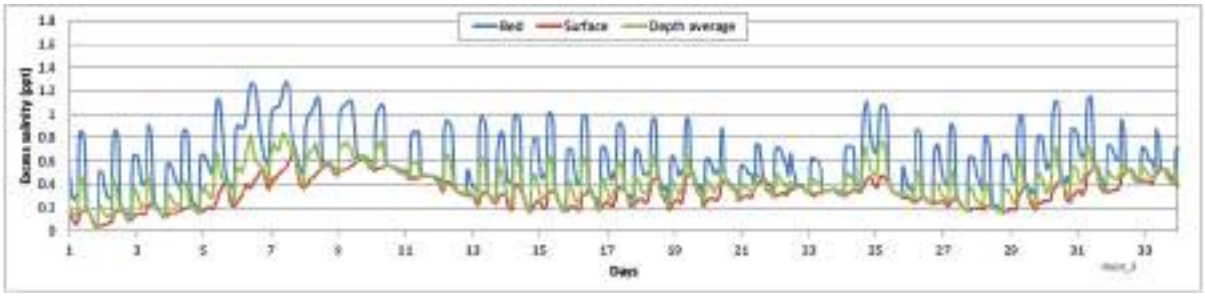


Figure 5-23 Predicted Excess Salinity at Ras Al Khaimah Convention Centre

Weak Winds



Strong Winds

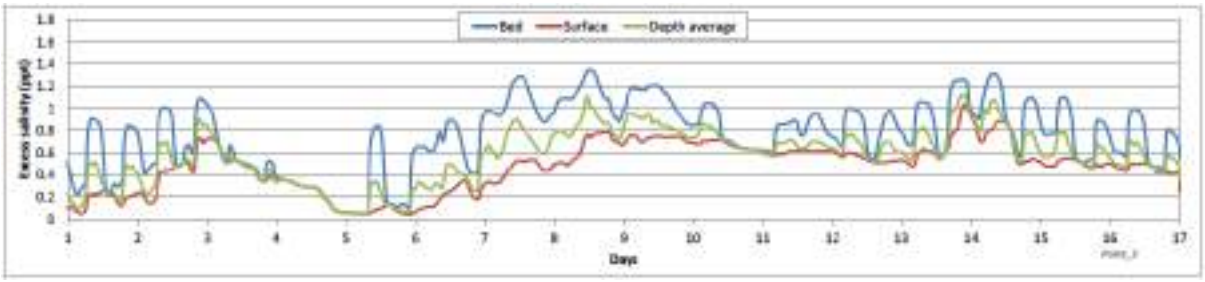
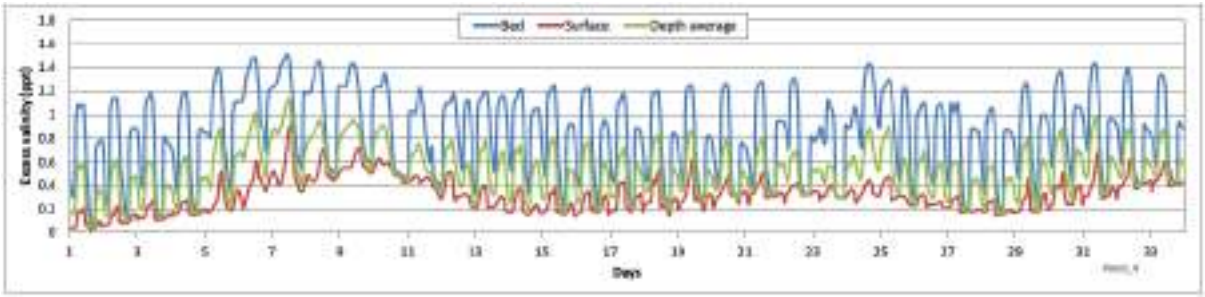


Figure 5-24 Predicted Excess Salinity at Tidal channel

Weak Winds



Strong Winds

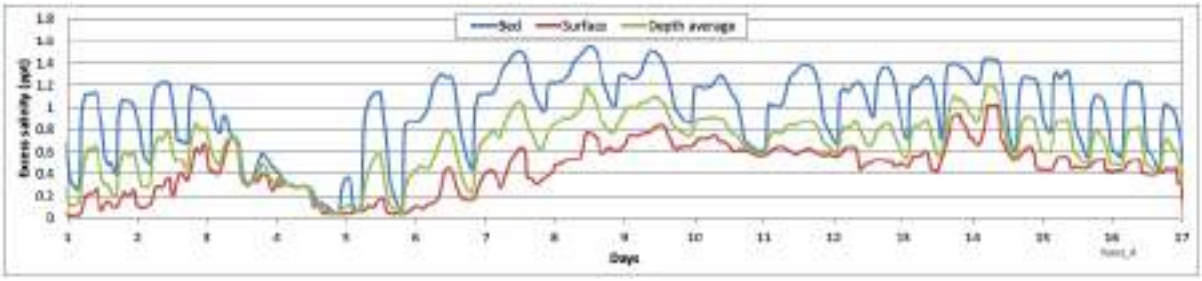
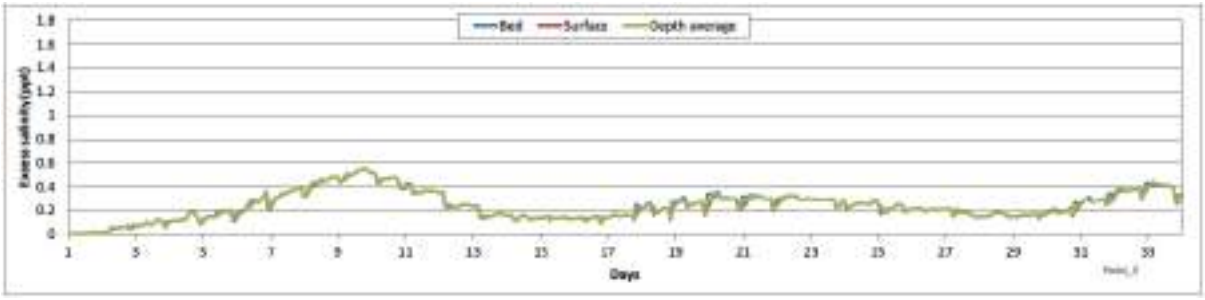


Figure 5-25 Predicted Excess Salinity at Rocky Intertidal Habitat

Weak Winds



Strong Winds

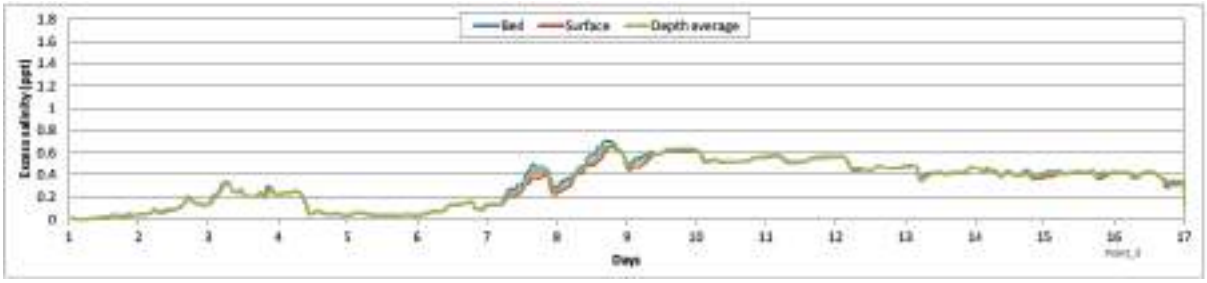
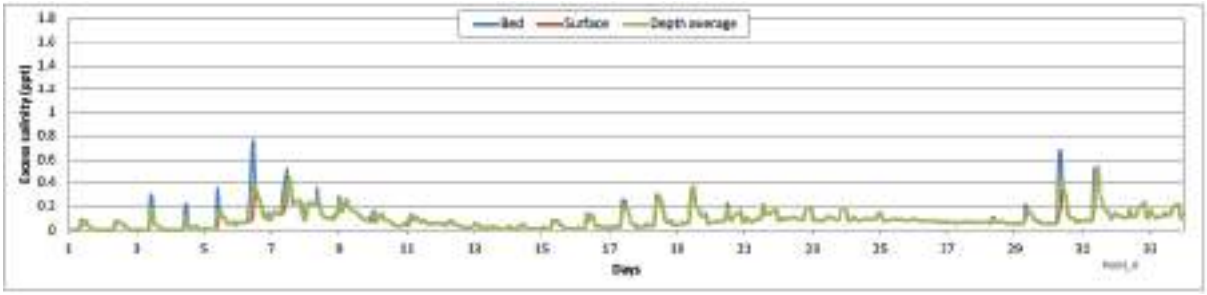


Figure 5-26 Predicted Excess Salinity at Al Sinniyah Island (north)

Weak Winds



Strong Winds

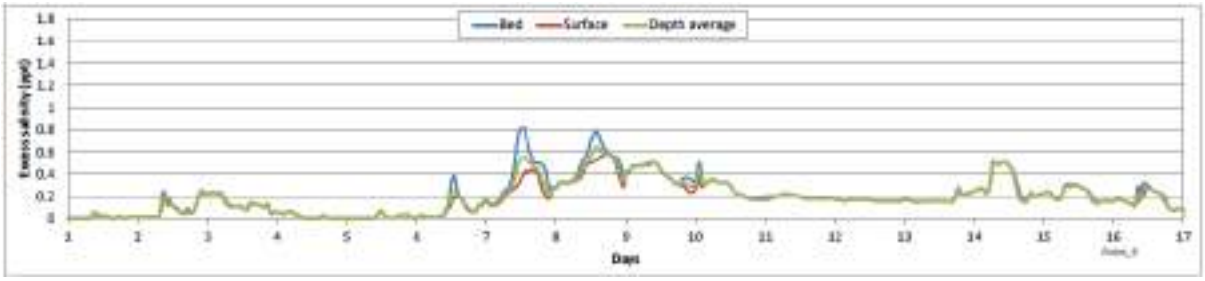
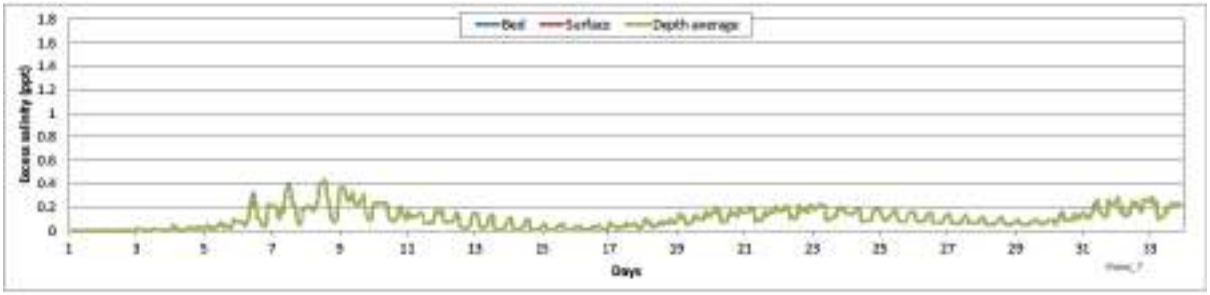


Figure 5-27 Predicted Excess Salinity at Residential Compound 3

Weak Winds



Strong Winds

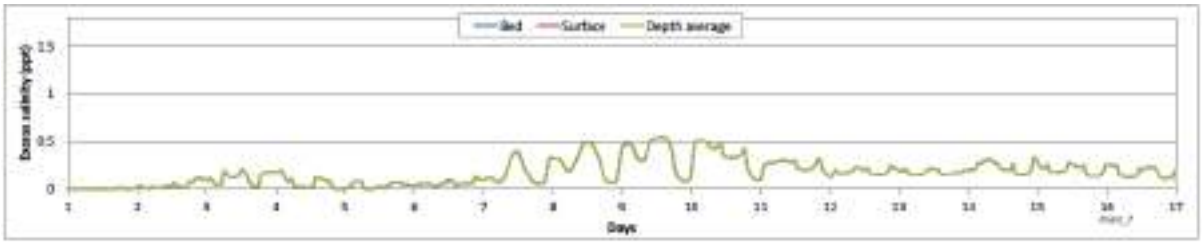
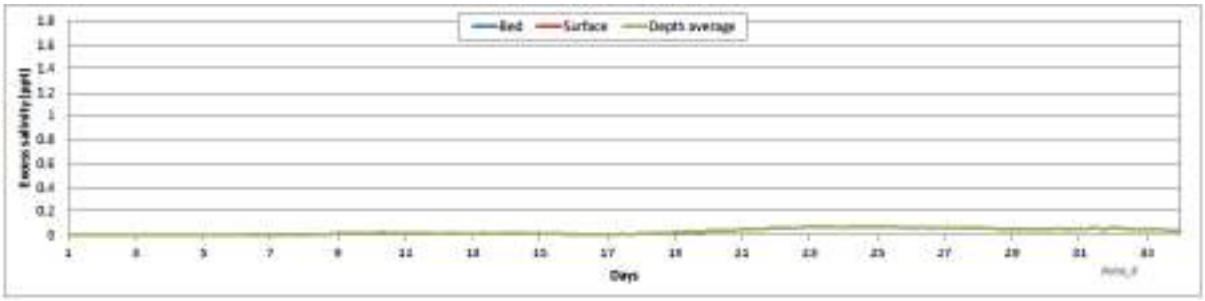


Figure 5-28 Predicted Excess Salinity at Al Sinniyah Island (south)

Weak Winds



Strong Winds

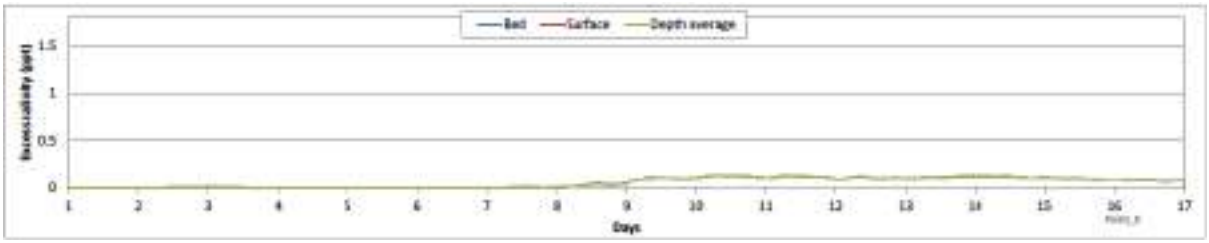
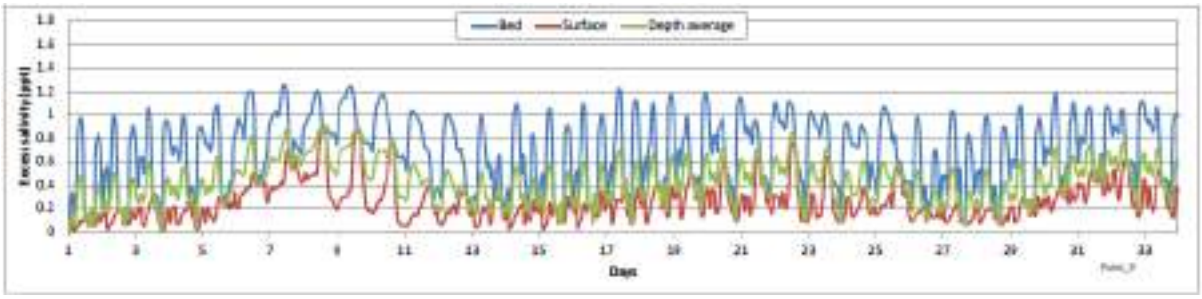


Figure 5-29 Predicted Excess Salinity at Sparse Seagrass Habitat (south)

Weak Winds



Strong Winds

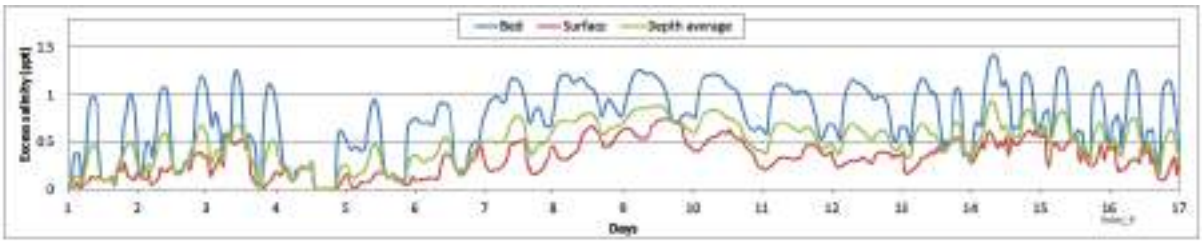
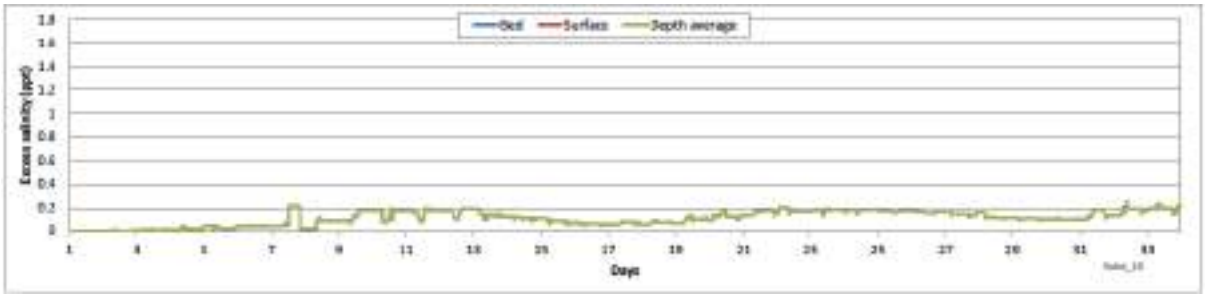


Figure 5-30 Predicted Excess Salinity at Residential Compound 5 (south)

Weak Winds



Strong Winds

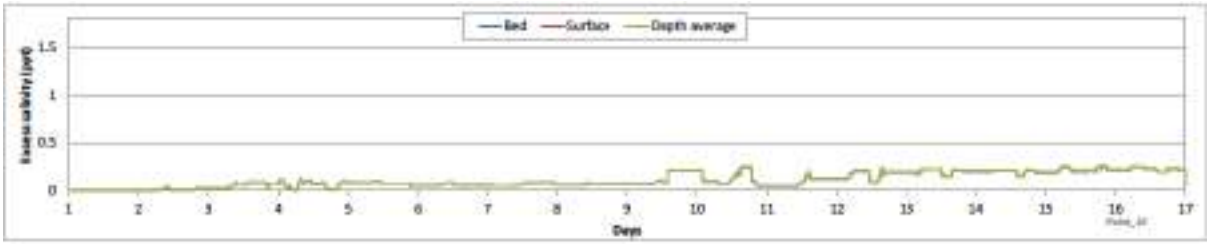
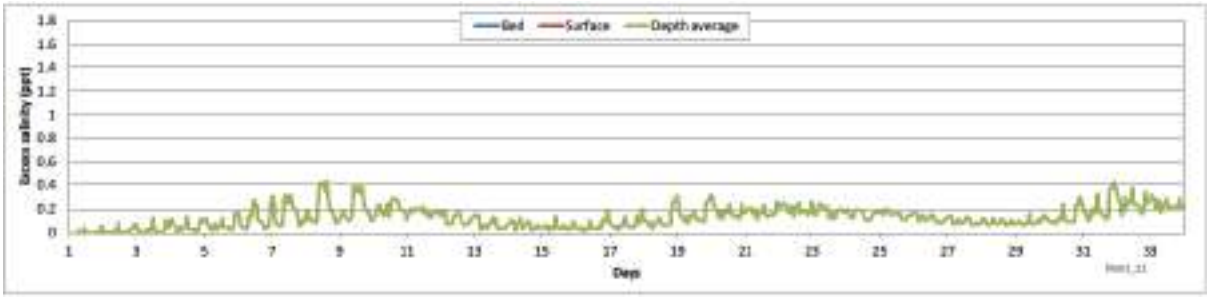
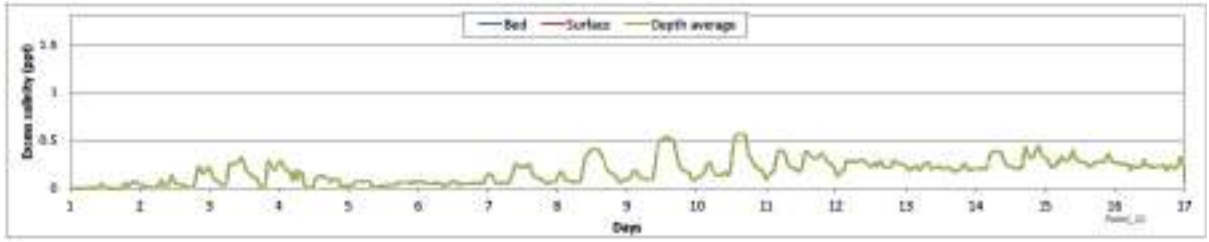


Figure 5-31 Predicted Excess Salinity at Area of Observed Turtles

Weak Winds



Strong Winds



Conclusions

The concept diffuser design for the brine discharge comprises of a 1,500 m-long diffuser section, with 40 single-port risers equally spaced along the pipe between 2.1 km and 3.6 km offshore where water depths are around 6 m.

The outfall is predicted to reduce excess salinities to within 5 % of the ambient values within the near-field area, which is estimated to be 30-40 m from the discharge point. This is in compliance with the most stringent of the environmental standards the project is required to adhere to. The saline layer that forms at the bed will be around 2-3 m deep resulting in the spreading discharge layer occupying a large proportion of the water depth.

At the seabed, maximum excess salinities outside the near-field region are below 2 ppt, although excess salinities above 1 ppt are predicted up to around 4 - 8 km from the outfall. On average, excess salinities are predicted to exceed 1 ppt up to 2 km from the outfall. This indicates that rates of dilution in the spreading layer beyond the near-field are likely to be slow.

Similar excess salinities of up to 0.8 ppt were predicted at both types of intake, offshore and open channel, with highest levels typically predicted to occur during stronger Shamal winds.

In both scenarios, maximum predicted excess salinities between 0.1 ppt and 1.6 ppt were predicted at nearby marine receptors. At the north-eastern corner of Al Sinniyah Island, maximum excess salinities of 0.8 ppt were predicted. However, the horizontal salinity gradient is relatively strong near this site, and only a small change in the plume position would be required to increase concentration.

The results from using an open intake channel instead of the offshore intake are generally similar in regards to excess salinity footprints and salinities at sensitive receptor sites. Peak predicted excess salinities at the open intake channel were increased slightly from 0.6 to 0.75 ppt (weaker winds scenario) and from 0.8 to 0.95 ppt (stronger wind scenario).

Table 5-36 Marine Environment-Impact Significance, Mitigation & Management Measures and Residual Impacts - Operation

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
Gradual increase in ambient salinity due to brine discharge	**Minor Negative**	Marine Ecology & Water quality	Low	**Negligible to Minor**	• Multiple brine discharge and pipeline length scenarios were undertaken to identify a design that complies with Abu Dhabi and Iranian mixing zones and international best practice guidelines. • Far field modelling has demonstrated that the proposed design achieves equilibrium during the modelling period and that longer-term build-up of salinity is not evident and that no further design based mitigation is applicable. • Regular and event-based monitoring of brine discharge will be conducted to demonstrate compliance with Abu Dhabi and Iranian mixing zones and international best practice guidelines.	**Negligible to Minor**
Entrainment of fish into the water intake	**Moderate Negative**	Marine Ecology	Medium	**Minor**	• Intake velocity will be in accordance with IFC guidance of < 0.15 m^3. • Design of the intake will be taken into consideration measures within the Federal TGD on the impingement and entrainment of organisms into water intakes and implement mitigation measures where practical. • Periodic monitoring of intakes will be undertaken during the first year of operation to record the effectiveness and ensure that there is no injury to protected species such as turtles. • A bubble curtain should be installed across the entrance of the intake channel to prevent jelly fish and other marine animals from through the intake channel. • Brief visual observation of the intake channel should be undertaken daily to check that reptiles,	**Negligible to Minor**

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
					mammals and large fish are not within the channel. • The management of the control methods will be in accordance to the season and the risks and any observed increases in jellyfish off shore and in those ending up in the waste skips from the screens of the intake pump.	
Exposure of marine habitat to pollutants and untreated discharge	**Moderate Negative**	Marine Ecology	Low	**Minor**	• All wastewater streams generated by the project will be treated at site, re-used or transported off-site. If to be discharged, all streams are first be treated at a wastewater treatment plant prior to discharge to the marine environment in accordance with Abu Dhabi and Iranian marine discharge standards.	**Negligible to Minor**
	Moderate Negative	Water quality and sediment	Low	**Minor**		**Negligible to Minor**

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
	Minor Negative	Intertidal area	Medium	**Minor**	• Untreated discharge of sludge, backwash, oily chemical, or sanitary wastewater to the marine environment will be prohibited. • Residual chlorine discharge will be within the Abu Dhabi and Iranian standards and with IFC requirements. It is rapidly degraded in seawater upon release, resulting in no short term or long-term build up in the marine environment. • Potentially hazardous materials and water treatment chemicals will be stored in designated areas in accordance with the requirements of Federal standards and international best practices guidelines so as to prevent any spills or seepage to groundwater or coastal waters. • Process monitoring and planned maintenance of desalination equipment will ensure no unintentional discharges into the brine water. • An Operation Control Plan to provide a monitoring programme to ensure that IUCN Conservation species (turtles) are not negatively affected during operation. • Monitoring of treatment processes for backwash water, sanitary, oily and chemical wastewater streams to record flows and treatment efficiency and re-use on site or disposal off site (zero discharge of treated wastewater or sludge to marine environment).	**Negligible to Minor**

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
Loss of habitat biodiversity from intertidal rocky habitat	**Minor Negative**	Intertidal area	Medium	**Minor**	• Retention of existing intertidal rocky habitat will be undertaken where practical although it is likely to be within the footprint of the open channel intake. • Restoration of intertidal rocky habitat will be achieved through the construction of open channel breakwaters which will also benefit plant operations by reducing risk of silt being drawn into the plant. In addition, the open channel will also reduce the risk from jelly fish blooms as they can be managed before blocking pipes in the plant. • The OESMP and supplementary plans will describe the operational conditions and specific measures to reduce entrainment of large fauna such as turtles and fish, whilst also minimising risks which could be posed by jelly fish in the future. • The open channel intake provides an opportunity to create extensive new habitat on the rock revetment which must be preferably from gabro rock or natural stone. Concrete blocks or for the breakwaters will not be suitable. • The breakwater (LHS) will be 600m in length and the breakwater (RHS) will be approximately 700m. Assuming from Spring HW to Spring LW will be approximately 1m, this will equate to 1300m^2 of new habitat on the outside of the breakwater and a similar area on the inside. This will mitigate for any loss of existing rocky habitat which is 100m^2. • In addition to the intertidal habitat, the new breakwaters will also provide up to 4,000m^2 of sub-tidal habitat suitable for colonisation by macroinvertebrates, sponges and corals and providing a rich habitat for fish species too.	**Neutral to Minor Positive**

5.4 Monitoring

The EPC Contractor will undertake marine monitoring during the construction phase of the project. The minimum expected requirements for the monitoring are outlined in the table below. The final monitoring methodology with specific details (i.e. locations, frequencies, durations, parameters etc.) will be developed in a specific 'Environmental Monitoring Plan'.

Table 5-37 Marine Environment - Monitoring Requirements

Monitoring	Parameters	Frequency & Duration	Location	Responsibility
Construction				
Fauna species	Species of conservation value (e.g. turtles)	Daily visual observations in marine construction areas.	All work areas in the marine habitat	EPC Contractor
Groundwater De-watering Discharge	Total Suspended Solids, Turbidity	Daily visual observations of turbidity & Monthly sampling and laboratory analysis or analysis by calibrated in-situ probe,	At all groundwater dewatering discharge points (after any mitigation)	EPC Contractor
Ambient Water Quality	Total Suspended Solids, Turbidity	Continuous water quality analysis	At discharge point of settlement ponds and at representative locations outside the silt curtain in proximity to nearby sensitive receptors	EPC Contractor
	Range of parameters including physical, heavy metals, bacteriological and hydrocarbons (ref. to ESIA baseline suite)	Monthly sampling and laboratory analysis.	Representative locations outside the silt curtain and in proximity to nearby receptors	
Operational				
Operational Discharge Monitoring	Residual Chlorine	Daily sampling and analysis.	From outfall discharge	O&M Company
	Range of parameters including physical, heavy metals, bacteriological (ref. to ESIA baseline suite).	Monthly sampling and laboratory analysis.	From outfall discharge	O&M Company

Monitoring	Parameters	Frequency & Duration	Location	Responsibility
HABS and Jellyfish	Monitoring of HABS and analysis of *chlorophyll a* is recommended to provide early warning for potential from algal blooms or bloom from jellyfish	Monthly sampling and laboratory analysis.	Open channel Intake and screens	O&M Company
Protected Fauna and Fish	Species of conservation value (e.g. turtles) and large fish	Daily observations (visual)	Intake channel and screens	O&M Company
Marine Ecology, Water & Sediment Quality	Benthic habitats including sea bed dwelling flora and fauna species, fish species, Ambient water quality, sediment quality	Annually	At representative locations along the intake and outfall pipeline alignment and at locations within the modelled mixing zone (as per ESIA dispersion modelling)	O&M Company

6 TERRESTRIAL ECOLOGY

This chapter describes the potential impacts and effects that may occur as a result of the project's construction and operational activities and identifies the measures that will be undertaken and implemented in order to mitigate these impacts.

6.1 Standards and Regulatory Requirements

Federal Law No. 24 of 1999 for the Protection and Development of the Environment establishes the framework for the protection of the environment in the UAE, and specifies the following relevant objectives:

- Protection and conservation of the quality and natural balance of the environment;
- Control of all forms of pollution and avoidance of any immediate or long-term harmful effects resulting from developments;
- Conservation of biological diversity; and
- Compliance with international and regional conventions.

6.2 Observation and Baseline Conditions

The flora and fauna diversity of the UAE is influenced by the habitats that are created by the varying topography, geology and localised climate conditions. The vast majority of the UAE is characterised by arid desert conditions and extreme temperatures which presents a harsh environment for species to live in. This is true for the proposed project site conditions.

However, by comparison the coastal zones in the UAE provide greater diversity of flora and fauna species, owing to increased variability of the landscape and climate conditions, as well as the habitats afforded by the marine environment. For instance, the proposed project site is approximately 3.5 km from Al-Sinniyah Islands which is recognised for its flora and fauna diversity.

The Island has the largest Socotra cormorant colony in the UAE (Muzaffar et al. 2017) which is listed as Vulnerable by the IUCN Red List of Threatened Species (IUCN, 2017). The Island also provides habitat for wading birds such as heron species, flamingos, the Great Knot and Crab Plover among other species like gazelles, red foxes and feral cats.

6.2.1 Habitat Classification

With reference to the Interpretation Manual of the Major Terrestrial Natural and Semi Natural Habitat (Brown & Böer, 2004) and the Abu Dhabi Emirate Habitat Classification and Protection Guideline (Al Dhaher et al (2017)), the project area and laydown areas can be broadly categorised into the following categories:

- Non-vegetated, exposed sandy beaches with coastal development, recreational activities and trash.
- Sand sheets and dunes with perennial herbs and graminoids with dunes less than 20 m in elevation, and without significant cover of trees, shrubs and dwarf shrubs. Vegetated to non-vegetated sand and dune areas colonised by perennial herbs and/or graminoids.
- Sand sheets and dunes with distinct dwarf shrub cover with *Haxolylon Salicornium, Zygophyllum qatarense*

Plates 6-1 Sand Dune Habitat (Project site 1 & 2 respectively)

Plates 6-2 Beach Sands Habitat (with Marjan Island to the north)

With respect to habitat types and based on the baseline conditions, the project footprint, the habitat around the project site can be classified as "Modified habitat" (in regard to IFC PS6) as it has been substantially modified due to the construction and operation of the E11 highway and the unpaved access roads connecting the E11 highway on the eastern and western extents of the project site 1 & 2.

Plates 6-3 Example of Modified Habitat Within the Project Site (next to project site 1 and laydown area 1)

Plates 6-4 Power lines on the western side of Project site 2 and on the east of laydown area 1 respectively

6.2.2 Ecological Survey

Methodology

Review of the satellite imagery and site walkovers have identified a number of flora species within the project site. The survey of flora species was conducted on 25th September 2018 within representative locations of the project site. The Site walkover was undertaken by two members of the survey team to assess the flora species available.

The site walkover also included an ecological survey at representative locations within the project site in order to identify the fauna species within the project site.

The surveys were undertaken through a combination of walkover and drive-over for observation. All fauna species and tracks or signs of fauna were documented such as burrows, tracks or animal droppings indicating evidence of recent activity. Evidence of avifauna species was also recorded during the survey.

In summary, the site survey included visual observations of mammals, including sightings, tracks, burrows, droppings, etc., visual and photographic documentation of avian species and visual observations of reptile species.

Results

Flora

The flora species identified within the project site are listed in the table below:

Table 6-1 Floral Species Encountered in the project Site 1 (2018)

Scientific Name	Abundance	Conservation Value/IUCN Category	Photo
Tetraena qatarense	Abundant- This species was encountered across the Project site in large numbers	Not Evaluated.	
Cynomorium coccineum	Rare- this parasitic specie was only sighted once during the site walkover.	Not Evaluated.	
Acacia	Occasional- Encountered only occasionally during the survey	Not Evaluated	

Scientific Name	Abundance	Conservation Value/IUCN Category	Photo
			
Unknown plant species	Rare-only one specie was sighted during the site walkover	N/A	
Stippa agrostis	Frequently seen across the site	Not Evaluated	
Cornulaca monacantha	Abundant- This species was encountered across the Project site in large numbers	Not Evaluated	

Scientific Name	Abundance	Conservation Value/IUCN Category	Photo
Salsola sp.	Frequently encountered across the site during the site visit	Not Evaluated	
Shrub indet.	Rare-only one specie was sighted during the site walkover	N/A	
Arnebia hispidissima	Occasional - this specie was only sighted a few times during the walkover	Not Evaluated	

Scientific Name	Abundance	Conservation Value/IUCN Category	Photo
Suaeda Vermiculata	Common-encountered in large numbers across the site during the site visit	Not Evaluated	
Salsola Sp.	Common-encountered in large numbers across the site during the site visit	Not Evaluated	
Arthrocnemum glaucum	Rare-this specie was only sighted a few times during the walkover	Not Evaluated	 *File photo*

Fauna

Table 6-2 Fauna Species Encountered in the Project Site 1 (2018)

Description	Abundance	Conservation Value/IUCN Category	Photo
Sand print possibly by Dhub spiny-tailed lizard (Uromastyx sp.)	Rare-Only one set of sand print was sighted during the site walkover	Vulnerable	
Mammal droppings were sighted during the site survey which are most likely to be camel	Few animal droppings were sighted during the site survey	N/A	
Unknown fauna species burrow. Most likely to be small lizards or small rodents.	Burrows were frequently sighted across the project site	N/A	

Description	Abundance	Conservation Value/IUCN Category	Photo
Unknown animal tracks were sighted on the sand dunes which most likely belong to small lizards	Frequent particularly on the sand dunes	N/A	
Animal paw prints were sighted during the site walkover. Most likely they belong to stray dogs which have underground burrow on the banks of a pond on site	Occasional - animal paw prints were encountered occasionally during the site walkover	N/A	
Caelifera (grasshopper)	Frequent sightings of grasshoppers were made during the site walkover	Not Evaluated	

Description	Abundance	Conservation Value/IUCN Category	Photo
These large burrows were sighted near the pond water and most likely belong to feral dogs	Rare-only 3 such big burrows were sighted across the project site	N/A	

Table 6-3 Avifauna Species Encountered in the project Site

Scientific Name	Abundance	Conservation Value/IUCN Category	Photo
Upapa epops	Rare-only one individual was sighted during the site survey	Least Concern	 *File photo*
Isabelline/Desert Wheatear	Rare-only 2 individuals were sighted during the site walkover	Least Concern	 *File photo*

Scientific Name	Abundance	Conservation Value/IUCN Category	Photo
Passer simplex	A flock of sparrows were sighted during the site walkover	Least Concern	 *File photo*

Dusk Surveys (2018)

Besides general observations made from numerous site visits and walkovers, a specific dusk ecological survey was undertaken on the evening of 13th November 2018 approximately between 17:00 to 18:00 at the project site 1. The surveys were undertaken through a combination of walkover quadrant transects (10 m x 10 m) and drive-over for general observations.

The five (5) quadrant transects were walked by two members of the survey team and all flora and fauna species encountered including animal tracks were examined and documented. In addition, any burrows or debris were identified and closely inspected for evidence of any activity.

Two (2) wildlife trail cameras were installed in secluded areas of the sand dune habitat at the project site and were run for 12 hours in order to identify/capture any fauna species that were active at dusk and night (i.e. nocturnal species) and those active at dawn. The rationale for installing the trail cameras at the project site was due to the fact that there is a probability that there are fauna species within the project area of IUCN conservation value.

Figure 6-1Location of quadrant transects-project site 1

Plates 6-5 Ecological Survey Transects on Project Site 1

Figure 6-2 Location of trail cameras on project site 1 (2018)

Table 6-4 Wildlife trail cameras installation coordinates on the project site 1

ID	Co-ordinates		Photo
	Northing	Easting	
C-1	25°39'17.27"	55° 44'53.35"	

ID	Co-ordinates		Photo
	Northing	Easting	
C-2	25°39'17.81"	55° 44'47.90"	

Results

Apart from movement captured on camera 1 from what appeared to a rodent and bugs attracted to the light sensors on the camera, the two trail cameras did not capture any fauna species of significance at the project site. However, the table below provides a summary of the observations made during the quadrant transect survey at project site 1.

Table 6-5 Results from Quadrant Transects (November 2018-Project Site 1)

Quadrant	Observation
Quadrant-1	• 2 burrows • Multiple animal tracks observed on the sand dunes. • 65% vegetation cover • *Salsola sp.* and *Stippa agrostis* as the predominant plant species.
Quadrant-2	• 3 burrows • Multiple animal tracks observed on the sand • 30% vegetation cover • 18 colonies of plants identified
Quadrant-3	• 7 burrows identified • Multiple animal tracks • 40% plant cover • 27 plant colonies
Quadrant-4	• 6 burrows, two of which were large. • 40 % plant cover

Quadrant	Observation
	• 30 plant colonies
Quadrant-5	• 9 burrows • 35% plant cover • *7 Tetraena qatarense* • *7 Salsola sp.*

Table 6-6 Fauna Species identified within the Project site (Dusk Survey)-Project Site 1

Description	Abundance	Conservation Value/IUCN Category	Photo
Tenebrionidae	2 sighted during the survey	This specie has not yet been assessed for the IUCN Red List hence, no IUCN recognition	

Dawn and Dusk Ecological Survey (19th & 20th June 2019)

Due to the increase in the project footprint (from 10 ha to 23.5 ha), an additional dusk and dawn ecological surveys were conducted between 8:00 pm to 9:00 pm on 19th June 2019 and 5:00 am to 6:30 am on 20th June 2019 respectively on the project site 2. The surveys were undertaken through a combination of site walkover and drive-over for general observations.

Two (2) wildlife trail cameras were installed including two pits fall traps at representative locations at the project site 2. These were installed for 12 hours in order to capture/identify any fauna species that were active at dusk and night (i.e. nocturnal species) and those active at dawn.

Figure 6-3 Location of trail cameras & pit fall traps on project site 2 (2019)

Table 6-7 Wildlife trail cameras installation coordinates on the project site 2

ID	Co-ordinates		Photo
	Northing	Easting	
C-1	25°39'15.4"	55° 45'01.9"	

ID	Co-ordinates		Photo
	Northing	Easting	
C-2	25°39'8.07"	55° 45'4.42"	

Table 6-8 Pit fall traps installation coordinates on the project site 2

ID	Co-ordinates		Photo
	Northing	Easting	
PT-1	25°39'14.7"	55° 45'17.6"	
PT-2	25°39'9.49"	55° 45'3.60"	

ID	Co-ordinates		Photo
	Northing	Easting	
			

Figure 6-4 Location of dawn and dusk site walk over on project site 2 (2019)

Results

Apart from a flock of unidentified birds captured on camera 2 flying from the east side of the site towards the west and bugs attracted to the light sensors on the camera, the two trail cameras did not capture any fauna species of significance at the project site. In addition, no fauna was observed in the two pits fall traps set up at the project site, apart from ants sp.

However, the tables below show the fauna species identified during the dusk and dawn site walkovers.

Dusk Survey

Flora

The flora species identified within the project site are listed in the table below:

Table 6-9 Floral Species Encountered in the Project Site 2 (19th June 2019)

Scientific Name	Abundance	Conservation Value/IUCN Category	Photo
Tetraena qatarense	Abundant- This species was encountered across the Project site in large numbers	Not Evaluated	
Stippa agrostis	Frequently seen across the site	Not Evaluated	
Arthrocnemum glaucum	Rare-this specie was only sighted a few times during the walko`ver	Not Evaluated	

Scientific Name	Abundance	Conservation Value/IUCN Category	Photo
Acacia	Occasional-Encountered south of project site 2	Not Evaluated	 
Centaurea pseudosinaica Czerep	Occasional at the north of project site 2	Not Evaluated	 File Photo

Scientific Name	Abundance	Conservation Value/IUCN Category	Photo
Annual indet	Occasional at the north of project site 2	N/A	
Stipagrostis sp.	Occasionally sighted during the site survey	Not Evaluated	
Shrub indet.	Rare-only one specie was sighted during the site walkover	N/A	

Fauna & Avifauna

Table 6-10 Fauna Species Encountered in the project Site (19th June 2019)

Scientific Name	Abundance	Conservation Value/IUCN Category	Photo
Stenodactylus arabicus	4 were sighted during the survey	Not Evaluated	
Stenodactylus leptocosymbotes	2 were sighted during the survey	Not Evaluated	
Sicarius hahni	4 recorded during the survey	Not Evaluated	

Scientific Name	Abundance	Conservation Value/IUCN Category	Photo
Caelifera (grasshopper)	10 sighted during the survey	Not Evaluated	
Tenebrionidae	4 sighted during the survey	Not Evaluated	
Tiger Beetle sp.	2 sighted during the survey		

Scientific Name	Abundance	Conservation Value/IUCN Category	Photo
Neuroptera	1 sighted during the survey	Not Evaluated	 File photo
Animal paw prints were sighted during the site walkover. Most likely they belong to stray dogs which have underground burrow on the banks of a pond on site	1 stray dog was spotted during the site survey near the pond area	N/A	
Unknown fauna species burrow. Most likely to be small lizards or small rodents.	Multiple burrows were observed across the project site	N/A	

Scientific Name	Abundance	Conservation Value/IUCN Category	Photo
Unknown animal tracks were sighted on the sand dunes	Only one set of sand print was sighted during the site walkover	N/A	

Dawn Survey

Table 6-11 Fauna & Avifauna Species Encountered in the project Site (20th June 2019)

Scientific Name	Abundance	Conservation Value/IUCN Category	Photo
Ant sp.	Multiple sightings across the project site		
Apentanodes arabicus	Multiple sightings across the sight	Not Evaluated	

Scientific Name	Abundance	Conservation Value/IUCN Category	Photo
Passer simplex	2 sighted at the project site	Least Concern	 File photo
Merops persicus	6 sighted at the project site	Least Concern	 File Photo
White checkered bulbuls	2 sighted at the project site	Least Concern	 File Photo

Scientific Name	Abundance	Conservation Value/IUCN Category	Photo
Spilopelia senegalensis	2 sighted at the project site	Least Concern	 File Photo
Francolinus pondicerianus	1 sighted at the project site	Least Concern	 File Photo
Acridotheres tristis	3 sighted at the project site	Least Concern	 File photo

Scientific Name	Abundance	Conservation Value/IUCN Category	Photo
Cinnyris asiaticus	1 sighted at the project site	Least Concern	 File Photo
Stray dog	1 sighted at the project site	Least Concern	N/A
Caelifera (grasshopper)	Frequent sightings of grasshoppers were made during the site walkover	Not Evaluated	
Unknown animal tracks were sighted on the sand dunes which most likely belong to small lizards	Frequent particularly on the sand dunes	N/A	

Ecological Survey of the Laydown Areas 30th July 2019

After the receiving the coordinates of the laydown areas from ACWA Power and the EPC Contractor, 5 Capitals conducted a site walkover on 30th July 2019 between 07:00 am to 10:00 am. Similar to the project sites 1 & 2, the predominant species found at the laydown areas include *Tetraena qatarense*, *Cornulaca monacantha* and *Stippa agrostis*. There was little vegetation cover observed on laydown area 2 since majority of the vegetation has been eaten back by camels from the camel holding area. However, additional flora species such as three Ghaf tree "bushes" which is protected in the UAE were identified in laydown area 1 as shown in the table below.

Table 6-12 Additional Floral Species Encountered in the Laydown Areas 1 & 2 (July 2019)

Scientific Name	Abundance	Conservation Value/IUCN Category	Photo
Prosopis cineraria	Three sighted at laydown area 1	Locally protected but has not been assessed under the IUCN Red list	
Sporobolus ioclados	Rare, sighted only once near the pit at the laydown area 2	Not Evaluated	

Scientific Name	Abundance	Conservation Value/IUCN Category	Photo
Indigofera colutea	Rare, only sighted once during at laydown area 1	Not Evaluated	
Juncus conglomeratus	Sighted on loose sand at laydown area	Least concern	
Annual indet	Occasional at laydown area 2	N/A	

Fauna

The following fauna species were observed at the laydown area 1 during the site walkover.

Table 6-13 Fauna Species Encountered in the project Site (19th June 2019)

Scientific Name	Abundance	Conservation Value/IUCN Category	Photo
Schmidt's Fringe-fingered Lizard	6 were sighted during the site walkover at laydown area 2	Least Concern	
Sand print possibly by Dhub spiny-tailed lizard (Uromastyx sp.)	Rare-Only one set of sand print was sighted during the site walkover at laydown area 1	Vulnerable	
Burrow belonging to small mammals or reptiles	Multiple across laydown area 1 & 2	N/A	

6.3 Receptors

Table 6-14 Terrestrial Ecology-Receptor Sensitivity

Receptor	Sensitivity	Justification
Sand dune habitat	**Medium**	Although abundant in the UAE, ecological survey shows that there is a possibility that this habitat may support fauna species of IUCN conservation value.
Site grasses, shrubs and low vegetation	**Low**	Site grasses, shrubs and low vegetation are common to the region and present minimal ecological value.
Ghaf Tree	**High**	The Ghaf tree is protected under the Federal Law No.24 of 1999 on 'Protection of the Environment'. Removal, uproot or damage of any tree without authorization from competent authority is prohibited.
Fauna-small mammals and reptiles i.e. Dhub spiny tailed lizard	**High**	The Dhub spiny tailed lizard is protected locally and listed as 'Vulnerable' on the IUCN Red list. Presence of any Dhub lizard is therefore considered to be of high ecological value.
Beach sand	**Low**	The beach sand habitat is widespread and abundant across the UAE
Avifauna	**Medium**	Birds species found in the project site are typical of the UAE desert sand areas and are classified as Least Concern under the IUCN Red List.

6.4 Potential Impacts

6.4.1 Construction Phase

Habitat Loss

In general, it is expected that site preparation activities will include the removal of vegetation in the project footprint, followed by grading for foundations, excavations for below ground infrastructures, and trenching and backfilling for cables and pipelines. Trenching activities could result in direct mortality of small fauna. These impacts are considered direct and permanent, as fauna may be required to find suitable alternative habitat in the surrounding area.

If the project site is not properly graded and no erosion barriers are installed, then runoff composed of sediment and organic material may be washed into the sea and potentially compromising the water quality.

Disturbance of Fauna

In addition to loss of habitat, construction activities will also generate noise & vibration during day time and lighting during night-time works, which could potentially cause disturbance of ecological receptors (such as small mammals and reptiles). A flight response is likely to be triggered for any fauna within the project area once construction works commences. However, reptiles and small mammals may not abandon their burrows, in which case there is a potential for the use of construction equipment to injure or kill such species in the Project area.

Direct Mortality of Fauna

The movement of vehicles and heavy machinery within the project site as well as site clearance and excavation could cause direct mortality of fauna species such as invertebrates, reptiles, birds or small mammals. Reptiles such as lizards and small mammals could be particularly affected since they may retreat back to their burrows which potentially exposes them to the risk of being injured or killed by the construction equipment.

Table 6-15 Terrestrial Ecology Impact Significance, Mitigation and Management Measures and Residual Impacts-Construction

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
Habitat Loss	**Moderate Negative**	Sand dune habitat	Medium	**Moderate**	• Translocation of protected fauna (i.e. Dhub spiny tailed lizard) and protected flora species (Ghaf trees) species on the site to a pre-determined suitable location by a translocation company in coordination with the Umm Al Quwain Municipality will be undertaken prior to any site clearance or levelling activities. Translocation of other reptiles is recommended as compensation for loss of biodiverse semi-natural habitat. • Translocation activities must be coordinated and supervised by a registered environmental consultant and strictly follow the guidelines provided by UAQ Municipality, with collection of associated evidence as proof of translocation. • Prior to any work being undertaken on the project site and laydown areas (and after translocation is completed) the top soil will be retained for future restoration. This will be stored on site and covered with green mesh to retain seed viability within the soil. • No construction works, laydown areas or vehicles are allowed in the natural habitat outside the boundaries of the project site. • EPC Contractor and subcontractors' staff to receive awareness training on ecological species present within the project site. • Hazardous materials used during the construction stage will be adequately managed, in order to minimise the potential	**Minor**
	Moderate Negative	Site grasses, shrubs and low vegetation	Low	**Minor**		**Negligible to Minor**
	Moderate Negative	Ghaf trees	High	**Major to Moderate**		**Minor**
	Moderate Negative	Fauna-small mammals and reptiles such as Dhub spiny tailed lizard	High	**Major to Moderate**		**Minor**
	Minor Negative	Beach sand	Low	**Negligible to Minor**		**Negligible to Minor**
	Minor Negative	Avifauna	Medium	**Negligible to Minor**		**Negligible to Minor**

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
					risk of spillage and therefore potential contamination of the ecosystem. • Any sightings of fauna must be reported to the Environmental Manager. • The project area boundaries will be fenced to avoid fauna from entering the active construction site where they may be injured. • Land clearance will be restricted to within the boundaries of the project site. • The EPC Contractor will return the laydown area to the original state before the beginning of construction works. • The restoration of the laydown areas to pre-development condition will include the establishment of habitats such as dunes (up to 7m in height) and sand sheets. Sufficient vegetation cover to reduce erosion including the restoration of local plant communities where practicable.	
Noise, Vibration and Lighting Disturbance to Fauna	**Moderate Negative**	Fauna-small mammals and reptiles such as Dhub spiny tailed lizard	High	**Major to Moderate**	• Translocation of fauna species will be undertaken prior to any site clearance or levelling activities. • Permits to be in place for all night time construction works • Night time construction works where required to avoid impacts onto habitat outside of the project site or laydown areas. • Minimise light and noise pollution as much as its practical. • Appropriate training should be provided to relevant personnel concerning noise, vibration and lighting control and management.	**Minor**

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
Direct Mortality to Fauna	**Moderate Negative**	Fauna-small mammals and reptiles such as Dhub spiny tailed lizard	High	**Major to Moderate**	• Translocation of fauna species will be undertaken prior to any site clearance or levelling activities • It is strictly prohibited to capture or remove any fauna from their natural habitat. • The site clearance will be planned in one direction to minimise risk of trapping any fauna within the project site. • Awareness training program and training on species found within the project site will be included within the HSE training program. • Any reptiles or mammals found on the site must be immediately recorded. It is not permitted to kill or eat any fauna on the site. Any mortality must be formally reported and recorded on the same day of occurrence. • A 20km/hr speed limit will be imposed across the construction site in order to minimise the risk of direct mortality of fauna. Vehicle speeds will be restricted to 15km/hr on haul road and unsurfaced areas of the site.	**Minor**
	Minor Negative	Avifauna	Medium	**Minor**		**Negligible to Minor**

6.4.2 Operational Phase

Due to the likely paving and hard standing, construction over the majority of the proposed site, it is anticipated that impacts during the operational phase to any on site vegetation will be minimal. As such, the only activities that could negatively impact the ecology of the site would be through indirect measures, relating to poor management practices of any designated landscaped areas; or to the introduction of alien or invasive species.

However, waste management will be controlled to prevent inadequate storage and handling of hazardous materials, and inappropriate design and storage of wastes that could potentially result in contamination of soils and groundwater or attract pest species. Food wastes will be in covered bins to avoid scavenging from birds and vermin such as rodents and flies. Use of fertilizers will be minimal while the use of pesticides will be controlled and any persistent or non-biodegradable types will be prohibited. In addition, flora species used in landscaping will be restricted to native species or drought tolerant/adapted species and avoid any invasive species.

Table 6-16 Terrestrial Ecology Impact Significance, Mitigation and Management Measures and Residual Impacts – Operation

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
Inappropriate landscaping using non-native or indigenous species could result in the introduction of invasive species	**Minor**	Site grasses	Low	**Negligible to Minor**	• The project OESMP will include details regarding landscaping requirements including a restriction to the use of native and naturalised plant species to be only sourced from reputable suppliers.	**Neutral**
Application of pesticides or fertilizers. Avoiding invasive species	**Negligible Negative**	Site grasses, shrubs and low vegetation	Low	**Negligible to Minor**	• Landscaping on site will incorporate indigenous halophytic and xerophytic plant species to minimise irrigation requirements and the need for fertilisers/pesticides. Intentional replanting of vegetation will enhance the biodiversity of the site as well as improve the visual aesthetics of the site. • Use of persistent biocides will be prohibited. • Prevent introduction of any alien or invasive species that might spread beyond the boundary of the RO plant. • Hazardous materials and chemicals will be stored in designated areas in accordance with the requirements of Federal Standards and good practices guidelines so as to prevent any spillage on the site.	**Negligible**
	Minor Negative	Avifauna	Medium	**Minor**		**Negligible**

6.5 Monitoring

During construction phase, the EPC Contractor will undertake daily checks for any fauna that might be encountered on site after the translocation programme has been completed. Any animals that are found on site will be reported to the Environmental Manager and will be removed by a UAQ Municipality Registered Consultant. The minimum expected monitoring requirements are outlined in the table below. The final monitoring methodology with specific monitoring details (i.e. locations, frequencies, durations, parameters etc.) will be developed in specific 'Environmental Monitoring Plan'.

Table 6-17 Terrestrial Ecology- Monitoring Requirements

Monitoring	Parameters	Frequency & Duration	Location	Responsibility
Construction				
Flora	Ghaf Trees (this includes trees that have been previously cut back and are now "shrub-like"	Keep an inventory of all trees and their location prior to any site clearance and levelling. Ensure all trees have been translocated from the project site. Monthly monitoring of the progress of the translocated Ghaf trees and a record of the health of the translocated trees.	The entire project site and laydown area	EPC Contractor
Fauna	Fauna species found on the site i.e. Dhub spiny tailed lizard	Records including photos demonstrating that translocation has been undertaken prior to the commencement of site grading or clearance works	In all working areas and temporary laydowns requiring land grading or earthworks	EPC Contractor
		Daily visual observations of fauna species	In all working areas requiring land grading or earthworks	EPC Contractor

7 SOILS, GEOLOGY AND GROUNDWATER

This chapter describes the potential impacts and effects that may occur to local geology soil and groundwater as a result of the projects construction and operation activities and identifies the measures that will be undertaken and implemented in order to mitigate these impacts.

7.1 Standards and Regulations

7.1.1 National Standards

Since Umm Al Quwain does not have specific standards for soil and groundwater quality, the project must comply with Federal Law No. (24) of 1999 and Local Order No. 61 of 1991 which strictly prohibit the uncontrolled pollution of soils and groundwater. it is also recommended that Dubai Municipality soil contamination standards are used as a benchmark for guidance.

Table 7-1 summarises Land Contamination Indicator Levels as provided by DM-Information Bulletin (May 2003) 'Environmental Standards and Allowable Limits of Pollutants on Land, Water and Air Environment'.

Table 7-1 DM Land Contamination Indicator Levels

Parameter	DM Soil mg/kg
Arsenic	50
Barium	400
Cadmium	5
Chromium (total)	250
Copper	100
Lead	200
Manganese	700
Mercury	2
Zinc	500
Selenium	2
Pesticides	2
Fluoride	500
Phenol	1
Benzene	1
BTEX(total)	100
Chlorinated Hydrocarbons (total)	1
Polychlorinated Biphenyls	0.5
TPH <C9	1,000
TPH>C9	10,000
Cyanide (free)	10

7.1.2 Lenders Requirements

The UAE Federal Regulations do not include guidelines for groundwater quality. As such, the widely used Dutch Ministry of Housing, Soil and Groundwater Intervention Values Guidelines may be used as a good practice benchmark.

The Dutch Standards identify maximum allowable concentrations for contaminants in soil and groundwater. The groundwater target values provided by the Dutch Standard provide an indicator of the benchmark for environmental quality in the long term, assuming there are negligible risks for the ecosystem.

Table 7-2 Dutch Ministry of Housing Soil Intervention Values Guidelines

Contaminant	Soil /Sediment (mg/kg dry weight)		Groundwater (µg/l)	
	Target	Intervention	Target (7)	Intervention
1. Metals				
Antimony	3	15	-	20
Arsenic	29	55	10	60
Barium	200	625	50	625
Cadmium	0.8	12	0.4	6
Chromium	100	380	1	30
Chromium III	-	180	-	-
Chromium VI	-	78	-	-
Cobalt	9	240	20	100
Copper	36	190	15	75
Mercury	0.3	10	0.05	0.3
Mercury (inorganic)	-	36	-	-
Mercury (Organic)	-	4	-	-
Lead	85	530	15	75
Molybdenum	3	200	5	300
Nickel	35	210	15	75
Zinc	140	720	65	800
2. Other inorganic substances				
Chloride (mg Cl/l)	-	-	100	-
Cyanide (free)	1	20	5	1500
Cyanide (complex)	5	50	10	1500
Thiocyanate	1	20	-	1500

7.2 Observations and Baseline Conditions

7.2.1 Topography

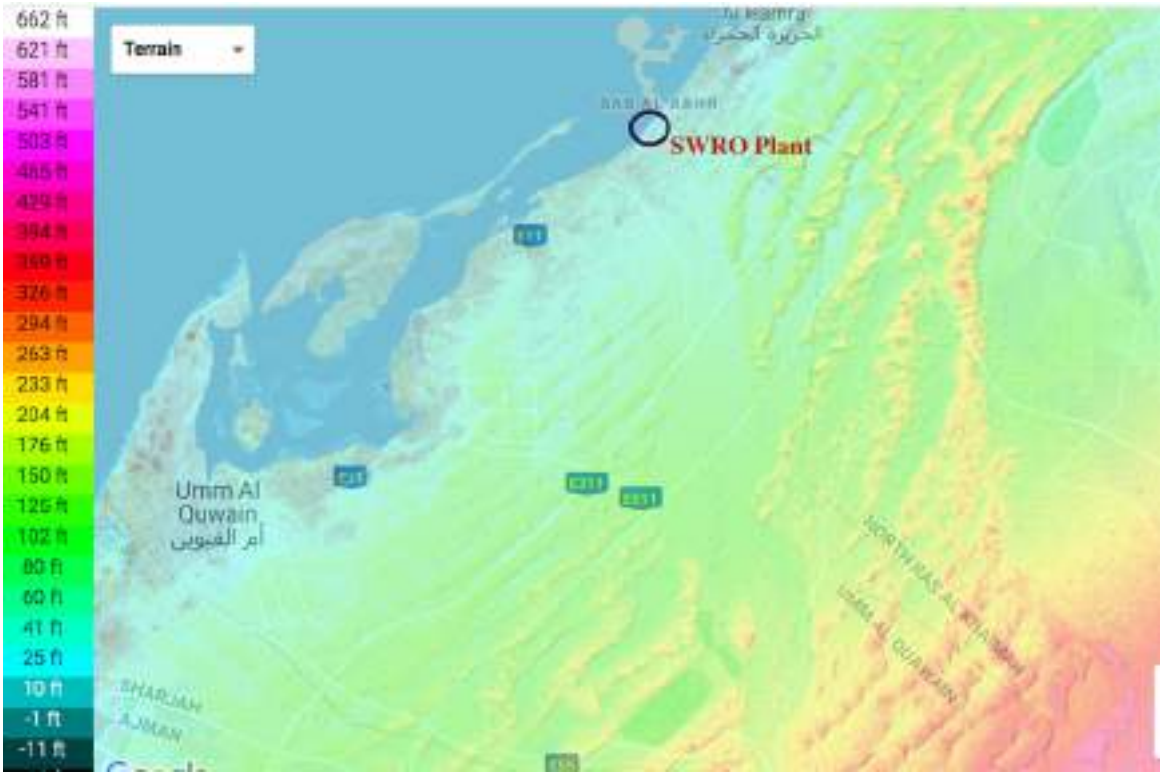
The proposed project site 1 and laydown area 1are located immediately adjacent to the Arabian Gulf coastline of Umm Al Quwain. The western side of the sites slopes gently towards the sea while the eastern side is characterised by sand dunes gently sloping to form dune

troughs with scattered vegetation. Laydown area 1 has a pit located at the western boundary which is at an elevation of -1m compared to surrounding dunes at 6m in elevation.

Project site 2 and laydown area 2 are located east of the north bound E 11 carriage way with an undulating topography with scattered vegetation and shrubs amongst sandy soils. In addition, these two sites were observed to have less vegetation compared to project site 1 and laydown area 1 since most of it has been eaten back by camels from the camel holding area near the project boundary.

The E11 highway is slightly elevated above the site level and gently slopes towards the beach on the west side. The coastal zone of the project site is characterised by a flat sandy beach with limited vegetation.

Figure 7-1 Topographic Map of Umm Al Quwain (including the Project Site)



Source: http://en-gb.topographic-map.com/places/Umm-Al-Quwain-7141216/

Plates 7-1 Topography of the Proposed Site 1 & 2 respectively- Sand Dune Area

Plates 7-2 Topography of the Project Site – Beach Area near the Project Site

Plates 7-3 Topography of the laydown areas 1 & 2

Laydown Area 1

Pit located at the western end of laydown area 1

Laydown area 2

Vegetation eaten back by camels at laydown area 2

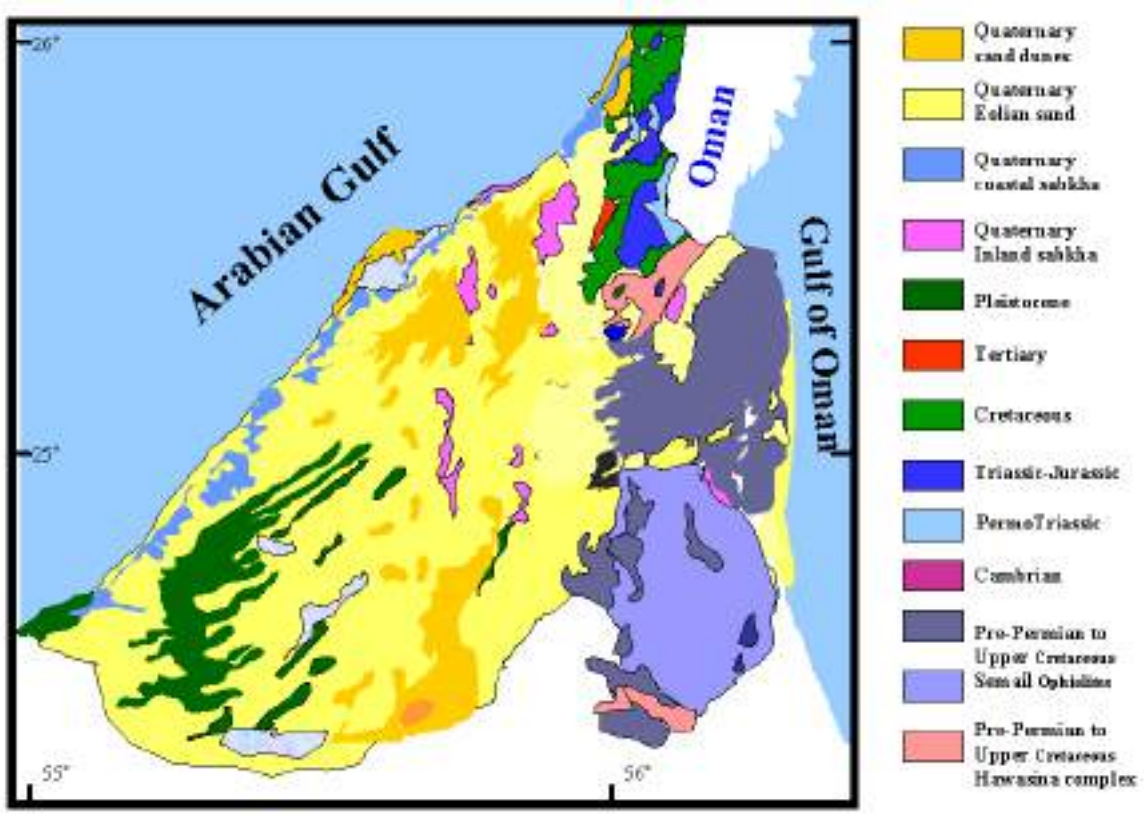
7.2.2 Geology

The UAE and Umm Al Quwain lies over the Arabian Platform, which is a Phanerozoic terrain consisting of clastic, calcareous and evaporitic successions dipping gently eastward away from the Arabian Shield. These sedimentary layers crop out as relatively flat lying beds of sandstone, siltstone, limestone, and evaporites (salt deposits), and were deposited on the underlying Precambrian basement. Therefore, the age of the platform is from the pre-Cambrian to the present.

The youngest deposits in the region include coral limestone and unconsolidated sand, silt, gravel, and sabkha, which have accumulated in well-known areas such as the Rub al Khali and An Nafud, and have filled dried-up lake beds and wadis, and fringed the coastlines.

The coastal plains of the UAE rise gently towards the Hajar mountains, consisting of granular soils (sands, gravels, boulders and cobbles), overlying tertiary limestone, shale, siltstone and sandstone) or crystalline rocks.

Figure 7-2 Geological Map of the United Arab Emirates



Project Site Geology

The geology of the project site was investigated through geotechnical surveys carried out by Arab Centre for Engineering Studies (ACES)between 17th October to 12th November 2017. The geotechnical results from 17 onshore boreholes drilled up to 25.0 m show that the geology of the project site can be classified into three layers as shown in the table below.

Table 7-3 Ground Material Properties of Onshore Boreholes

Layers	Geological Description	Thickness (m)	Material Classification
01	Brown/ light brown slightly silty/ silty, slightly gravelly fine/ fine to medium sand	7.50-4.50	Relative Density (RD) Medium dense to dense locally loose

Layers	Geological Description	Thickness (m)	Material Classification
02	Light brown/ brown/ slightly silty to silty, slightly gravelly to gravelly, fine to medium poorly consolidated sand. Gravel size subangular to subrounded calcarenite/ substone fragments (Class-D Calcarenite/Sandstone)	2.35-0.25	RD: Very Dense
03	Reddish brown/ brown, fine grained Calcarenite/Sandstone partially to distinctly weathered (Class B/C Gritty Sandstone) locally destructured weathered (Class D Gritty Sandstone), fractures close to medium spaced	20.20-15.65	Strength of Rock (STR) Extremely weak to very week

In summary, the project site consists of 6.35 m thick of overburden sand which is underlain by partially to distinctly weathered Sandstone/ Calcarenite layer up to 25.0 m below the existing ground surface.

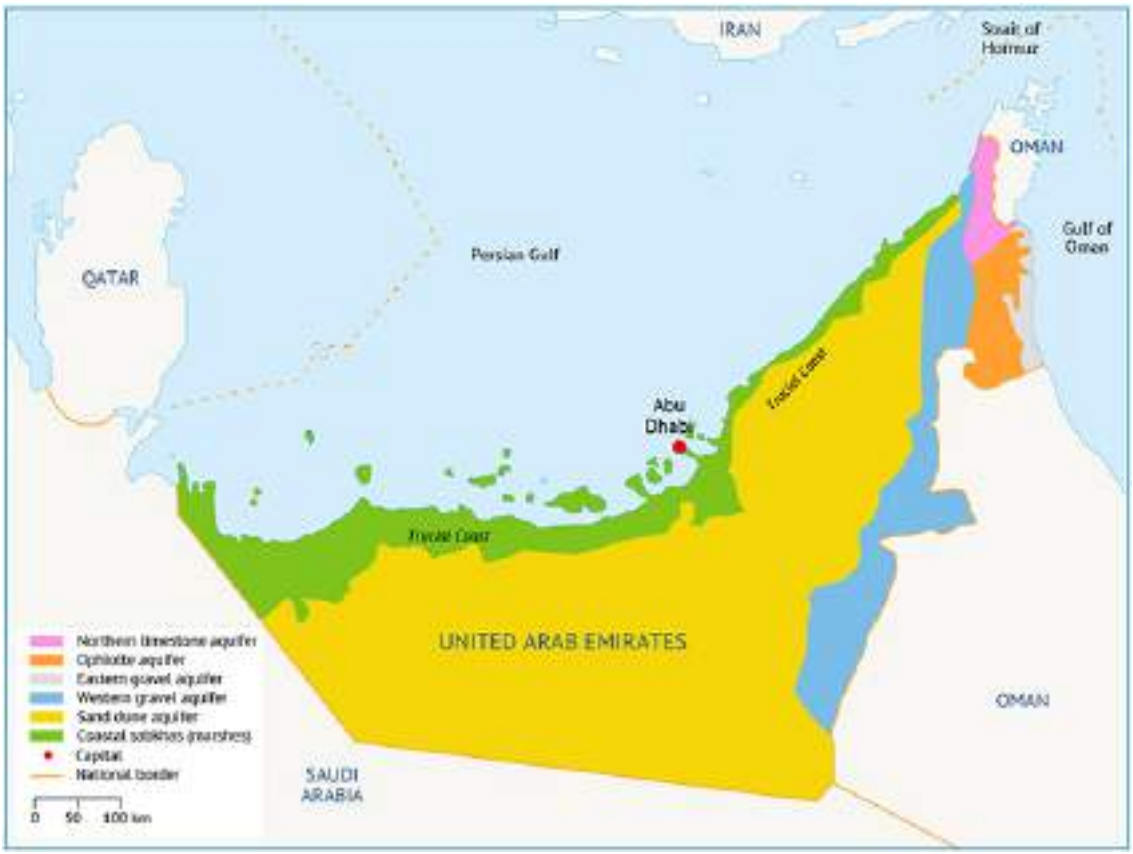
Two near shore boreholes were also drilled up to 25.0 m below existing sea bed surface. The boreholes show loose to medium dense slightly silty to silty sand of approximate thickness 3.0 m below sea bed level, followed by very dense slightly silty, slightly gravelly, fine sand up to 25.0 m below sea bed level.

7.2.3 Groundwater

Ground water resources in the UAE mainly occur in the following aquifer systems:

- Alluvial Aquifer System: composed of extensive terrestrial deposits of boulders, cobbles, pebbles and sand;
- Batinah Coastal Plain Aquifer: Composed of alluvial fan material consisting of coarse sand, gravels and boulders, ending with fine-grained sabkha deposits in some areas; and
- Deep Carbonate Aquifer System: Composed of thick carbonate rock sequences underlying the southern of Abu Dhabi.

Figure 7-3 Main Aquifers in the United Arab Emirates



Source: *Nouh. M. (2008). AN overview for the water resources of the United Arab Emirates.*

7.2.4 Project Site

Soil Quality (September 2018)

Methodology

Soil investigation was carried out on 4th September 2018 to primarily identify existing soil quality condition and characteristics within the project site. This was also to ascertain the presence of potential soil subsurface contamination.

Sub-surface soil samples at four (4) locations within the project site were collected by a certified laboratory. Sampling locations were selected to provide representative soil condition for the site in general (Figure 7-3). This included a targeted effort to select sampling locations in the sand dune, dune troughs and where vehicle tracks were visible. Soil samples were collected into a 1*1kg glass bottle at a depth of 0.1m (10cm) using the scoop method. Descriptions of the observed soil characteristics are presented in the table below.

Table 7-4 Soil Sampling Coordinates 2018

ID	Sampling Points	
	Northing	Easting
S-1	25.654819	55.746942
S-2	25.654806	55.747374
S-3	25.654139	55.752123
S-4	25.655791	55.746530

Figure 7-4 Soil Sampling Locations 2018

Table 7-5 Soil Sampling Observations

ID	Observations (Soil Characteristics)	Photo
S-1	Loose unconsolidated sand dune with evidence of plant debris on the surface.	

ID	Observations (Soil Characteristics)	Photo
S-2	Semi-consolidated soil. Evidence of vehicle tracks in the sample area.	
S-3	Loose unconsolidated fine sand dune.	
S-4	Semi-consolidated soil with evidence of plant and gravel debris on the surface.	

Results

The soil samples were analysed for pH, oils and greases, Total Petroleum Hydrocarbons (TPH)and heavy metals.

Table 7-6 Soil Analysis Results

Parameter	Minimum Detectable Limit	S-1	S-2	S-3	S-4	Unit	Dutch Standards (Intervention Value)
pH @ 25 °C *	0.1	9.4	8.8	9.3	9.3	-	-
Total Petroleum Hydrocarbons							
Oil & Grease	0.15	1.71	1.05	2.51	2.20	% dry solid	-
Gasoline Range (C5 - C10)	2.0	< 2.0	< 2.0	< 2.0	< 2.0	mg/Kg	-
Diesel Range (C11 - C28)	20.0	< 20.0	< 20.0	< 20.0	< 20.0	mg/Kg	-
Motor Oil Range (C29 - C40)	50.0	< 50.0	< 50.0	< 50.0	< 50.0	mg/Kg	-
Inorganic Parameters							
Chloride as Cl	1	34	18	20	62	mg/Kg	-
Sulphate as (SO_4)	1	10	<1	<1	50	mg/Kg	-
Phosphate Phosphorus as PO_4	1.0	743.6	518.1	493.4	891.3	mg/Kg	-
Orthophosphate as P_2O_5	1.0	555.7	387.2	368.8	666.2	mg/Kg	-
Nitrate as NO_3	1.5	<1.5	15.9	19.0	51.2	mg/Kg	-
Total Kjeldahl Nitrogen (TNK)	5	<5.0	<5.0	<5.0	<5.0	mg/Kg	
Sodium as Na	1.0	1615.5	1359.4	1075.6	2893.1	mg/Kg	-
Potassium as K	1.0	1071.8	1125.3	1295.4	942.1	mg/Kg	-
Metals							
Arsenic as As *	5.0	< 5.0	< 5.0	< 5.0	< 5.0	mg/kg	55
Barium as Ba *	1.0	20.5	24.7	24.0	24.1	mg/kg	625
Cadmium as Cd *	2.0	< 2.0	< 2.0	< 2.0	< 2.0	mg/kg	12
Chromium as Cr *	1.0	67.6	63.7	70.5	52.4	mg/kg	380
Hexavalent Chromium as Cr VI	5.0	< 5.0	< 5.0	< 5.0	< 5.0	mg/Kg	78
Copper as Cu *	1.0	8.9	1.7	1.7	<1.0	mg/kg	190
Lead as Pb *	1.0	4.3	1.9	1.1	4.3	mg/kg	530
Manganese as Mn *	2.0	134.0	125.6	139.4	92.3	mg/kg	-
Mercury as Hg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	mg/kg	10
Nickel as Ni *	2.0	40	55.1	66.3	23.5	mg/kg	210

Parameter	Minimum Detectable Limit	S-1	S-2	S-3	S-4	Unit	Dutch Standards (Intervention Value)
Selenium as Se *	1.0	< 1.0	< 1.0	< 1.0	< 1.0	mg/kg	-
Zinc as Zn *	2.0	2.4	< 2.0	2.7	<2.0	mg/kg	720

The soil quality analytical results have been compared with the Dutch Soil Quality Standards. The screening levels are considered as 'intervention values', defined as levels above which a risk assessment is required in order to evaluate whether the site should be cleaned-up and the level of urgency.

The pH ranges in the site range between 8.8 to 9.4, resulting in a moderately alkaline soil. The soil was also analysed for Total Petroleum Hydrocarbons (TPH) which were all below the detectable limit apart from oil and grease that was above the detectable limit for all sites. The nutrients examined were not analysed any further since there are no standards to compare with.

The metal concentrations of collected samples indicate that no pollutant concentrations in the surveyed samples were above the intervention values. These results should be indicative of the soil's naturally occurring conditions at the project site.

Soil Quality (June and July 2019)

Methodology

Due to the increase in the project footprint, 5 Capitals commissioned additional soil investigation on 24th June and on 30th July 2019 to identify the existing soil quality condition and characteristic within the project site 2 and laydown areas 1 and 2.

Sub-surface soil samples at six (6) locations within project site 2 and laydown areas 1 & 2 were collected. Sampling locations were selected to provide representative soil conditions for site 2 in general (see the figure below). This included a targeted effort to select sampling locations in the area where unauthorised construction waste has been dumped and at the sand sheet south of the project site 2, 1 sample at laydown area 2 at the sand sheet and three at laydown area 1 (one at the pit and 2 at the sand sheets).

Table 7-7 Soil Sampling Coordinates

ID	Sampling Points	
	Northing	Easting
S-5 (Project site 2)	25.653140	55.752048
S-6 (Project site 2)	25.652668	55.750461
S-7 (Laydown area 1)	25.651386	55.743389
S-8 (Laydown area 1)	25.650667	55.744083
S-9 (Laydown area 1)	25.652611	55.745778

ID	Sampling Points	
	Northing	Easting
S-10 (Laydown area 2)	25.650389	55.750056

Figure 7-5 Soil Sampling Locations (2019)

Table 7-8 Soil Sampling Observations

ID	Observations (Soil Characteristics)	Photo
24th June 2019		
S-5	Semi-consolidated soil with evidence of gravel debris on the surface.	

ID	Observations (Soil Characteristics)	Photo
S-6	Semi-consolidated soil with evidence of plant debris on the surface.	
30th July 2019		
S-7	Crusty sabkha like soil	
S-8	Semi-consolidated soil with evidence of plant debris on the surface	

ID	Observations (Soil Characteristics)	Photo
S-9	Semi-consolidated soil with evidence of plant and gravel debris on the surface	
S-10	Semi-consolidated soil with evidence of plant and gravel debris on the surface	

Project Site 2 Soil Sample Results

The soil samples for were analysed for pH, oils and greases, Total Petroleum Hydrocarbons (TPH)and heavy metals.

Table 7-9 Soil Analysis Results

Parameter	Minimum Detectable Limit	S-5	S-6	Unit	Dutch Standards (Intervention Value)
pH @ 25 °C *	0.1	9.3	9.8	-	-
Total Petroleum Hydrocarbons					
Oil & Grease	0.15	<0.15	<0.15	% dry solid	-
Gasoline Range (C5 - C10)	2.0	<2.0	<2.0	mg/Kg	-
Diesel Range (C11 - C28)	20.0	<20.0	<20.0	mg/Kg	-
Motor Oil Range (C29 - C40)	50.0	<50.0	<50.0	mg/Kg	-
Inorganic Parameters					

Parameter	Minimum Detectable Limit	S-5	S-6	Unit	Dutch Standards (Intervention Value)
Chloride as Cl	1	72	68	mg/Kg	-
Sulphate as (SO_4)	1	52	12	mg/Kg	-
Phosphate Phosphorus as PO_4	0.1	545.98	458.32	mg/Kg	-
Orthophosphate as P_2O_5	2.0	408.0	342.5	mg/Kg	-
Nitrate as NO_3	1.5	13.3	7.6	mg/Kg	-
Total Kjeldahl Nitrogen (TNK)	5	160.9	108.9	mg/Kg	
Sodium as Na	1.0	325.7	248.9	mg/Kg	-
Potassium as K	1.0	862.1	837.8	mg/Kg	-
Metals					
Arsenic as As *	5.0	<5.0	<5.0	mg/kg	55
Barium as Ba *	1.0	20.8	21.7	mg/kg	625
Cadmium as Cd *	2.0	<2.0	<2.0	mg/kg	12
Chromium as Cr *	1.0	34.1	31.8	mg/kg	380
Hexavalent Chromium as Cr VI	5.0	<5.0	<5.0	mg/Kg	78
Copper as Cu *	1.0	6.9	7.1	mg/kg	190
Lead as Pb *	1.0	10.2	6.5	mg/kg	530
Manganese as Mn *	2.0	145.6	169.2	mg/kg	-
Mercury as Hg	1.0	<1.0	<1.0	mg/kg	10
Nickel as Ni *	2.0	71.9	86.2	mg/kg	210
Selenium as Se *	1.0	<1.0	<1.0	mg/kg	-
Zinc as Zn *	2.0	26.8	13.1	mg/kg	720

The pH ranges in the project site 2 range between 9.3-9.8 resulting in alkaline soil. The soil was also analysed for Total Petroleum Hydrocarbons (TPH) which were all below the detectable limit for S-5 and S-6. The nutrients examined were not analysed further since there are no standards to compare with.

The metal concentrations of collected samples indicate that no pollutant concentrations in the surveyed samples were above the intervention values. These results should be indicative of the soil's naturally occurring conditions at the project site.

Laydown Areas 1 & 2 Soil Sample Results

At the writing of these report, the soil sample results from the laydown areas 1 and 2 were not available to 5 Capitals and were still being analysed by the laboratory. The results will be reviewed by 5 Capitals and additional management and mitigation measures will be included

in the CESMP. However, since no historical signs of soil contamination were observed during the soil sampling process, it is envisioned that the soil analysis results will be within the Dutch Soil Quality Standards.

Table 7-10 Soil Analysis Results

Parameter	Minimum Detectable Limit	S-7	S-8	S-9	S-10	Unit	Dutch Standards (Intervention Value)
pH @ 25 °C *	0.1	8.9	9.2	8.7	9.0	-	-
Total Petroleum Hydrocarbons							
Oil & Grease	0.15	0.22	0.16	0.17	0.15	% dry solid	-
Gasoline Range (C5 - C10)	2.0	<2.0	<2.0	<2.0	<2.0	mg/Kg	-
Diesel Range (C11 - C28)	20.0	<20.0	<20.0	<20.0	<20.0	mg/Kg	-
Motor Oil Range (C29 - C40)	50.0	<50.0	<50.0	<50.0	<50.0	mg/Kg	-
Inorganic Parameters							
Chloride as Cl	1	3616	20	30	30	mg/Kg	-
Sulphate as (SO_4)	1	4197	6	32	10	mg/Kg	-
Phosphate Phosphorus as PO_4	0.1	393.06	744.42	344.62	582.54	mg/Kg	-
Orthophosphate as P_2O_5	2.0	293.8	556.4	257.6	435.4	mg/Kg	-
Nitrate as NO_3	1.5	70.5	49.3	69.4	48.5	mg/Kg	-
Total Kjeldahl Nitrogen (TNK)	5	100	50.6	100.8	99.6	mg/Kg	
Sodium as Na	1.0	3089.9	420.0	388.2	253.4	mg/Kg	-
Potassium as K	1.0	840.5	696.5	604.5	940.2	mg/Kg	-
Metals							
Arsenic as As *	5.0	<5.0	<5.0	<5.0	<5.0	mg/kg	55
Barium as Ba *	1.0	17.9	23.6	21.8	20.0	mg/kg	625
Cadmium as Cd *	2.0	<2.0	<2.0	<2.0	<2.0	mg/kg	12
Chromium as Cr *	1.0	30.8	38.2	43.0	35.6	mg/kg	380
Hexavalent Chromium as Cr VI	5.0	<5.0	<5.0	<5.0	<5.0	mg/Kg	78
Copper as Cu *	1.0	3.8	3.9	2.7	5.2	mg/kg	190
Lead as Pb *	1.0	<1.0	<1.0	<1.0	<1.0	mg/kg	530
Manganese as Mn *	2.0	110.3	126.2	121.1	153.4	mg/kg	-
Mercury as Hg	1.0	<1.0	<1.0	<1.0	<1.0	mg/kg	10

Parameter	Minimum Detectable Limit	S-7	S-8	S-9	S-10	Unit	Dutch Standards (Intervention Value)
Nickel as Ni *	2.0	88.7	49.4	63.3	86.0	mg/kg	210
Selenium as Se *	1.0	<1.0	<1.0	<1.0	<1.0	mg/kg	-
Zinc as Zn *	2.0	7.9	4.9	8.3	8.9	mg/kg	720

The pH range in the laydown areas range between 8.7 to 9.2 which indicates that the soil is slightly alkaline. The analysed TPH were all below the detectable limit, whilst oil and grease was above detectable limits for all of the sites sampled. The nutrients examined were not analysed any further since there are no standards to compare with.

The metal concentrations of collected samples indicate that no pollutant concentrations in the surveyed samples were above the Dutch Soil Quality Standards intervention values. These results should be indicative of the soil's naturally occurring conditions at the laydown areas 1 & 2.

The full set of soil analysis results from the laboratory is presented in Appendix G.

Groundwater Quality

Methodology

In order to obtain a project specific baseline condition of the groundwater quality within the project site 1 & 2, groundwater quality analysis was conducted at two (2) survey locations within the project site (1 & 2) on 4th September 2018. The two groundwater samples are considered to be a representative of the baseline groundwater quality in the project area including the laydown areas 1 & 2.

Groundwater samples were obtained by a certified laboratory and transferred into laboratory containers for analysis.

Table 7-11 Groundwater Sampling Coordinates

ID	Depth (meters)	Sampling Points	
		Northing	Easting
GW1	3	25.654344	55.747632
GW2	1.3	25.654376	55.750250

Figure 7-6 Groundwater Sampling Locations

Plates 7-4 Ground Water Sampling

GW1

GW2

Results

The results of the groundwater quality analysis are presented in the table below.

Table 7-12 Groundwater Analysis Results

Parameter	Minimum Detectable Limit	GW1	GW2	Unit	Dutch Standards (Intervention Value)
pH @ 20 °C *	0.1	7.7	7.1	-	-
Total Petroleum Hydrocarbons					
Oil & Grease (emulsified) *	10	< 10	< 10	mg/L	-
TPH Gasoline Range (C5 - C10)	0.02	< 0.02	< 0.02	mg/L	-
TPH Diesel Range (C11-C28)	0.10	< 0.10	< 0.10	mg/L	-
TPH Motor Oil Range (C29 - C40)	0.50	< 0.50	< 0.50	mg/L	-
Inorganic Parameters					
Chloride as Cl- *	1	15530	55811	mg/L	-
Total Sulfates as SO4 *	8	4499	9599	mg/L	-
Phosphate - Phosphorus as PO4 *	0.02	< 0.02	< 0.02	mg/L	-
Orthophosphate as P2O5 *	0.02	< 0.02	< 0.02	mg/L	-
Nitrate as NO3 *	0.01	7.30	15.80	mg/L	-

Parameter	Minimum Detectable Limit	GW1	GW2	Unit	Dutch Standards (Intervention Value)
Total Kjeldahl Nitrogen (TKN) *	0.5	< 0.5	< 0.5	mg/L	-
Potassium as K *	0.10	230.00	1304.00	mg/L	-
Sodium as Na *	0.10	6270.00	31280.00	mg/L	-
Metals					
Arsenic as As *	0.01	< 0.01	< 0.01	mg/L	0.06
Barium as Ba	0.01	0.05	< 0.01	mg/L	0.625
Cadmium as Cd *	0.002	< 0.002	< 0.002	mg/L	0.006
Chromium as Cr *	0.006	< 0.006	< 0.006	mg/L	0.03
Hexavalent Chromium as Cr VI	0.05	< 0.05	< 0.05	mg/L	-
Copper as Cu *	0.006	0.006	< 0.006	mg/L	0.075
Lead as Pb *	0.015	< 0.015	< 0.015	mg/L	0.075
Manganese as Mn *	0.002	0.061	0.011	mg/L	-
Mercury as Hg	0.001	< 0.001	< 0.001	mg/L	0.0003
Nickel as Ni *	0.005	< 0.005	< 0.005	mg/L	0.075
Selenium as Se *	0.02	< 0.02	< 0.02	mg/L	-
Zinc as Zn *	0.006	0.018	0.046	mg/L	0.80
Microbiological Parameters					
Total Coliforms	1	280	Not Detected	CFU/100 ml	-
Fecal Coliforms	1	200	Not Detected	CFU/100 ml	-
Escherichia coli	1	200	Not Detected	CFU/100 ml	-

Note: the Dutch Groundwater intervention values have been converted from µg/l to mg/l because the analysis results were provided in mg/l.

The pH ranges in the groundwater range between 7.1 to 7.7. The concentration of Total Petroleum Hydrocarbons and heavy metals are very low and below the detection limit apart from zinc which was 0.018mg/l for GW1 and 0.046mg/l for GW2 but still below the Dutch intervention value of 0.80mg/l. When compared to the Dutch groundwater intervention values, all the heavy metals are below the established limits.

Micro-organisms were detected in the ground water for GW1above the minimum detectable limit. This is most likely to be attributable to possible groundwater contamination originating from the Wastewater Treatment Plant that is approximately 106.3 m north east of the project site.

In comparison with other existing guidelines such as the Dubai Municipality 'Environmental Standards and Allowable Limits of Pollutants on Land, water, and Environment, May 2003' at 200 CFU/100 ml and the 'Directive 2006/7/EC of the European Parliament and the Council of

15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC' at 500 CFU/100ml the *Escherichia coli* present in the groundwater is within the allowable maximum limits. However, these guidelines do not have the provisions for *Fecal Coliforms* and hence no comparison to determine maximum allowable limits could be done.

The full set of the groundwater analysis results from the laboratory is presented in Appendix H.

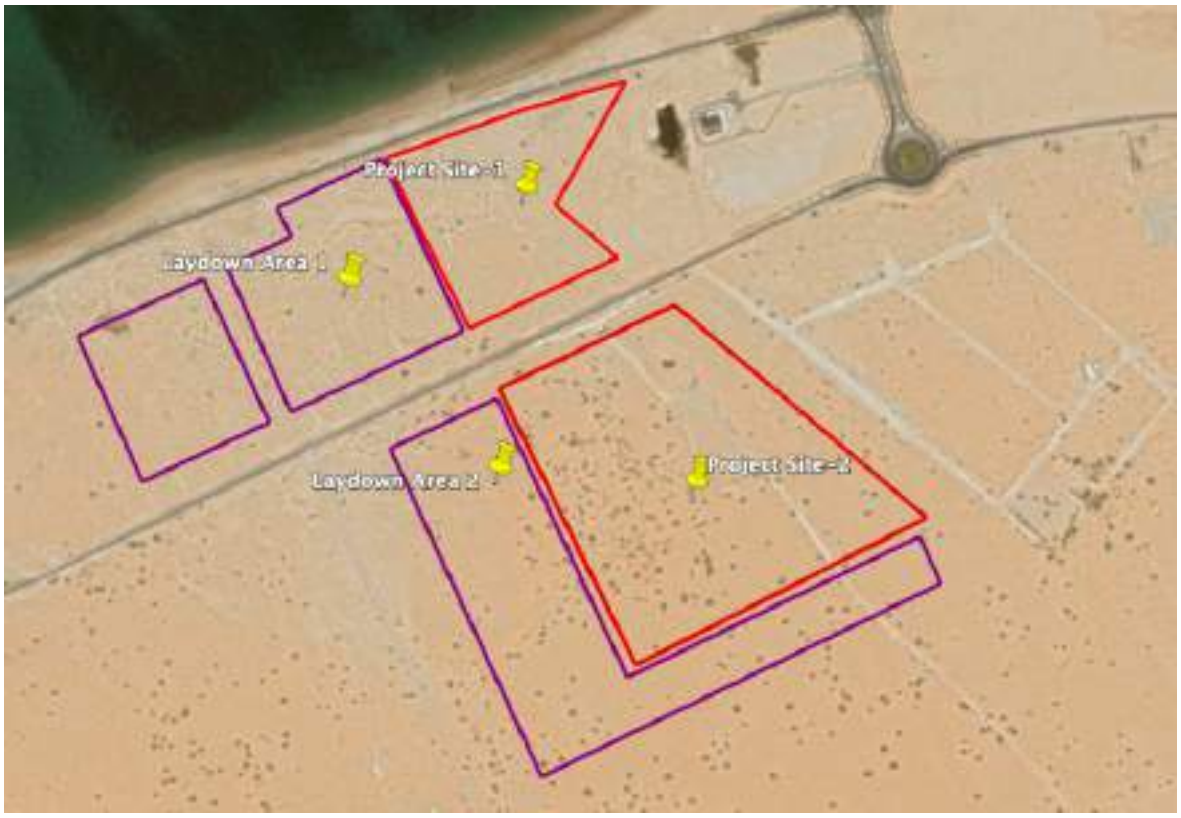
Pond Water Quality

During the site visit, a surface pond was observed in the proposed project site 2. The source of the water is thought to be groundwater since the groundwater levels in the project site 2 is 1.3 m. There was no evidence that the pond water has any particular ecological value, or is providing a specific ecosystem service.

By review of Google Maps "time-series" the water pond can be first seen in the satellite images in 2011. The satellite imageries do not provide close up for the project site for previous years and there is therefore no way to confirm when the water pond was first excavated.

Figure 7-7 Water Pond at the Project Site 2 (2011, 2013 & 2016)


Project Site-1
Laydown Area 1
Laydown Area 2
Project Site-2


Project Site-1
Laydown Area 1
Laydown Area 2
Project Site-2

Plates 7-5 Pond Water at the Project Site 2

Methodology

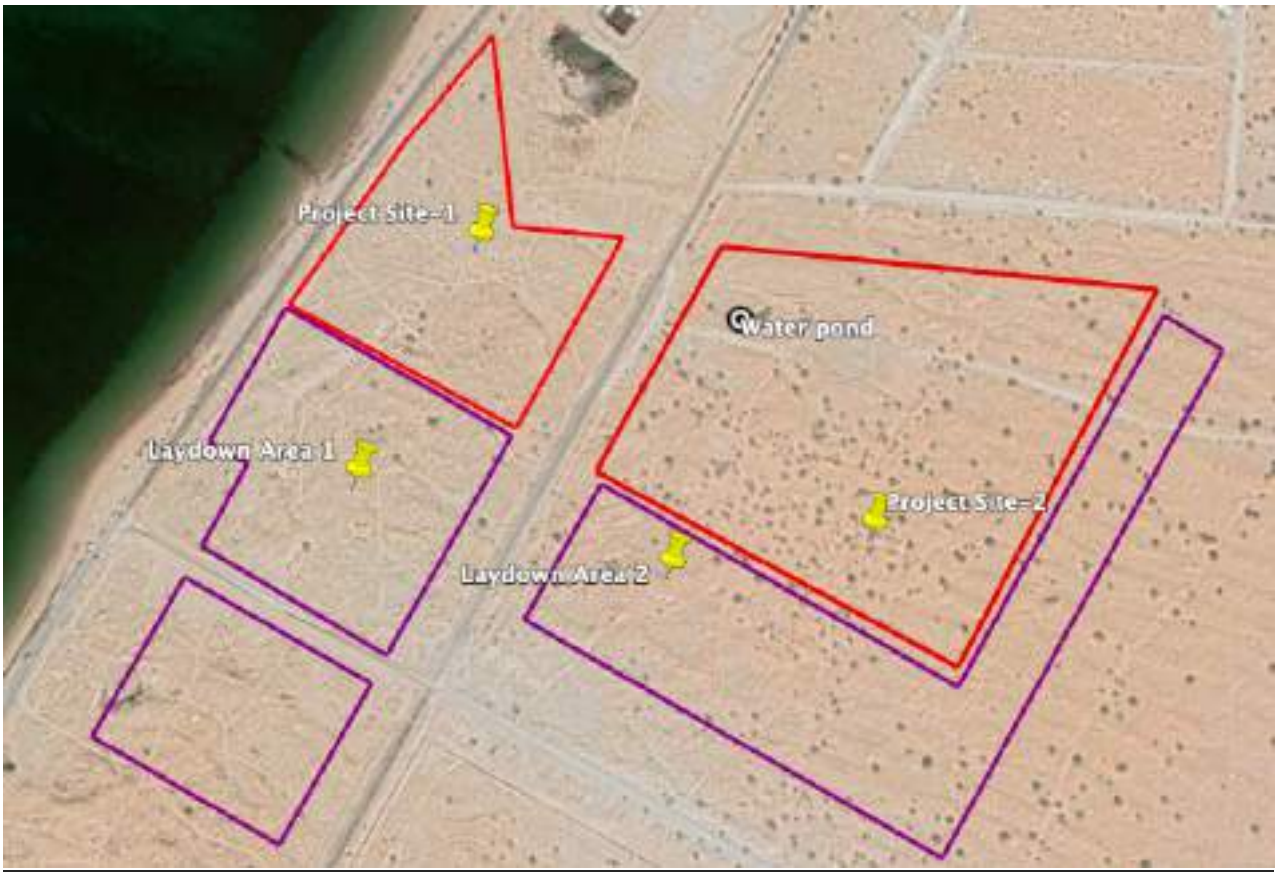
In order to obtain the baseline condition of the pond's water quality within the project site 2, surface water quality analysis was conducted.

One (1) surface water sample was obtained by a certified laboratory on 4th September 2018 and transferred into laboratory containers for analysis.

Table 7-13 Pond Water Sampling Coordinates

ID	Sampling Points	
	Northing	Easting
Pond Water	25° 39'15.2"	55° 45'01.9"

Figure 7-8 Pond Water Sampling Location



Plates 7-6 Pond Water Sampling

Results

The results of the surface water taken from the pond water at project site 2 presented in the table below.

Table 7-14 Pond Water Analysis Results

Parameter	Minimum Detectable Limit	Results	Unit	Dutch Standards (Intervention Value)
pH @ 20 °C *	0.1	8.1	-	-
Total Petroleum Hydrocarbons				
Oil & Grease (emulsified) *	10	< 10	mg/L	-
TPH Gasoline Range (C5 - C10)	0.02	< 0.02	mg/L	-
TPH Diesel Range (C11-C28)	0.10	< 0.10	mg/L	-
TPH Motor Oil Range (C29 - C40)	0.50	< 0.50	mg/L	-
Inorganic Parameters				
Chloride as Cl- *	1	40281	mg/L	-
Total Sulfates as SO4 *	8	8800	mg/L	-
Phosphate - Phosphorus as PO4 *	0.02	< 0.02	mg/L	-
Orthophosphate as P2O5 *	0.02	< 0.02	mg/L	-
Nitrate as NO3 *	0.01	0.80	mg/L	-
Total Kjeldahl Nitrogen (TKN) *	0.5	0.6	mg/L	-
Potassium as K *	0.10	898.00	mg/L	-
Sodium as Na *	0.10	20840.00	mg/L	-

Parameter	Minimum Detectable Limit	Results	Unit	Dutch Standards (Intervention Value)
Metals				
Arsenic as As *	0.01	< 0.01	mg/L	0.06
Barium as Ba	0.01	< 0.01	mg/L	0.625
Cadmium as Cd *	0.002	< 0.002	mg/L	0.006
Chromium as Cr *	0.006	< 0.006	mg/L	0.03
Hexavalent Chromium as Cr VI	0.05	< 0.05	mg/L	-
Copper as Cu *	0.006	< 0.006	mg/L	0.075
Lead as Pb *	0.015	< 0.015	mg/L	0.075
Manganese as Mn *	0.002	0.014	mg/L	-
Mercury as Hg	0.001	< 0.001	mg/L	0.0003
Nickel as Ni *	0.005	< 0.005	mg/L	0.075
Selenium as Se *	0.02	< 0.02	mg/L	-
Zinc as Zn *	0.006	< 0.006	mg/L	0.80
Microbiological Parameters				
Total Coliforms	1	Not Detected	CFU/100 ml	-
Fecal Coliforms	1	Not Detected	CFU/100 ml	-
Escherichia coli	1	Not Detected	CFU/100 ml	-

Note: the Dutch Groundwater intervention values have been converted from µg/l to mg/l because the analysis results were provided in mg/l.

The results of the pond water analysis show that the quality is similar to the groundwater at the project site 2 (GW2). The characteristics of the pond water are largely influenced by the groundwater which is found at 1.3 m at the site. Therefore, the pond water was compared against the Dutch Groundwater intervention values to determine the level of pollutant concentrations.

The concentration of Total Petroleum Hydrocarbons and heavy metals are very low and below the detection limit. In addition, when compared to the Dutch groundwater intervention values, all the heavy metals are below the established limits. The nutrients examined were not analysed any further since there are no standards to compare with although they were all above the detectable limit apart from phosphate as PO_4 and P_2O_5.

The analysis results from the laboratory are presented in Appendix I.

7.3 Receptors

Table 7-15 Geology, Soil and Groundwater – Receptor Sensitivity

Receptor	Sensitivity	Justification
Soil Quality	**Low**	The quality of the soil within the project site is typical of the soil characteristics/structure found in UAQ and across the UAE. Therefore, it is of low or medium importance and rarity on a local scale.
Groundwater	**High**	Water is scarce and vital resource and of high importance on a national scale and limited potential for substitution. Groundwater resources in the UAE are protected under Federal Law No. 24 of 1999 for the Protection and Development of the Environment, Chapter 2, Section 3 Protection of Drinking and Underground Water. However, the proximity of the project site to the Arabian Gulf means the groundwater is saline.

7.4 Potential Impacts

7.4.1 Construction Phase

Construction activities such as site preparation, civil works, electrical and mechanical works can lead to changes in the chemical and physical properties of the local soil as well as groundwater contamination thereby degrading soil and groundwater.

Excavation or Removal of Soils

The project will require excavation activities in order to establish foundations for building structures including the intake and outfall pipes etc. This may result in the interaction with the geology of the site which could potentially provide direct pathways for contamination of groundwater during the construction phase. On the other hand, the soil characteristics within the project site will be impacted directly through soil compaction activities to provide structural stability for the structures.

Historical Contamination

The project site (1 & 2) and laydown areas (1&2) for the SWRO plant has no evidence of any past industrial or commercial uses (soil analysis from laydown areas are pending). The soil, groundwater and pond water samples collected in September 2018 and June 2019 confirmed that there are no elevated concentrations of heavy metals or petroleum hydrocarbons present on the site.

There were micro-organisms detected on the project site above the minimum detectable limits which can be potentially attributed to the wastewater treatment plant that is approximately

106.3 m north of the project boundary. In comparison with other existing guidelines such as the Dubai Municipality 'Environmental Standards and Allowable Limits of Pollutants on Land, water, and Environment, May 2003' and the 'Directive 2006/7/EC of the European Parliament and the Council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC' the micro-organisms present in the groundwater are within the allowable maximum limits. However possible use of dewatered effluent during construction will require periodic testing to ensure that it is safe for dust suppression.

In addition, the discharge of groundwater to the sea following dewatering will not have any impact on sea water quality as the micro-organisms will be exposed to UV light and salt water which will act as an effective bactericide and prevent their survival.

Spills and Leaks Associated with Construction

Soil and groundwater may be susceptible to contamination from various sources during the construction phase. Primary sources of contamination are typically those placed along the handling of products where liquid waste and hazardous liquids/materials can escape directly into the soil potentially resulting in contamination to exposed soils and potentially being transferred via the high porosity sandy soils to the groundwater.

The risk of accidental spillage and leakage of various chemical products, are often attributable to storage areas of the construction site as well as during the transportation of such materials on and off the site. Improper methods of storing, transferring, and handling of these products can result in spillage to the ground and result in soil contamination.

If pollutants reach the groundwater, the spread of pollution can increase quite rapidly and can prove difficult to control. However, these risks will be managed through the implementation of the project CESMP and associated plans and procedures.

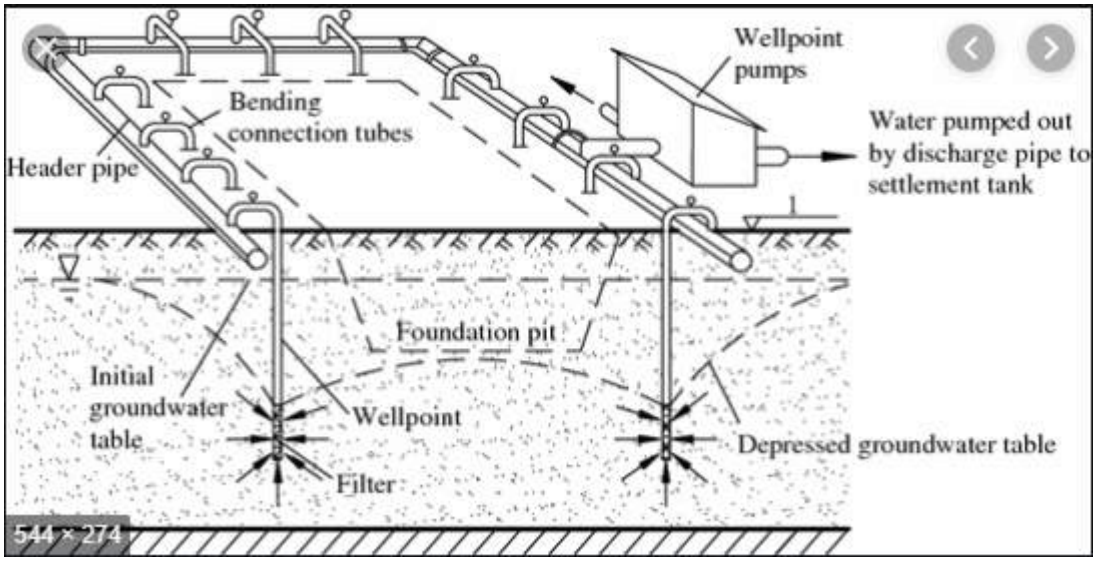
Groundwater Dewatering

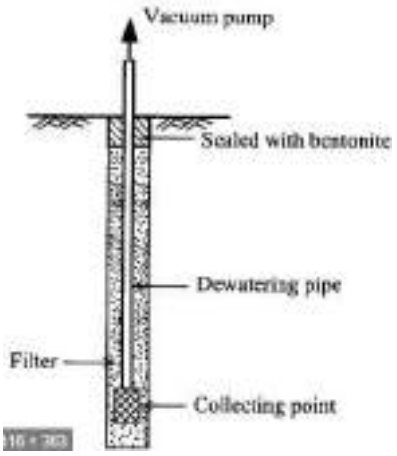
Since the groundwater is approximately 1.3 m at the project site 2 area and 3 m at the project site 1 below ground level, dewatering during the construction phase is likely as a result of earthworks and excavation activities. A well point dewatering method will be adopted for the project and will include:

- A 49mm PVC filter tube with a wall thickness of 3.0mm and a length of 1m (depending on the level of the groundwater and depth of the foundation), one end will be plugged while another will be inserted with dewatering pipe and sealed with bentonite. The filter tubes will have small round holes and enveloped by 2 layer of plastic woven cloth and 1 layer of nylon wire net for preventing the sand from being sucked into the pipe;
- Dewatering pipe: A rubber pipe of transparent tube will be inserted into the filter pipe and connected to the header pipe;
- Well point pump to deliver the dewatering to a settlement tank or pond; and

- Silt curtains will be deployed at the discharge point into the seawater.

Figure 7-9 Preliminary Design of the Project Dewatering Strategy





Any discharge into the marine environment will require the EPC Contractor to obtain the relevant NOCs from UAQ Municipality and adhere to the UAE Federal, Iranian effluent discharge standards including the lenders requirements (whichever is most stringent). In addition, if the discharge pipes will be tunnelled under the E11 highway, the EPC Contractor will be required to obtain separate NOCs from the Ministry of Infrastructure and Development, Ministry of Interior, FEWA and Du telecommunication company.

Inadequate Waste Management

Construction of the proposed project will involve activities that generate solid and hazardous waste, as well as potential liquid wastes. Hazardous wastes generated during these activities pose a threat to the site soils if not effectively managed, particularly where direct or indirect exposure may occur.

Table 7-16 Geology, Soils and Groundwater Impact Significance, Mitigation & Management Measures and Residual Impacts – Construction

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
Cross-contamination by soils imported onto site	**Negative Minor**	Soil Quality	Low	**Negligible to Minor**	• Implementation of good housekeeping practices during construction activities including procedures and requirements for proper handling, storage, and transport of hazardous materials and waste. • Washing of equipment, machinery and vehicles will only be permitted in designated areas, with impermeable surfaces and dedicated drain systems that lead to separate treatment facilities and/or lined evaporation ponds. • Imported soils brought to the site will be from accredited quarries with certificate of quality. • The re-use of material from cutter section dredger will be periodically tested for any contamination.	**Negligible to Minor**
Accidental leaks or spillage	**Minor Negative**	Soil Quality	Low	**Negligible to Minor**	• Storage of all hazardous materials such as fuels and chemicals on an impermeable base with liners and/or secondary containment bund with enough capacity to hold 110% of the maximum volume stored. • Store all chemicals/materials according to manufacturer's instructions and MSDS. • All machine using oils will have drip trays underneath to capture any oil leaks or drips. • Contractor will develop and implement an Emergency Response Plan (ERP) and Spill Response and Contingency. • Maintain an inventory of all potentially hazardous materials and chemicals used and stored on-site.	**Negligible to Minor**
	Minor Negative	Groundwater Quality	High	**Minor to Moderate**		**Negligible to Minor**

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
					• All spills and leaks will be reported promptly to the Construction Manager and to be investigated to confirm the cause and put in place appropriate corrective/preventative actions. • Refuelling and maintenance of vehicles/equipment will be within a dedicated depot area at the camp, on impermeable surface. • Availability of suitable containment and spill clean-up materials/equipment at specific locations within the project site (e.g. where refuelling is to take place). • Relevant personnel to be trained on emergency and spill response, containment, material handling and storage procedures. • Regular emergency drills to practice timely and effective spill response. • Fuel transport vehicles and equipment to be maintained and routinely inspected to ensure the tank, pumps, pipe work and the vehicle itself are free from leaks and fit for purpose-No equipment will be placed in service until deficiencies are corrected. • Implement regular maintenance program of vehicles and equipment to minimise leaks or mechanical failures and keep document evidence.	
Inadequate waste management	**Minor Negative**	Soil Quality	Low	**Negligible to Minor**	• The implementation of the project CESMP and associated Waste Management Plan and Procedures will ensure that spills are kept to a minimum and are cleaned up quickly using spill kits located in risk areas.	**Negligible to Minor**
	Minor Negative	Groundwater Quality	High	**Minor to Moderate**		**Negligible to Minor**

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
					• The EPC Contractor and sub-contractors will provide induction training and TBTs relating to the management, transportation and handling of hazardous materials and wastes.	
Dewatering	**Minor Negative**	Groundwater Quality	High	**Minor to Moderate**	• Where possible, evaporation ponds will be used to manage dewatering effluent. Where discharge to receiving waters is required, settlement ponds will be used to allow for sediment deposition prior to discharge of the dewatered effluent to the marine environment. • The EPC Contractor will be required to obtain all the relevant NOCs if the dewatered effluent is to be discharged into the marine environment. • The dewatering effluent will be monitored monthly and checked for compliance with Federal discharge limits. • The EPC Contractor will need to advice UAQ Municipality of any continued detection of bacteria within the groundwater and any indication that the contamination is from the Wastewater Treatment Plant • Re-use of dewatered groundwater for dust suppression purposes may be used subject to testing to ensure that bacteria concentrations are safe for this use.	**Negligible to Minor**

7.4.2 Operational Phase

Spills and Leaks Associated with Operation

The operation of the RO plant will require the storage of process chemicals for water treatment and for general maintenance and routine cleaning of the plant in accordance with the Operational Environmental and Social Management Plan (OESMP). All such chemicals will be stored inside buildings with impermeable base and in a fully bunded enclosure to ensure that any leaks or spills are fully contained, resulting in a fully bunded enclosure to ensure that any leaks or spills are fully contained, resulting in a negligible risk of soil or ground water becoming contaminated.

Hypochlorite solution will be used for intermittent shock chlorination to remove any biological growth that may block the pipes or membranes. All wastewater streams will be treated on site for re-use whilst any hazardous materials will be removed from site by a specialist contractor and taken to an Umm Al Quwain Municipality approved disposal site.

There will be minimal storage of fuels or oils on site sufficient for planned operations and maintenance works. Fuel for the back-up diesel generators and hydraulic oils and lubricants will be stored in fully bunded areas to protect the soil and groundwater from any leaks or spills.

Temporary handling, storage and treatment of organic wastewater streams with a high Biological Oxygen Demand (BOD) such as backwash water, sanitary waste and oily wastes will be contained and treated onsite to prevent the risk of causing soil, groundwater or coastal waters contamination.

Table 7-17 Geology, Soils and Groundwater Impact Significance, Mitigation & Management Measures and Residual Impacts – Operation

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
Accidental leaks and spillage	**Minor Negative**	Soil Quality	Low	**Negligible to Minor**	• Prepare project specific OESMP 3 months prior to the start of Operations which includes a Waste Management Plan and Procedures to minimise risks of leaks and spillages. • Relevant personnel to be trained on emergency and spill response, containment, material handling and storage procedures. • Integrity of all storage tanks and bunds to be inspected for leaks and flaws – Records to be recorded in inspection logs. • Fuel storage to be on impermeable bases with surrounding bund providing containment of 110% of the maximum volume stored. • Operator to develop and implement an Emergency Response Plan (ERP) and Spill Response Contingency Plan. • Leaking monitoring system to be installed on key tanks (e.g. large chemical storage tanks) so as to determine leaks at an early stage. • Permanent boreholes to be installed on site for periodic monitoring of groundwater quality as required by Umm Al Quwain Municipality • Availability of suitable containment and spill clean-up materials/equipment at specific locations within the project site. Particularly at chemical storage and fuel storage areas.	**Negligible to Minor**
	Negligible Negative	Groundwater Quality	High	**Minor**		**Negligible to Minor**
Organic wastes	**Minor Negative**	Soil Quality	Low	**Negligible or Minor**	• Toilet and sanitary facilities to have a secondary bund to contain any leakage or overflow.	**Negligible to Minor**

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
affecting soil or groundwater	**Negligible Negative**	Groundwater Quality	High	**Minor**	• Storage and treatment of organic waste streams will be in accordance with the OESMP. • Evaporation ponds if required will have secondary containment including an impermeable liner and leachate collection system. • Collection tanks and associated pipes will be routinely inspected for any leaks or overflow. • Permanent boreholes to be installed on site for periodic monitoring of groundwater as required by Umm Al Quwain Municipality	**Negligible to Minor**

7.5 Monitoring

Table 7-18 Geology, Soils and Groundwater – Monitoring Requirements

Monitoring	Parameter	Frequency & Duration	Location	Responsibility
Construction and Operation				
Soil Quality	Hydrocarbons and chemical pollutants such as acids or hypochlorite	Daily/weekly visual inspection	Project Site during construction	EPC & O&M Environmental Managers respectively
Groundwater Quality	Hydrocarbons, heavy metals and chemical pollutants such as acids or hypochlorite	Periodic groundwater analysis from permanent boreholes located on the project site. Quarterly during construction, annually during operations.	Project site boreholes during construction and operation	EPC Environmental Manager O&M Environmental Manager

8 AIR QUALITY

This chapter describes and assesses the potential impacts on air that may occur as a result of the project construction and operational activities and identifies measures to be undertaken and implemented in order to mitigate and manage these impacts. The assessment of potential impacts upon air quality has been made with respect to existing baseline conditions, as determined through field studies and measured against standards and regulatory requirements.

It is noted that as a SWRO desalination plant does not involve activities that generate air pollutants during operation, only the construction related air quality impacts have been assessed in this ESIA.

8.1 Standards and Regulatory Requirements

8.1.1 National Standards

Cabinet Decree No (12) of 2006 is the Federal regulation concerning the protection of Air from Pollution.

Table 8-1 Federal Ambient Air Quality Standards

Parameter	FEA		
	µg/Nm³ unless stated		
	1-hour	24-hour	Annual
PM_{10}	-	150	-
Nitrogen Dioxide	400	150	-
Sulphur Dioxide	350	150	60
Ozone	200	120 (8hr)	-
Carbon Monoxide	30 mg/m3	10 mg/m3 (8hr)	-
TSP	-	230	90
Lead	-	-	1

* Source: Ambient Air Quality Standards, Air Protection System, Federal Cabinet of Ministers Decree No (12) of 2006, E. [1] Emission levels are at 6% O2 v/v dry basis (0°C and 1 atm')

8.1.2 Lender Requirements

WHO ambient air quality standards as adopted by the IFC General EHS Guidelines are presented in the table below.

Table 8-2 WHO Ambient Air Quality Standards (µg/m³ unless stated)

Parameter	WHO Standards	
	24 hour	Annual
PM10	150 (Interim target 1)	70 (Interim target 1)
	100 (Interim target 2)	50 (Interim target 2)
	75 (Interim target 3)	30 (Interim target 3)
	50 (guideline)	20 (guideline)
PM2.5	75 (Interim target 1)	35 (Interim target 1)
	50 (Interim target 2)	25 (Interim target 2)
	37.5 (Interim target 3)	15 (Interim target 3)
	25 (guideline)	10 (guideline)
Nitrogen Dioxide	200 (1 hour)	40
Sulphur Dioxide	125 (Interim target 1)	500 (10-minute guideline)
	50 (Interim target 2)	
	20 (guideline)	
Ozone	100 (8 hour daily maximum guideline)	-

8.2 Observation and Baseline Conditions

8.2.1 General

The UAE is predominantly classified as a desert environment and experiences high temperatures, with many days of sunshine and high levels of humidity. Despite being generally low in volume, there are also periods of intermittent rainfall, which may occur several times a year. Average temperatures from January to December typically range from 17°C to 35°C while precipitation occurs between December to March. The prevailing winds in the UAE come from the Northwest and South and tend to vary depending on the time of year.

Due to the environment and low rainfall, dust hazes occur reasonably frequently, especially in the summer months. Dust storms can also occur in the region, and significantly impact upon ambient air quality, with high concentrations of suspended particulate matter.

8.2.2 Local Meteorological Conditions

There are no metrological stations positioned within the project site. The nearest source of publicly available meteorological data is the Umm Al Quwain station which is approximately 18 km from the project site. The table below presents monthly temperature, humidity, wind

speed values as well as monthly rainfall values averaged for the period 2003 to 2017 as obtained from the National Centre of Meteorology (NCM).

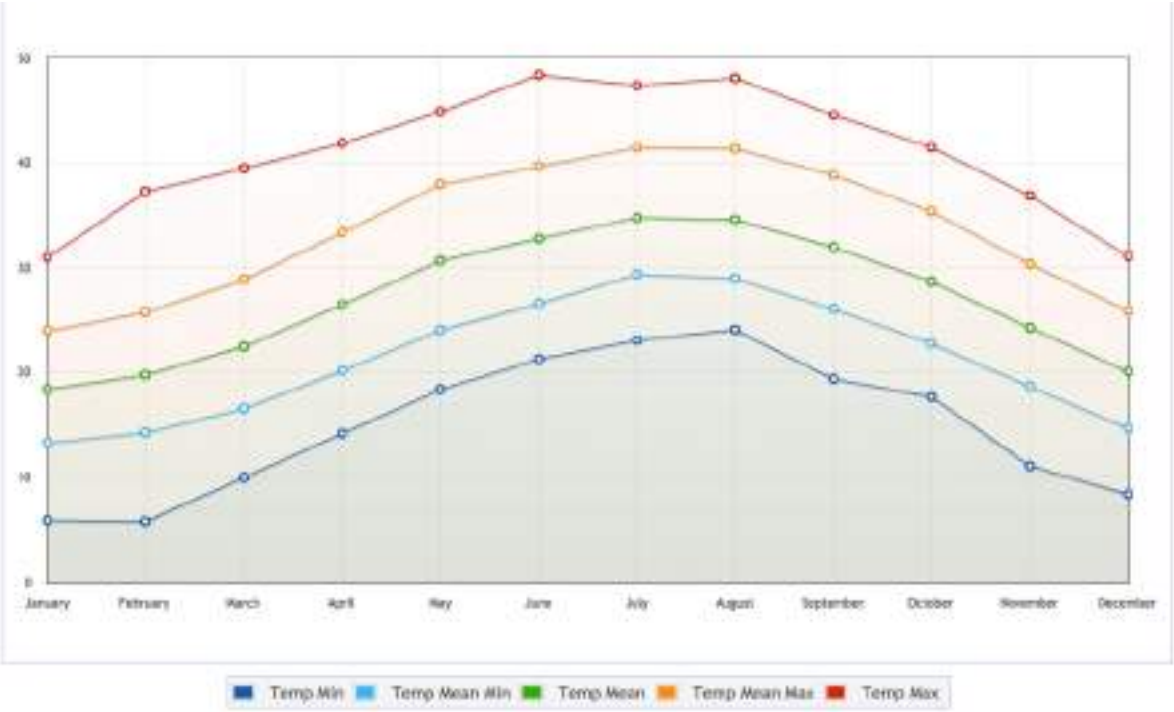
Table 8-3 Average Monthly temperature, Relative Humidity, Rainfall, Wind Speed and Solar Radiation in the Emirate of Umm Al Quwain from 2003 to 2017

Month	Temperature (C°)			Relative Humidity (%)			Wind (km/h)			Rainfall (mm)
	Max	Mean	Min	Mean Max	Mean	Mean Min	Mean	Max	Mean Max	
January	31	18.4	5.9	89	73	49	11	56.5	23	8.5
February	37.3	19.8	5.8	89	71	46	12	61.6	2.4	3.2
March	39.5	22.5	10	88	68	41	12.2	61.6	26.8	8.1
April	41.9	26.5	14.2	81	59	32	12.2	51.8	27.2	2.5
May	44.9	30.7	18.4	76	54	29	12.7	47.5	27.3	0.1
June	48.4	32.8	21.3	82	61	33	12.5	44.6	26.4	0
July	47.4	34.8	23.1	80	59	33	12.8	41.8	27	0
August	48.1	34.6	24.1	80	59	34	12.5	46.1	26.7	0.1
September	44.6	32	19.4	87	68	39	11.2	49.7	25.3	0
October	41.5	28.7	17.7	88	70	42	10.5	42.8	23.8	0
November	36.9	24.3	11.1	86	70	46	10.5	74.9	23.3	5.7
December	31.1	20.1	8.4	88	72	51	10.7	52.9	22.4	7.8

Note: Meteorological Data for Umm Al Quwain Station (25 31 60 N, 55 39 13 E, Elevation 20m

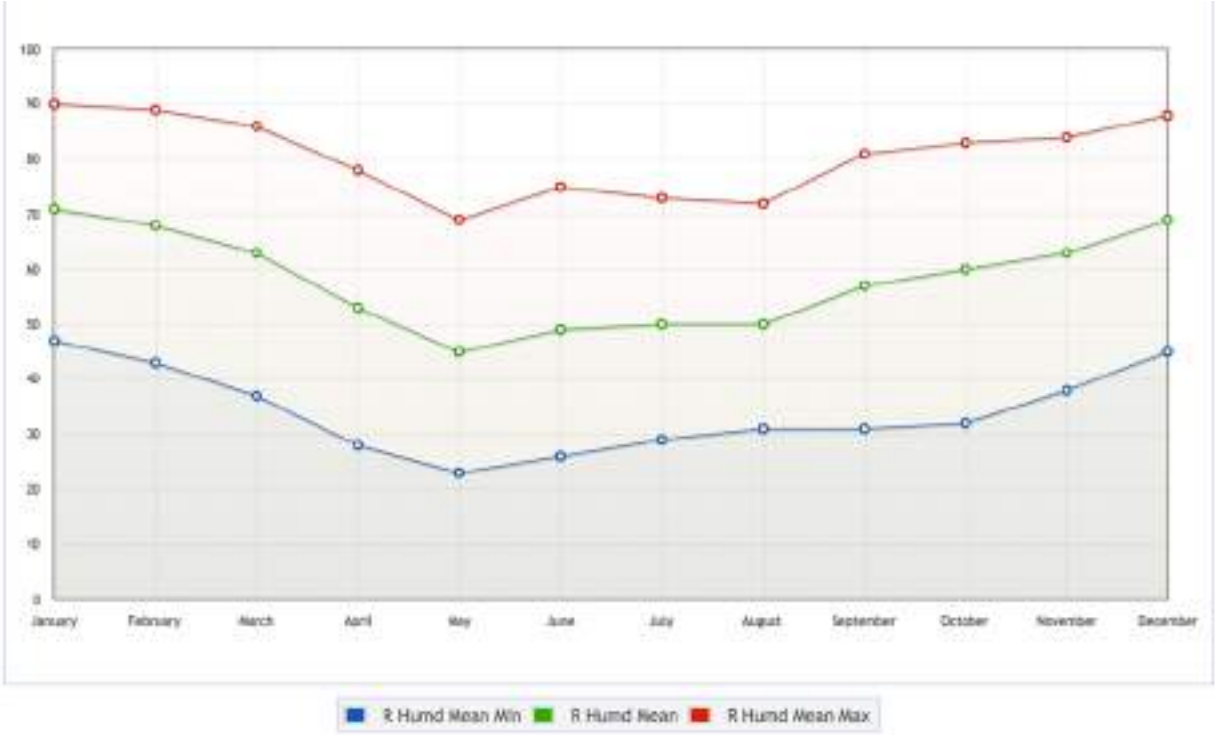
Source: Climate yearly Report for Umm AL Quwain Station, National Centre of Meteorology for 2003 to 2017. http://www.ncm.ae/en/climate-reports-yearly.html?id=111. Accessed 7th August 2018.

Figure 8-1 Temperature (C°) for the Period from 2004 to 2017



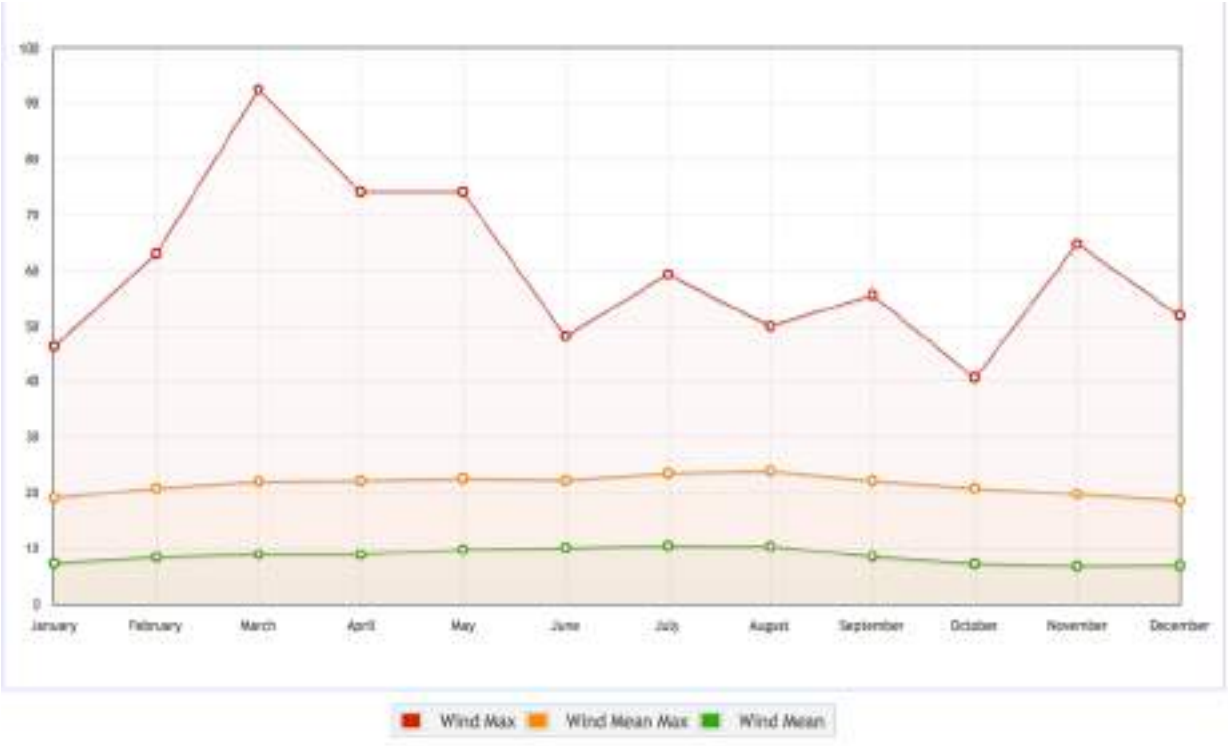
Source: http://www.ncm.ae/en/climate-reports-yearly.html?id=111. Accessed 7th August 2018.

Figure 8-2 Relative Humidity (%) for the Period from 2004 to 2017



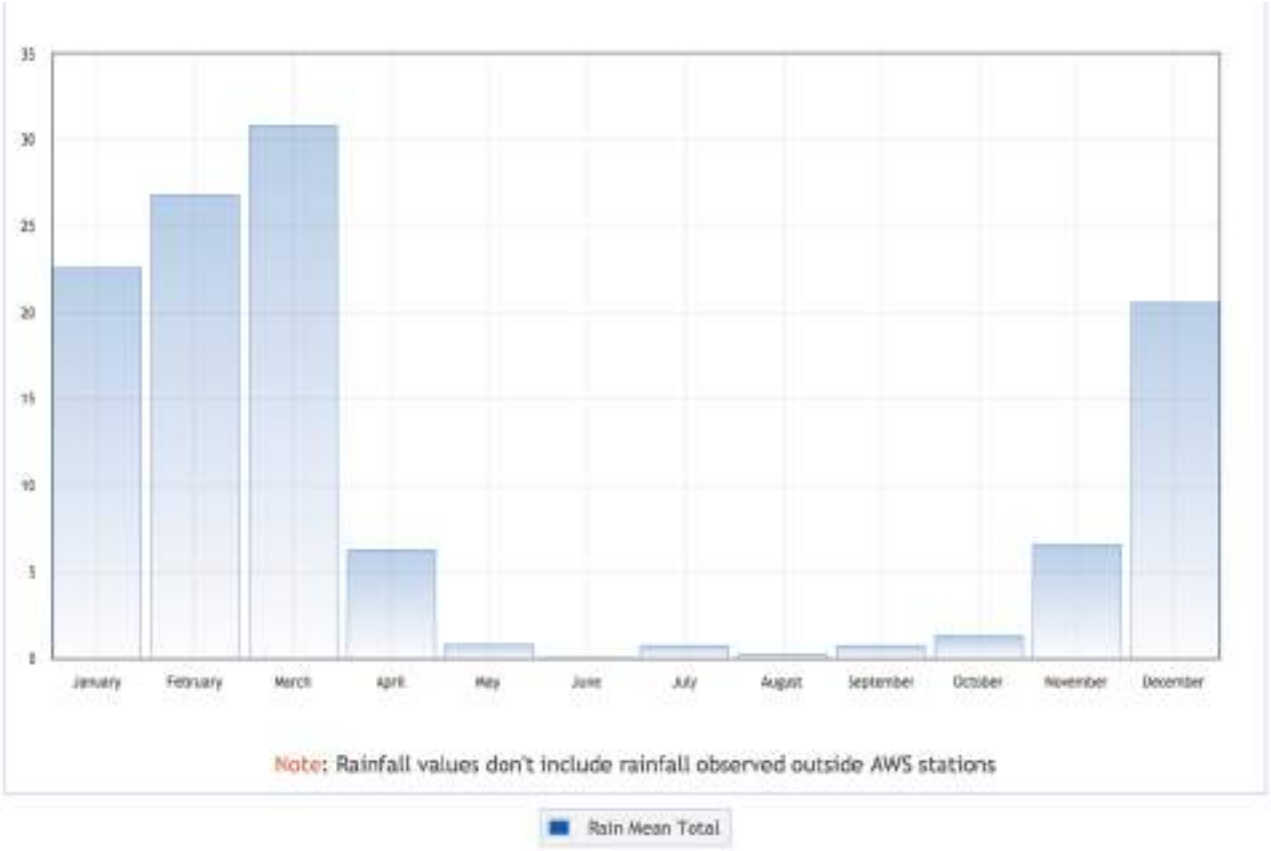
Source: http://www.ncm.ae/en/climate-reports-yearly.html?id=111. Accessed 7th August 2018.

Figure 8-3 Wind Speed (Km/h) for the Period from 2004 to 2017



Source: http://www.ncm.ae/en/climate-reports-yearly.html?id=111. Accessed 7th August 2018.

Figure 8-4 Mean of Monthly Total Rainfall (mm) for the Period from 2004 to 2017



Source: http://www.ncm.ae/en/climate-reports-yearly.html?id=111. Accessed 7th August 2018.

Air Quality

Air quality and in particular instances of poor air quality are influenced less by geographical considerations and more by proximity to pollution sources (e.g. cities, highways and industrial facilities). Typically, the air shed closer to a pollution source is of poorer quality than at a greater distance (due to pollutant dispersion), however air quality at a particular location is generally dependant on weather conditions particularly wind direction and wind strength; which has a large effect on the direction and dispersion of the pollutant plume.

The land-based section of the project (site 1 & 2) is located adjacent to the E11 carriageways and a wastewater treatment plant and is therefore likely to be impacted by pollutant emissions from these sources. The project site 2 is located approximately 1.2 km from the Ras Al Khaimah industrial zone. Emissions from this industrial area will result in ambient releases/or increase of NO_x (as NO_2, and NO), SO_2, CO, Particulate Matter and VOCs. These pollutants are however expected to be well mixed in the airshed at the proposed project site due to the distance.

During subsequent site visit in 2019, 5 Capitals observed approximately fifty waste water tankers and trucks in a period of one hour using the untarmacked road south of the laydown area 2. These vehicles use the untarmacked road to access the UAQ Construction and Demolition

Waste Plant and the Waste Water Treatment Plant 3.3 km east of laydown area 2. The vehicles were observed to be driving at high speed resulting to generation of dust.

Plate 8-1 Dust generation by waste vehicles using the untarmacked road south of laydown area 2

Ambient Air Quality Monitoring at Project Site 1 & 2

Ambient air quality monitoring for carbon monoxide (CO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), Ozone (O_3) and VOCs was undertaken between 4th September and 7th September 2018 at two (2) representative accessible locations within the project site 1 & 2 to establish the background gaseous ambient air quality in the area of the project.

As the primary environmental of concern for the construction phase will potentially be dust generation, particulate matter ($PM_{2.5}$ and PM_{10}) monitoring was also undertaken over the same period.

At the monitoring locations, a continuous high-volume mass sampler was set up for carbon monoxide (CO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), ozone (O_3) and particulate matter ($PM_{2.5}$ and PM_{10}) (Calibration certificates of equipment used are presented in Appendix J). A meteorological station was also set up at the same time to simultaneously log local weather conditions.

The Monitoring campaign ran for 72-hour period to ensure that ambient air quality concentrations could be compared with hourly and 24-hourly standards, but primarily to highlight and diurnal fluctuations in pollutant concentrations or influences due to weather conditions.

The location of the air quality monitoring stations are presented in the figure and table below.

Figure 8-5 Ambient Air Quality Monitoring Station Locations

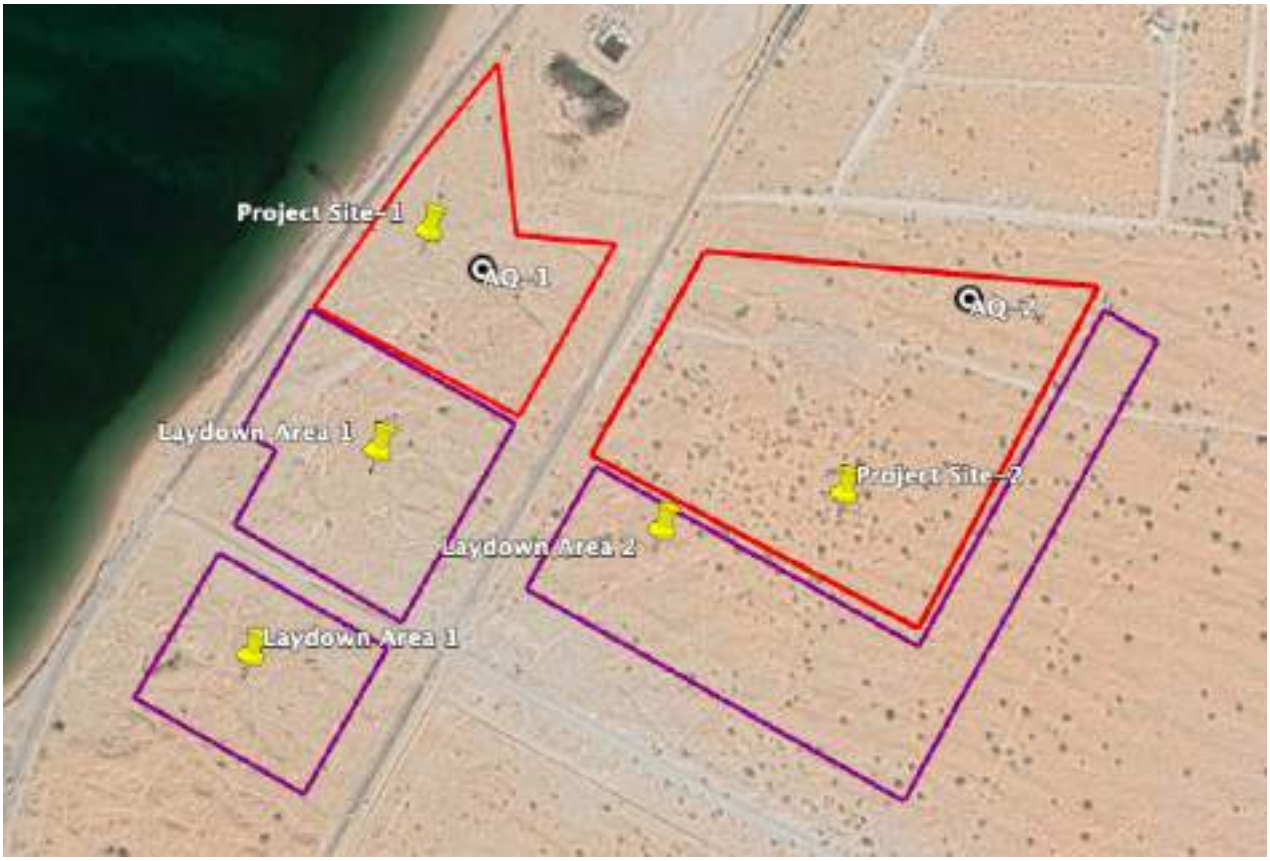


Table 8-4 Ambient Air Quality Monitoring Stations

ID	Co-ordinates		Photo
	Northing	Easting	
AQ-1	25° 39'18.0"	55°44'51.3"	
AQ-2	25° 39'14.7"	55°45'12.2"	

Ambient Air Quality Monitoring Results

The hourly average results obtained from the ambient air quality monitoring survey are presented in the table 8-5 while the 24-hour average results are presented in the table 8-6. These results have been compared with Local, federal and Lenders ambient air quality standards to assess the local air quality conditions.

The complete ambient air quality laboratory results are provided in Appendix K.

Table 8-5 Hourly Ambient Air Quality Results Obtained at the Ambient Quality Monitoring Stations (AQ-1 & AQ-2)

Hourly Average Results	CO mg/m³	NO_2 µg/m³	SO_2 µg/m³	O_3 µg/m³	VOC mg/m³	$PM_{2.5}$ µg/m³	PM_{10} µg/m³	Temp C°	RH %	WS kph	WD °
Detectable Limit	**0.02**	**38**	**52**	**20**	**0.02**	**10**	**10**	**0.1**	**0.1**	**0.1**	**1**
AQ-1											
4th September 2018											
9	1.25	146	<52	25	0.14	16	16	40.2	26.4	3.2	211.0
10	1.30	81	<52	34	0.43	10	24	43.2	21.0	4.1	254.5
11	2.42	79	<52	46	0.15	<10	18	44.5	21.6	9.7	262.3
12	2.15	47	<52	50	0.44	<10	53	38.4	47.9	9.6	291.0
13	2.11	25	<52	55	<0.02	<10	45	38.6	44.9	8.4	306.0
14	1.77	22	<52	59	<0.02	<10	40	39.2	38.9	8.3	312.0
15	2.29	22	<52	40	0.05	<10	31	38.9	39.8	6.0	301.3
16	2.02	16	<52	31	<0.02	18	36	38.1	44.4	7.1	299.0
17	1.46	24	<52	24	0.04	33	55	37.4	42.2	9.2	301.0
18	1.47	33	<52	26	0.03	47	71	36.5	44.8	9.1	284.5
19	1.04	48	<52	26	0.08	33	60	36.2	41.2	8.8	274.8
20	1.02	72	<52	24	<0.02	32	69	35.1	41.4	7.8	267.8
21	1.02	84	<52	<20	0.03	29	59	33.6	48.5	5.5	271.5
22	1.04	98	<52	<20	0.11	41	66	33.4	50.5	4.0	267.5
23	1.12	103	<52	<20	0.22	47	72	32.8	48.3	0.2	226.3
5th September 2018											
0	1.31	111	<52	<20	0.17	40	70	31.8	45.4	0.2	140.5
1	1.02	101	<52	<20	0.19	41	75	31.2	44.2	0.4	0.8
2	1.10	118	<52	<20	0.16	51	100	31.0	43.4	0.0	0.0

Hourly Average Results	CO mg/m³	NO_2 µg/m³	SO_2 µg/m³	O_3 µg/m³	VOC mg/m³	$PM_{2.5}$ µg/m³	PM_{10} µg/m³	Temp C°	RH %	WS kph	WD °
Detectable Limit	**0.02**	**38**	**52**	**20**	**0.02**	**10**	**10**	**0.1**	**0.1**	**0.1**	**1**
3	1.11	118	<52	<20	0.21	64	114	31.2	44.3	0.5	1.5
4	1.01	119	<52	<20	0.02	79	126	31.3	51.2	1.6	0.0
5	1.08	117	<52	<20	0.06	78	134	29.9	57.9	0.7	38.5
6	0.91	104	<52	<20	0.04	90	148	29.3	57.6	0.3	11.0
7	1.18	127	<52	23	0.02	88	148	34.0	54.4	1.9	50.5
8	1.31	114	<52	31	0.07	48	80	38.4	45.2	2.3	225.5
9	2.91	80	<52	32	0.07	47	65	41.2	27.8	0.0	330.0
10	2.83	65	<52	29	0.10	42	60	40.8	38.5	5.7	351.5
11	3.12	63	<52	39	0.14	51	70	38.2	56.0	8.5	24.3
12	2.82	47	<52	44	0.07	45	79	39.0	49.1	11.1	27.8
13	2.43	50	<52	49	0.04	51	73	38.1	54.2	13.0	26.0
14	2.48	32	<52	52	0.04	40	67	38.5	48.2	15.2	12.0
15	2.34	51	<52	56	0.02	41	71	38.1	50.5	17.2	0.0
16	1.70	41	57	36	0.06	65	108	37.9	50.4	17.1	6.3
17	3.64	42	103	24	<0.02	64	97	38.3	36.8	16.7	7.8
18	3.17	61	<52	28	0.10	85	118	37.7	34.5	13.1	23.3
19	1.84	80	<52	<20	0.04	70	104	36.2	36.9	11.9	24.5
20	1.85	68	<52	<20	0.03	52	76	35.6	37.8	11.8	20.0
21	1.86	92	<52	<20	0.10	77	106	34.8	41.8	11.2	19.8
22	1.33	101	<52	<20	0.11	77	103	35.1	41.6	8.5	13.5
23	1.19	94	<52	<20	0.13	73	101	34.8	37.5	3.9	0.0
6th September 2018											
0	1.44	100	<52	<20	<0.02	90	121	34.0	36.6	0.1	177.0

Hourly Average Results	CO mg/m³	NO_2 µg/m³	SO_2 µg/m³	O_3 µg/m³	VOC mg/m³	$PM_{2.5}$ µg/m³	PM_{10} µg/m³	Temp C°	RH %	WS kph	WD °
Detectable Limit	0.02	38	52	20	0.02	10	10	0.1	0.1	0.1	1
1	1.30	105	<52	<20	<0.02	98	131	35.1	34.6	0.7	257.3
2	1.01	87	<52	<20	0.06	69	98	34.5	35.6	3.9	119.0
3	1.19	110	<52	<20	1.18	96	141	33.4	43.0	1.0	76.5
4	1.27	115	<52	<20	<0.02	127	183	32.6	72.2	5.2	116.8
5	0.86	89	<52	<20	0.09	106	185	32.1	78.6	8.3	25.5
6	0.82	78	<52	24	0.06	82	223	30.8	80.2	13.0	0.0
7	0.89	68	<52	27	0.05	65	186	33.0	70.3	13.9	0.0
8	1.59	179	<52	30	0.07	<10	14	35.9	72.3	0.0	156.3
9	1.83	29	<52	34	<0.02	13	45	36.9	68.2	0.6	195.5
10	2.28	39	<52	43	0.02	14	61	37.9	61.5	3.0	193.0
11	1.91	36	<52	46	0.18	67	120	38.4	54.7	7.5	236.3
12	1.87	24	<52	52	0.12	94	168	39.9	45.3	7.4	253.5
13	1.99	21	<52	40	<0.02	56	111	39.8	38.9	7.6	263.5
14	2.19	32	<52	38	0.03	49	106	38.2	48.7	7.3	265.0
15	1.77	40	<52	36	0.06	92	179	37.5	51.8	7.6	297.0
16	1.68	29	<52	32	0.15	79	130	38.5	38.0	7.0	291.5
17	1.13	32	<52	24	0.09	91	144	38.2	35.3	5.6	266.0
18	1.12	48	<52	<20	0.13	77	147	37.1	36.1	2.8	270.8
19	1.01	50	<52	<20	0.06	79	147	36.3	37.6	2.0	269.0
20	1.03	87	<52	<20	0.14	78	136	34.4	41.6	1.6	0.5
21	1.00	89	<52	<20	0.16	63	113	33.2	41.5	1.1	194.8
22	1.21	115	<52	<20	0.18	75	135	32.7	40.8	2.8	49.5
23	1.09	118	<52	<20	0.14	85	136	33.2	37.0	1.8	76.3

Hourly Average Results	CO mg/m³	NO_2 µg/m³	SO_2 µg/m³	O_3 µg/m³	VOC mg/m³	$PM_{2.5}$ µg/m³	PM_{10} µg/m³	Temp C°	RH %	WS kph	WD °
Detectable Limit	**0.02**	**38**	**52**	**20**	**0.02**	**10**	**10**	**0.1**	**0.1**	**0.1**	**1**
7th September 2018											
0	1.16	116	<52	<20	0.14	76	116	33.1	35.0	2.1	3.5
1	1.19	116	<52	<20	0.13	56	92	32.3	36.6	1.9	29.8
2	1.05	97	<52	<20	0.10	49	83	32.8	39.4	0.8	1.0
3	1.02	113	<52	<20	0.12	52	91	32.4	50.1	0.2	0.8
4	0.50	44	<52	<20	0.18	21	52	31.9	64.5	2.1	147.8
5	0.30	52	<52	<20	0.16	<10	58	30.9	67.3	1.7	205.8
6	0.29	21	<52	<20	0.15	99	160	32.0	79.1	1.8	120.0
7	0.29	24	<52	21	0.13	81	154	33.0	64.0	2.0	0.0
8	0.29	18	<52	30	0.12	49	97	38.5	55.5	0.4	0.0
AQ-2											
4th September 2018											
10	0.22	42	<52	34	<0.02	29	91	42.3	55.0	15.0	69.5
11	0.37	71	<52	50	<0.02	18	50	39.5	43.6	16.3	22.0
12	0.33	49	<52	53	0.08	20	44	40.3	42.9	16.4	25.5
13	0.49	109	<52	54	0.37	106	135	40.2	43.7	16.4	26.0
14	0.43	87	<52	53	0.25	88	110	38.5	53.4	15.2	32.8
15	0.48	136	<52	51	0.31	109	184	39.2	47.7	12.5	36.0
16	0.36	58	<52	47	0.15	22	69	39.3	46.4	9.6	42.8
17	0.45	20	<52	39	<0.02	<10	<10	39.7	37.3	8.4	55.0
18	0.50	67	<52	25	0.05	22	75	39.1	32.0	4.0	94.8
19	0.44	83	<52	<20	<0.02	<10	62	37.6	34.6	2.3	142.5
20	0.56	106	<52	20	0.02	<10	64	35.9	37.1	2.9	144.5

Hourly Average Results	CO mg/m³	NO_2 µg/m³	SO_2 µg/m³	O_3 µg/m³	VOC mg/m³	$PM_{2.5}$ µg/m³	PM_{10} µg/m³	Temp C°	RH %	WS kph	WD °
Detectable Limit	**0.02**	**38**	**52**	**20**	**0.02**	**10**	**10**	**0.1**	**0.1**	**0.1**	**1**
21	0.53	94	<52	19	0.05	15	83	35.0	39.8	4.0	135.3
22	0.44	86	<52	13	0.07	41	170	34.4	42.6	1.3	128.3
23	0.44	57	<52	12	0.02	<10	78	34.9	42.3	0.5	128.0
5th September 2018											
0	0.42	81	<52	<20	0.03	21	121	34.6	37.9	1.8	132.0
1	0.34	70	<52	<20	0.11	16	69	33.8	37.0	1.8	152.3
2	0.55	120	<52	<20	0.17	36	122	34.8	36.2	1.7	112.5
3	0.69	139	<52	<20	0.19	34	159	33.7	37.3	1.2	144.5
4	0.65	120	<52	<20	0.17	54	253	32.1	44.6	1.8	143.8
5	0.73	130	<52	<20	0.19	42	173	31.5	72.4	1.5	100.8
6	0.65	128	<52	<20	0.14	51	166	31.6	82.2	1.4	122.0
7	0.06	41	<52	<20	0.10	23	60	30.4	79.1	0.0	174.5
8	0.25	59	<52	28	0.06	12	55	34.1	59.5	6.7	264.8
9	0.36	69	<52	35	0.04	20	64	36.6	66.9	10.4	334.0
10	0.39	82	<52	43	0.03	14	72	36.9	65.4	14.4	180.0
11	0.51	193	<52	52	0.07	88	110	38.2	58.0	17.2	27.8
12	0.39	139	<52	47	0.07	16	52	38.7	52.4	16.7	29.0
13	0.38	155	<52	53	0.08	35	71	39.3	47.9	15.8	31.8
14	0.21	128	<52	58	0.12	58	77	39.6	41.2	14.1	38.3
15	0.09	91	<52	55	0.10	55	72	38.7	48.2	11.6	49.0
16	0.16	114	<52	41	0.04	50	135	38.5	44.5	7.1	67.0
17	0.18	132	<52	30	0.06	49	105	39.8	33.3	2.7	98.8
18	0.24	160	<52	<20	<0.02	45	121	39.2	29.6	1.3	139.8

Hourly Average Results	CO mg/m³	NO_2 µg/m³	SO_2 µg/m³	O_3 µg/m³	VOC mg/m³	$PM_{2.5}$ µg/m³	PM_{10} µg/m³	Temp C°	RH %	WS kph	WD °
Detectable Limit	**0.02**	**38**	**52**	**20**	**0.02**	**10**	**10**	**0.1**	**0.1**	**0.1**	**1**
19	0.25	170	<52	21	0.07	45	137	37.5	32.9	3.6	153.5
20	0.17	110	<52	23	<0.02	<10	59	35.9	37.9	6.6	161.5
21	0.16	49	<52	<20	0.06	28	88	34.0	41.9	4.7	151.0
22	0.14	25	<52	<20	0.07	39	131	33.2	42.2	3.4	150.0
23	0.18	19	<52	<20	0.02	<10	77	32.2	42.6	4.4	56.0
6th September 2018											
0	0.18	26	<52	<20	0.06	27	128	32.4	38.7	1.5	118.3
1	0.38	78	<52	<20	0.13	54	130	32.3	37.0	1.2	40.3
2	0.45	126	<52	<20	0.15	27	73	31.8	38.1	2.9	41.3
3	0.63	179	<52	26	<0.02	<10	29	31.5	40.1	4.1	21.3
4	0.60	160	<52	<20	0.02	77	128	30.5	45.9	1.6	120.8
5	0.54	138	<52	<20	0.11	72	145	29.7	59.7	0.9	193.8
6	0.64	154	<52	<20	1.11	25	75	29.1	67.2	0.0	98.5
7	0.45	98	<52	<20	0.03	13	24	31.1	76.7	4.9	14.3
8	0.40	95	<52	23	0.07	43	62	34.1	52.4	12.1	14.0
9	0.29	107	<52	38	0.06	27	45	38.4	56.4	13.7	15.8
10	0.15	81	<52	50	0.08	22	51	36.5	67.5	13.3	17.0
11	0.22	114	<52	55	0.04	10	36	37.1	65.3	15.8	23.5
12	0.25	127	<52	57	<0.02	13	45	38.2	57.3	15.8	35.5
13	0.07	81	<52	64	0.04	32	52	41.5	47.8	15.1	39.0
14	0.00	49	<52	61	0.15	48	102	40.7	32.4	11.7	38.0
15	0.02	79	<52	52	0.12	49	99	41.3	28.7	10.1	48.3
16	0.02	44	<52	40	<0.02	33	64	43.2	25.9	6.5	53.3

Hourly Average Results	CO mg/m³	NO_2 µg/m³	SO_2 µg/m³	O_3 µg/m³	VOC mg/m³	$PM_{2.5}$ µg/m³	PM_{10} µg/m³	Temp C°	RH %	WS kph	WD °
Detectable Limit	**0.02**	**38**	**52**	**20**	**0.02**	**10**	**10**	**0.1**	**0.1**	**0.1**	**1**
17	0.22	34	<52	36	0.02	35	109	40.9	25.3	1.5	66.8
18	0.19	29	<52	29	0.07	92	190	33.8	28.1	1.6	169.8
19	0.26	26	<52	<20	0.09	68	131	31.9	28.3	0.1	164.0
20	0.16	32	<52	20	0.17	81	129	31.1	28.3	2.0	157.8
21	0.08	7	<52	21	0.07	54	120	30.7	28.3	1.6	106.0
22	0.10	13	<52	<20	0.14	67	160	30.5	28.8	3.5	131.0
23	0.22	31	<52	<20	0.14	57	100	30.4	29.0	2.1	87.0
7th September 2018											
0	0.48	10	<52	<20	<0.02	<10	22	30.3	29.3	0.6	47.8
1	0.55	71	<52	<20	0.05	27	74	30.2	29.4	0.9	103.8
2	0.54	84	<52	<20	0.12	98	182	30.2	29.8	0.8	100.8
3	0.39	123	<52	<20	<0.02	<10	24	30.2	30.2	3.7	28.3
4	0.52	86	<52	<20	0.04	68	121	30.2	30.6	1.6	152.0
5	0.42	81	<52	<20	0.03	20	70	30.2	31.1	1.5	137.3
6	0.33	90	<52	<20	0.05	<10	15	30.2	31.5	5.8	20.3
7	0.35	90	<52	36	<0.02	12	72	30.2	31.9	10.3	16.8
8	0.41	90	<52	46	0.06	25	66	30.2	32.4	11.5	14.3
9	0.25	24	<52	51	<0.02	<10	51	30.1	32.6	12.4	5.5
Federal Standards	**30**	**400**	**350**	**200**		**-**	**-**	**-**	**-**	**-**	**-**

Note: RH-Relative Humidity, **WS-**Wind Speed, **WD-**Wind Direction

Table 8-6 24 Hours Ambient Air Quality Results Obtained at the Air Quality Monitoring Stations (AQ-1 & AQ-2)

24 Hours Average Results	CO mg/m³	NO_2 µg/m³	SO_2 µg/m³	O_3 µg/m³	VOC mg/m³	$PM_{2.5}$ µg/m³	PM_{10} µg/m³	Temp C°	RH %	WS kph	WD °
Detectable Limit	**0.02**	**38**	**52**	**20**	**0.02**	**10**	**10**	**0.1**	**0.1**	**0.1**	**1**
AQ-1											
Day 1 4th-5th Sept 2018	1.40	80	<52	25	0.11	38	71	35.6	43.5	4.5	192
Day 2 5th-6th Sept 2018	1.91	79	<52	24	0.11	67	107	36.1	48.5	8.8	76
Day 3 6th-7th Sept	1.22	58	<52	21	0.11	63	116	35.4	48.7	3.3	151
AQ-2											
Day 1 4th-5th Sept 2018	0.45	84	<52	24	0.11	33	102	36.2	48.0	6.4	115
Day 2 5th-6th Sept 2018	0.33	114	<52	26	0.11	37	89	35.1	47.1	6.9	84
Day 3 6th-7th Sept	0.26	62	<52	29	0.06	39	87	33.7	34.6	6.2	73
Federal Standards	**-**	**150**	**150**	**-**	**-**	**-**	**150**	**-**	**-**	**-**	

Table 8-7 8 Hours Ambient Air Quality Results Obtained at the Air Quality Monitoring Stations (AQ-1 & AQ-2) for CO and O_3

8 hours Average Results	CO mg/m³		O_3 µg/m³	
Location	**AQ-1**	**AQ-2**	**AQ-1**	**AQ-2**
4th September 2018				
9	1.91	-	43	-
10	1.94	0.39	42	47
11	1.96	0.43	41	46
12	1.79	0.44	39	42
13	1.65	0.47	35	38
14	1.51	0.47	31	34
15	1.42	0.47	25	29
16	1.27	0.47	21	24
17	1.18	0.47	18	19
18	1.13	0.46	16	15
19	1.08	0.47	14	13
20	1.09	0.50	12	11
21	1.09	0.51	10	8
22	1.10	0.53	9	6
23	1.08	0.56	9	4
5th September 2018				
0	1.09	0.51	10	5
1	1.09	0.49	13	7
2	1.33	0.49	16	10
3	1.54	0.47	19	15
4	1.79	0.45	23	22

8 hours Average Results	CO mg/m³		O_3 µg/m³	
Location	**AQ-1**	**AQ-2**	**AQ-1**	**AQ-2**
5	2.02	0.42	27	28
6	2.19	0.37	33	34
7	2.38	0.32	37	41
8	2.53	0.32	41	46
9	2.58	0.31	42	48
10	2.67	0.29	41	47
11	2.71	0.27	41	44
12	2.55	0.24	38	40
13	2.43	0.21	34	37
14	2.36	0.18	29	32
15	2.22	0.17	24	27
16	2.07	0.18	18	21
17	2.04	0.19	15	16
18	1.75	0.21	13	12
19	1.48	0.24	11	12
20	1.39	0.28	10	12
21	1.32	0.34	9	10
22	1.20	0.39	10	9
23	1.13	0.45	9	9
6th September 2018				
0	1.10	0.48	12	10
1	1.12	0.51	14	13
2	1.18	0.50	18	17
3	1.34	0.47	23	22

8 hours Average Results	CO mg/m³		O_3 µg/m³	
Location	**AQ-1**	**AQ-2**	**AQ-1**	**AQ-2**
4	1.43	0.41	29	26
5	1.51	0.37	35	32
6	1.65	0.31	39	40
7	1.82	0.23	39	45
8	1.93	0.18	40	50
9	1.94	0.13	40	52
10	1.85	0.12	39	52
11	1.71	0.12	36	49
12	1.59	0.13	32	45
13	1.49	0.12	27	40
14	1.37	0.12	22	35
15	1.24	0.13	18	28
16	1.16	0.16	14	23
17	1.09	0.21	11	18
18	1.10	0.26	9	13
19	1.09	0.30	7	10
20	1.09	0.32	5	9
21	1.03	0.36	5	7
22	0.94	0.40	6	5
23	0.83	0.43	7	5
7th September 2018				
0	0.72	0.45	9	9
1	0.62	0.44	13	15
2	0.53	0.40	19	21

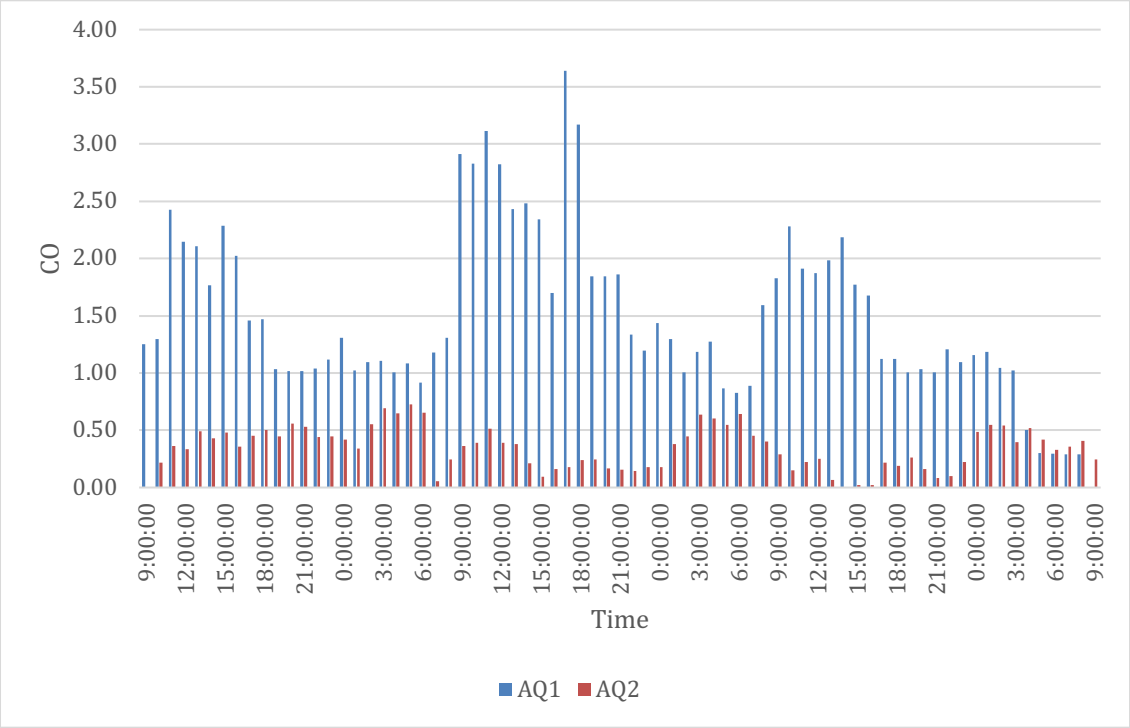
8 hours Average Results	CO mg/m³		O_3 µg/m³	
Location	**AQ-1**	**AQ-2**	**AQ-1**	**AQ-2**
3	0.45	0.38	19	29
4	0.33	0.38	21	27
5	0.29	0.35	24	31
6	0.29	0.34	26	34
7	0.29	0.34	28	37
8	0.29	0.33	31	37
9	-	0.30	-	35
Federal Standards	**10**		**120**	

Carbon Monoxide (CO)

The hourly monitoring result obtained for carbon monoxide at AQ-1 and AQ-2 are within the Federal standard of 30 mg/m^3 with concentration ranging between 0.29 mg/m^3 and 3.64 mg/m^3 for AQ-1 and 0.00 mg/m^3 and 0.73 mg/m^3 for AQ-2. The concentration for this pollutant was 100% above the detection limit of 0.02 mg/m^3 for AQ-1 and 98.6 % for AQ-2 during the monitoring period.

The 8 hours average results show that carbon monoxide concentrations were within the Federal standards of 10 mg/m^3 for both AQ-1 and AQ-2. The maximum concentration for AQ-1 was 2.71 mg/m^3 and 0.56 mg/m^3 for AQ-2.

Figure 8-6 Hourly Ambient Air Quality Monitoring CO (mg/m^3)



According to the figure above, the CO concentrations were higher at monitoring station AQ-1 than AQ-2. This could be attributed to the fact that AQ-1 was located at the project site with the E11 highway on the eastern and western extents.

Nitrogen Dioxide (NO_2)

The hourly results for nitrogen dioxide indicate that the ambient NO_2 concentrations at the monitoring stations (AQ-1 & AQ-2) are within the Federal standard of 400 µg/m^3 with concentration ranging between 16 µg/m^3 and 179 µg/m^3 for AQ-1 and 7 µg/m^3 and 193 µg/m^3 for AQ-2. The concentrations of this pollutant were recorded to be above the detection limit approximately 76.4% for AQ-1 and 81.9% for AQ-2 during the monitoring period.

The average 24 hourly NO_2 results were all above the detection limit of 38 µg/m^3 throughout the three days of the monitoring period for AQ-1 and AQ-2.

Sulphur Dioxide (SO_2)

The SO_2 concentrations for AQ-1 were between 103 µg/m^3 and 3 µg/m^3 and between 0 µg/m^3 and 29 µg/m^3 for AQ-2. These results indicate that the concentrations for this pollutant are below the limit set by the Federal standard concentration of 350 µg/m^3. The concentration for SO_2 was only above the detectable limit of 52 µg/m^3 between 16:00hrs and 17:00hrs on 5th September 2018 at 57 µg/m^3 and 103 µg/m^3 respectively for AQ-1.

The average 24-hours concentrations of SO_2 were below the detection limit of 52 µg/m^3 for AQ-1 and AQ-2. This was well below the Federal 24-hourly ambient SO_2 concentration of 150 µg/m^3.

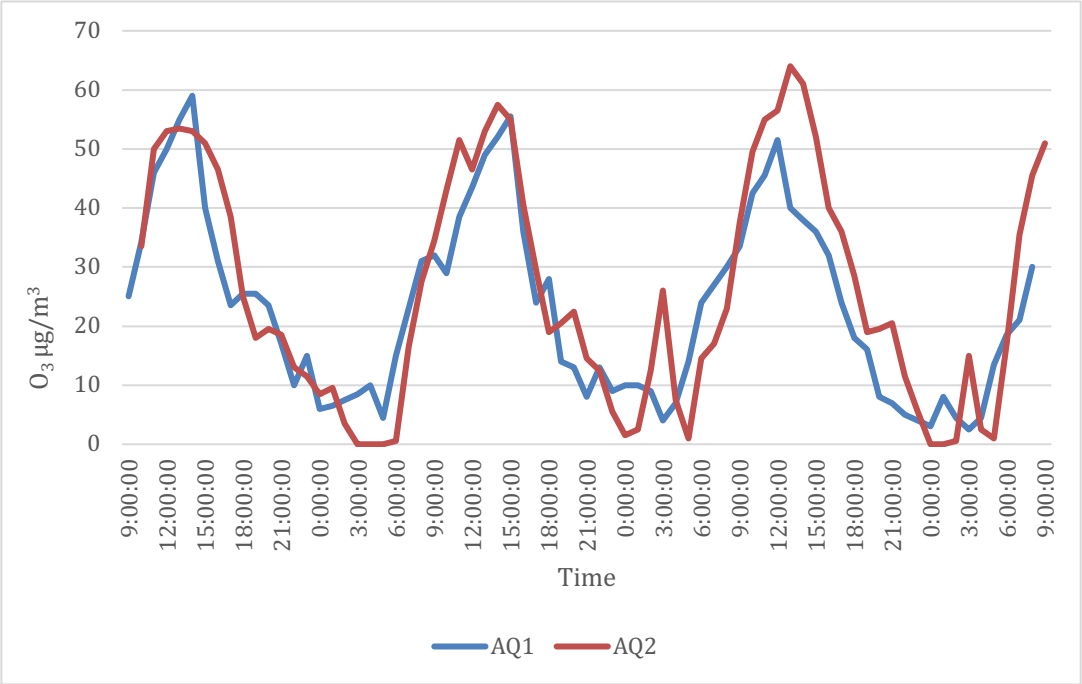
Ozone (O_3)

Ozone is not a direct emission, but it is formed by a secondary photochemical reaction between NOx and VOCs in the presence of UV light. Ambient concentrations of ozone tend to be high during summer due to longer exposure of UV, light or during the middle of the day when the sun is strongest.

The hourly monitoring concentration for ozone throughout the monitoring period was identified to below the Federal standard of 200 µg/m^3 for AQ-1 and AQ-2. AQ-1 SO_2 concentrations were between 3 µg/m^3 and 59 µg/m^3 while those of AQ-2 were between 0 µg/m^3 to 64 µg/m^3.

O_3 concentrations for AQ-1 and AQ-2 were identified to be below detection limit (20 µg/m^3) during late night and early morning hours but increased during the day between 7:00hrs and 18:00hrs before decreasing. This elevated concentration in ozone during this period can be attributed to the sun resulting in an increase in the chemical reactions between ambient concentrations of oxides of nitrogen (NOx) and Volatile Organic Compounds (VOC). The figure below shows the O_3 concentration for AQ-1 and AQ-2 during the monitoring period.

Figure 8-7 Ambient Air Quality Monitoring O_3 (4th-7th September 2018)



The 8-hour ozone concentration was below the Federal standard of 120 µg/m³. The maximum O_3 concentration for AQ-1 was 43 µg/m³ and 52 µg/m³ for AQ-2 all of which are within the limit.

The highest 24-hour average concentration of ozone was 25 µg/m³ which occurred on Day 1 for AQ-1 and 29 µg/m³ for AQ-2 which was above the detectable limit of 20 µg/m³. However, comparison cannot be made because a 24-hour Federal standard has not been established for ozone.

Volatile Organic Compounds (VOC)

The VOC concentrations for AQ-1 was 81.9% and 80.6% for AQ-2 above the detectible limit of 0.02 mg/m³. The maximum concentrations for this pollutant was 1.18 mg/m³ for AQ-1 and 1.11 mg/m³.

Particulate Matter (PM_{10} and $PM_{2.5}$)

The highest hourly concentration of PM_{10} during the monitoring period was 223 µg/m³ for AQ-1 and 252.8 µg/m³ for AQ-2 which occurred on 6th at 6:00hrs 5th at 4:00hrs respectively. The Federal standards do not provide a maximum limit for PM_{10} hourly concentrations. However, the concentrations were 100% above the detectable limit of 10 µg/m³ during the monitoring period for AQ-1 and AQ-2.

The average 24-hours monitoring results were found to be below the maximum allowable limits of Federal standards of 150 µg/m³ for both AQ-1 and AQ-2.

On the other hand, the highest hourly concentration for $PM_{2.5}$ during the monitoring period was 127 µg/m³ for AQ-1 and 109 µg/m³ for AQ-2 on 6th at 4:00hrs and 4th at 15:00hrs respectively.

The concentrations were 88.9% and 83.3% above the detectable limit of 10 µg/m³ for AQ-1 and AQ-2 respectively. However, hourly and 24-hourly results obtained for PM2.5 cannot be compared as standard values have not been designated by the Federal standards.

The figures below show that periods of higher humidity coincide with periods of higher particulate concentrations. This is likely to be due to a higher density of the ambient air and the enhanced ability for the air to suspend particles.

Figure 8-8 Ambient Air Quality Monitoring Particulate Matter (µg/m³) vs Humidity (%)- AQ-1

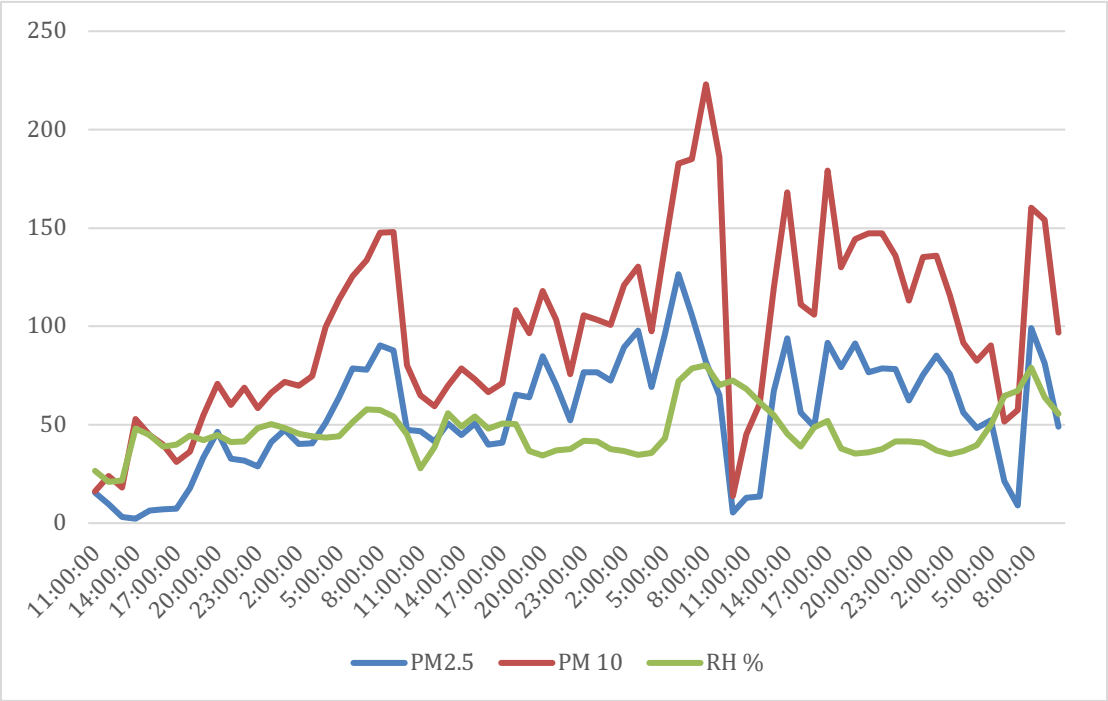
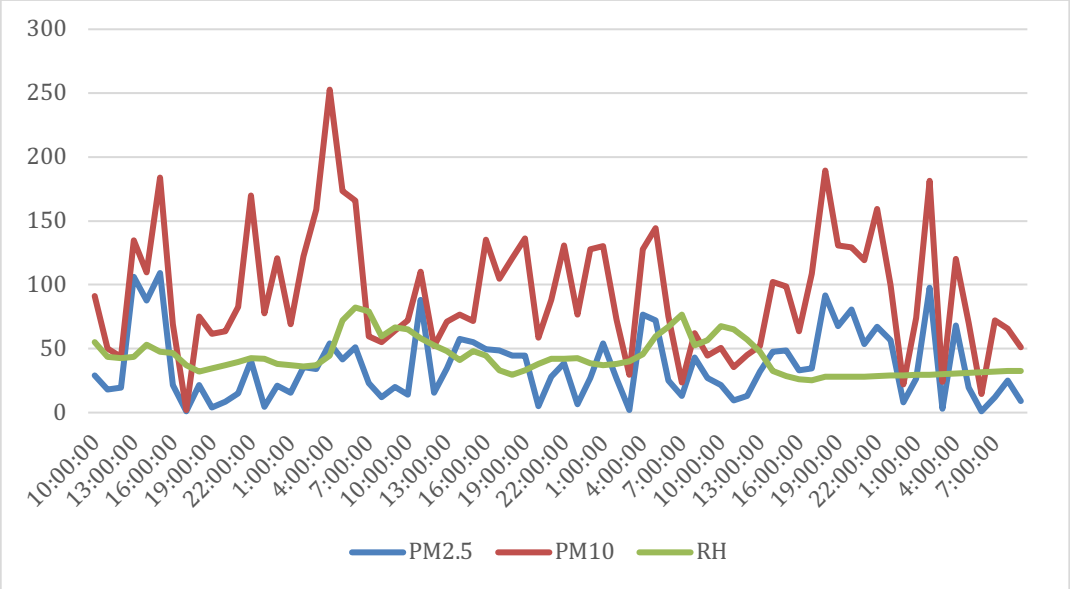


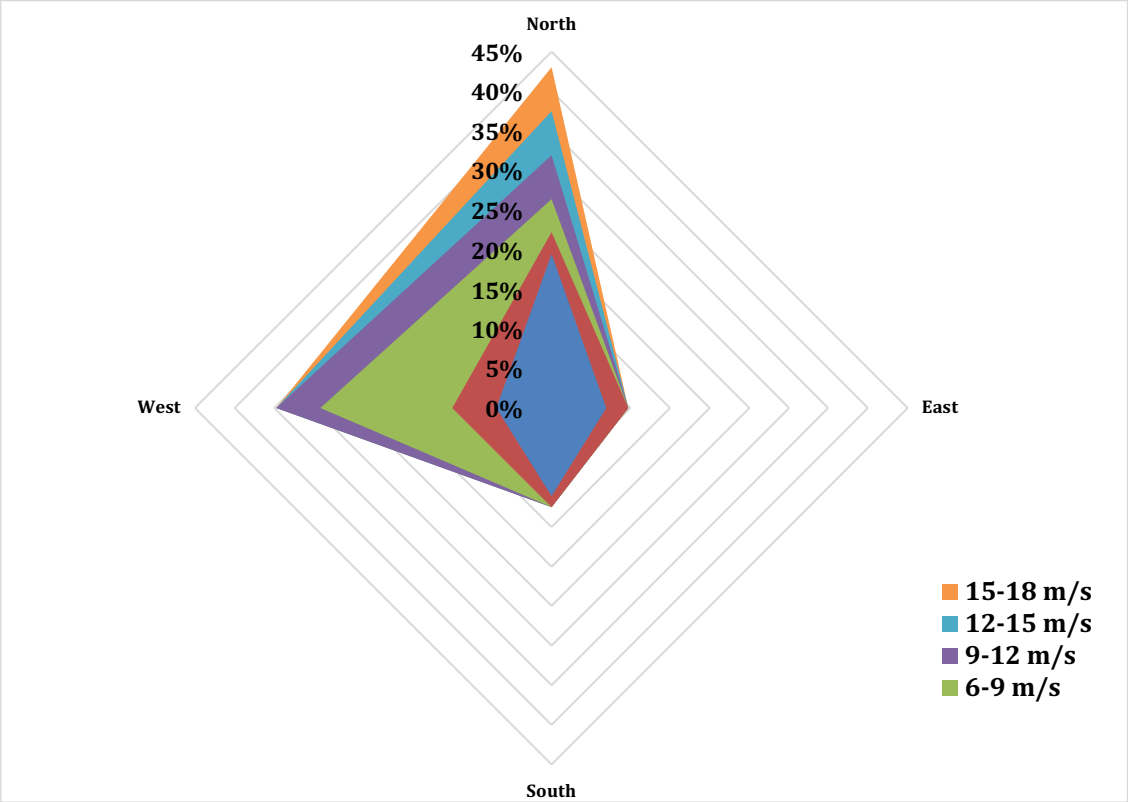
Figure 8-9 Ambient Air Quality Monitoring Particulate Matter (µg/m³) vs Humidity (%)- AQ-2



Wind

According to the wind speed and wind direction data collected during the monitoring period, the wind at the project site is predominantly coming from the north with speed of up to 18 m/s as shown in the wind rose below.

Figure 8-10 Windrose Data at the Project Site



Ambient Air Quality Monitoring at Laydown Area 1 & 2

The project site laydown areas 1 and 2 are located adjacent to the south of the project site 1 and 2 respectively. Due to the close proximity of the laydown areas to the project sites, ambient air quality monitoring conducted for a period of 72 hours between 4th September and 7th September 2018 at two locations is considered a sufficient representation of the local conditions. This is particularly because the main emission sources (from vehicular traffic on the E11) are the same proximity from the laydown areas as they are from the site monitoring locations. As a result, no additional ambient air quality monitoring was conducted for the laydown areas 1 & 2.

8.3 Receptors

As the project is an SWRO desalination plant and it does not include combustion sources, the operational phase of the project will not result in primary emissions to air. As such impacts upon ambient air quality are expected to be temporary and limited to the construction phase of

the project. As such, only those receptors associated with the construction phase have been identified below.

Findings from the site visit and the review of satellite imagery identified few receptors within 500 m of the project boundary that maybe vulnerable to changes in ambient air quality as a result of the construction activities (such as dust generation and mobile gaseous emissions).

According to the UK's IAQM Guidance on the Assessment of Dust from Demolition and Construction, when there is a 'human receptor' within 350 m of the construction works or within 50 m of a route used by construction vehicles on public roads (up to 500 m from the site entrance), and where there is no 'ecological receptor' within 50 m of the boundary of the site, or within 50 m of a route used by construction vehicles on public roads (up to 500 m from the site entrance) there may be potential for impacts to dust dispersion and settlement.

With respect to the screening above, the site's boundary is approximately 106.3 m away from a wastewater treatment plant and approximately 44m from Arabian sea. In addition, the site is approximately 431m from Ras Al Khaimah Tourism Development Authority and 475.9m from Rixos Ban Al Bahr resort while towards the north east, the project is approximately 474m from commercial compound 2. A camel holding area is also located approximately 128m south of the laydown area 2. The project construction workers will also be vulnerable to changes in ambient air quality particularly during the site preparation stage (site clearance, levelling of sand dunes areas and earthworks) and by exhaust fumes of construction vehicles, equipment and temporary power generators.

The proximity of these receptors to the proposed project site introduces the risks associated with air quality degradation especially during the construction phase of the project.

Table 8-8 Air Quality – Receptor Sensitivity

Receptor	Sensitivity	Justification
Project construction workers	**High**	Workers at the construction site will be particularly vulnerable to changes in the ambient air quality as they will be working on the project site during the construction activities.
SWRO Operation & Maintenance personnel	**Low**	O&M personnel will have a low vulnerability to changes in the ambient air quality during the operation of the SWRO plant.
Workers at the wastewater treatment plant	**Medium**	Workers at the wastewater treatment plant are located approximately 106.3m from the project site boundary and will therefore be relatively vulnerable to changes in the ambient air quality as a result of the project's construction activities.
Ras Al Khaimah Tourism Development Authority & Rixos Bab Al Bahr Resort and Commercial Compound 2	**Medium**	These receptors are almost 500 m from the project site and will not be significantly impacted by changes in ambient air quality as they are of low vulnerability

Receptor	Sensitivity	Justification
Camel Holding Area Workers	**Medium**	The camel holding area is located approximately 128m from the project boundary and will be relatively vulnerable to changes in ambient air quality as a result of construction activities.

Figure 8-11 Air Quality Receptors

8.4 Potential Impacts

8.4.1 Construction Phase

During construction, local ambient air quality may potentially be affected by increased dust, particularly during the site preparation stage (site clearance, levelling of sand dunes areas and earthworks) and by exhaust fumes of construction vehicles, equipment and temporary power generators.

In particular, impacts are likely to be associated with:

- Dust deposition, resulting in the soiling of surfaces;
- Visible dust plumes, which are evidence of dust emissions;

- Increased Particulate Matter concentrations, as a result of dust generating activities on site and vehicle movement son unpaved surfaces;
- Localised temporary increase in concentrations of airborne particles and gaseous pollutants (e.g. nitrogen dioxide, carbon monoxide, sulphur dioxide) due to exhaust emissions from diesel powered vehicles and equipment used on site (non-road mobile machinery) and vehicles accessing the site;
- Stored VOCs and other volatile hazardous materials due to release of volatile gases; and
- Odour from temporary wastewater facilities, or wastewater containment.

Dust Emissions

The principle sources of dust and particulate emissions during construction will be:

- Excavations and earthworks, such as ground breaking, cutting, filling and levelling;
- Truck movements on unpaved, or compacted surfaces; and
- Particulate dispersion from uncovered truckloads.

Dust Emissions from Site Preparation

Dust resulting from excavations and earthworks typically comprises large diameter particles, which settle rapidly and close to the generation source.

In the case of this project, far field dust impacts from construction may be discernible to the human receptor at the wastewater treatment plant and the construction site. However, the magnitude of dust impacts from construction works will depend on the wind speed and wind direction at the project site.

Dust Emissions & Particulate Emissions from Movement of Vehicles

Except for vehicle movements on unpaved surfaces (i.e. along any unauthorized tracks), dust generation from truck movements and particulate dispersion from uncovered truckloads would only occur where mitigation measures are not effective implemented at the site, or by the Contractors and/or sub-contractors bringing materials to the site. Uncontained and/or un-sheeted trucks may be subject to losses of material where the containment is not effective (e.g. spills), or where wind or other air turbulence may disturb the contents and result in dispersion of material. Such impacts have potential to degrade local air quality in the immediate area of such movement.

Gaseous Emissions

The operation of Project related vehicles and fuel consuming construction equipment will be the only sources of gaseous emissions to air during construction. Such vehicles and equipment are likely to include, those included to the table below. The quantity of gaseous emissions from this equipment will depend on the number of vehicles/equipment deployed on site, hours of

operation and efficiency. It is considered that the overall emissions of such sources will be respectively low, when compared with emissions from existing highway sources adjacent to the site.

Table 8-9 Vehicles & Construction Equipment During the Construction Phase

Construction Vehicles and Equipment	
Mortar Mixer	Lorry Mounted Crane
Concrete Mixing Trucks	7T Forklift
Concrete Transfer Pumps	5T Forklift
Mobile Cranes	Veneer Reeling Machine
Gantry Crane	Air Compressor
Excavators	Diesel Generators
Flatbed Trucks	Workers buses
Motor Trucks	Staff private vehicles
Auto dumper	
Mobile Cranes	
Wheel loader	
Bulldozers	
Road Roller	
Crawler Cranes	

Greenhouse Gas Emissions

The number of vehicles and construction equipment provided in the table above will vary depending on the construction activities and requirements during the 33 months of construction. However, it should be noted that based on the construction phase vehicle and equipment requirements submitted to 5 Capitals by the EPC Contractor, majority of the vehicles and equipment will be used for 28 months only.

During the construction phase it is estimated that the fuel consumption will be approximately 15,000 l/month, during peak periods of construction. This translates to a maximum of 180,000 l/per year and 420,000 litres for the entire construction period. Using the IFC Carbon Emissions Estimation Tool (CEET) the GHG emissions for the construction period are provided in the table below:

Table 8-10 GHG Emissions During the Construction Phase of the Project.

Fuel Consumed in Mobile vehicles	Annual Fuel Consumption (Litres)	Fuel Consumption During 28 Months of Construction (Litres)	t CO2-eq per year based on 28 months of the construction
Diesel	180,000	420,000	1,153

It is noted that the above emissions scenario presents an assumed worst-case where there will be 15,000 litres of fuel consumption every month, which is based on peak fuel consumption for the highest month during construction.

Emission of Volatile Organic Compounds (VOCs)

A small quantity of fuels, paints, solvents and other volatile substances are likely to be required during the construction phase, which will be stored in secure areas within the construction laydown areas. If not adequately contained, such substances have the potential to result in the dispersion of volatile emissions to the immediate air shed. Given that the storage of such volatile substances will be in small quantities, any potential impacts will be temporary and limited to the immediate surrounding area, likely to be within the project site or in close proximity to the construction boundaries.

Odours

On site sanitation and toilet facilities (including septic tanks) will be provided for construction staff. There is the potential for release of odour to the immediate surrounding areas from inappropriate containment and coverage associated with wastewater holding/septic tanks. Any such impacts are likely to be temporary and limited to the project site or in close proximity to the construction site boundaries.

Table 8-11 Air Quality – Impact Significance, Mitigation & Management Measures and Residual Impacts -Construction

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
Dust emissions within 500 m of the project boundary – Generated as a result of site preparation works and movement of vehicles on unpaved surfaces	**Minor Negative**	Project construction workers	High	**Minor to Moderate**	• Any land grading, excavations and moving of uncovered waste/materials will be undertaken during periods of low winds (e.g. < 15 km/h is recommended as a threshold when a review of works is conducted) • Daily review of weather updates, to give warning of likely strong winds to assist with the management of windblown dust • All dust generating activities will cease during periods of high winds conditions (15 km/h) • Material stockpiles higher than 15 m will be avoided where possible, with a dust control method (e.g. dust suppression sprays or cover) being utilised on any piles during periods where the wind speeds exceed 15 km/h • Where sand and other dusty materials are transported to the site, trucks will not be overloaded and will be appropriately covered/sheeted to avoid loses en-route. • Cement and other fine powders will be sealed after use or bunded containers. • Dusty material stockpiles (i.e. any fine powders and sand) dust generating activities (stone cutting) are to be located away from the site boundaries and be contained to avoid dust dispersion during storage or use. • Vehicle speed on all site roads will be restricted to 20 km/h.	**Minor**
	Negligible Negative	Workers at the wastewater treatment plant	Medium	**Negligible to Minor**		**Negligible to Minor**
	Negligible Negative	Ras Al Khaimah Tourism Development Authority & Risox Bab Al Bahr resort and	Medium	**Negligible to Minor**		**Negligible**

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
		Commercial Compound 2			• Where paved routes are not available vehicles routes will be clearly demarcated and appropriate signage displayed around the site. • Wetting down of any unpaved site roads in order to reduce dust generation. • The provision of wheel-washing facilities or high-pressure hose to ensure all vehicles leaving the site are in a satisfactory state of cleanliness. Dry wheel cleaning is recommended. • Provide project workers with full PPE kit including dust masks.	
	Moderate Negative	Camel Holding Area Workers	Medium	**Moderate**		**Minor**
Gaseous emissions – From vehicle exhaust	**Minor Negative**	Project construction workers	High	**Minor to Moderate**	• Limit unnecessary usage of vehicles, plant and equipment- No unnecessary idling. • Deliveries equipment/plant to the site will be efficiently managed to reduce the number of trips. • Appropriate quality of fuel used- Fuel to international standards to be sourced through a licensed local company. • Exhaust fumes and particulates emitted from trucks and vehicles will be minimised by ensuring the use of good condition vehicles (e.g. compliant to national mobile emission/vehicle emission requirements) • Lorries and trucks engines will be turned off while waiting on site to minimise gaseous emissions. Air conditioned or heated shelters will be provided for drivers in designated waiting, loading and unloading areas. • Emissions from vehicles, plant and equipment will be free from significant black smoke.	**Negligible to Minor**
	Minor Negative	Camel Holding Area Workers	Medium	**Minor**		**Negligible**
Emissions of VOCs and other	**Minor Negative**	Project construction workers	High	**Minor to Moderate**	• Hazardous materials stored and use on site with potential gaseous emissions (e.g. Volatile Organic Compounds) will be located in well-ventilated, but	**Negligible to Minor**

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
hazardous volatiles					secure low-risk areas, away from major transport routes. • Volatile fuels and chemicals will be stored in sealed containers. On site storage of large quantities of volatile fuels will be avoided, equally prolonged exposure to direct sun and heat will be avoided. • Fires and material burning will not be allowed on the project site.	
Odour from onsite sanitary facilities	**Minor Negative**	Project construction workers	High	**Minor to Moderate**	• Adequate and sufficient sanitary facilities for site workers must be provided • Effective cleaning and maintenance of toilets to be undertaken to avoid odour dispersion. • All septic tanks must be sealed and fully functioning. • Septic tanks must be operated and maintained according to manufacturer recommendations.	**Negligible to Minor**

8.4.2 Operational Phase

As the project is a SWRO desalination plant it will not include combustion related activities or any direct (Scope 1) air emissions to the local air shed. However, a footprint of GHG emissions are expected due to the SWRO electricity consumption from the grid.

Greenhouse Gas Emissions (GHG)-Scope 2

The EPC Contractor has advised that the FEWA 150 IWP will require approximately 1,023,200MWh per annum. The Scope 2 emissions related to this amount of grid drawn electricity have been calculated using the IFC Carbon Emissions Estimation Tool (CEET), based on the carbon intensity of grid electricity generation in the UAE.

Table 8-12 GHG Emissions During the Operational Phase of the Project.

Region/Country	National All Fuels Average Elec. Consumption (kWh)	t CO2-eq per year
United Arab Emirates	1,023,200,000	611,689

It should be noted that the CEET was last updated in 2013 and therefore it does not account for the renewable energy that has been developed and put online in the UAE between 2013-2019. Therefore, the above emissions are considered as a worst-case scenario and are expected to be slightly lower (and decreasing over time) during the operational phase of the project, as additional renewable energy is added to the grid electrical generation mix.

Since the GHG emissions for the project are above 100,000 tonnes/year, the Project Company will publicly disclose the annual GHG emissions in line with the Equator Principles requirements.

Gaseous Emissions

Emissions form the operation of vehicles are anticipated during the operational phase of the project. However, it is anticipated that the overall emissions will be respectively low when compared with the emissions from existing highway sources adjacent to the site. Proposed mitigation and management measures for this are outlined in the table below.

Table 8-13 Air Quality – Impact Significance, Mitigation & Management Measures and Residual Impacts – Operation

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
Gaseous emissions – From vehicle exhaust	**Negligible Negative**	SWRO Operation & Maintenance Personnel	Low	**Negligible to Minor**	• Appropriate quality of fuel used- Fuel to international standards to be sourced through a licensed local company. • Limit unnecessary usage of vehicles-No unnecessary idling • Planned inspection and maintenance of project vehicles and mobile equipment shall be undertaken annually to ensure worthiness and compliance to the required national emission limits.	**Neutral**

8.5 Monitoring

The EPC Contractor and the O&M Company will undertake air quality monitoring during both the construction and operational phases of the project respectively and these are outlined in the table below. The final monitoring methodology with specific monitoring details (i.e. locations, frequencies, durations, parameters etc.) will be developed in the specific 'Environmental Monitoring Plan'.

Table 8-14 Air Quality Monitoring Requirements

Monitoring	Parameter	Frequency & Durations	Location	Responsibility
Construction				
Dust generation	Dust	Visual observation for dust emissions to be undertaken on daily basis. To be monitored quantitatively if generation is considered to be excessive or complaints are received.	Access roads. construction site and laydown areas. Dispersion to external receptors from point of generation	EPC Contractor
Emissions from engines	Vehicle emissions	Prior to acceptance of equipment on site	All non-road vehicles and engines	EPC Contractor
Sanitary facilities	Odour	Daily olfactory observations – as part of maintenance and inspection checks	All sanitary facilities available within the laydown areas and work fields	EPC Contractor
Operation				
Emissions from engines	Vehicle emissions	Planned annual inspection and regular maintenance of project vehicles	All road and non-road vehicles and engines	O&M Company
Electricity Consumption	GHG emissions	Annual public disclosure of GHG emissions	Project site	O&M Company

9 NOISE AND VIBRATION

This chapter describes the potential noise and vibration impacts and effects that may occur as a result of the project construction and operation activities. Further, it identifies the measures that will be implemented as controls to mitigate and manage these impacts.

9.1 Standard and Regulatory Requirements

9.1.1 National Standards

Cabinet Decree No. 12 of 2006 concerning the protection of Air from Pollution establishes the Federal Ambient Noise Standards, which are applicable to the project both during construction and operational phases. In accordance with FEA noise limits the following table (Table 9-1) summarises the environmental noise requirements in regard to community noise, which is broken down by the sensitivity of the community and the time of day.

Table 9-1 Federal Maximum Allowable Limits for Noise Level in Different Areas.

Receptor Areas	Allowable Limits of Noise (dbA)	
	Daytime (7am -8 pm)	Evening (8pm-7am)
Residential Areas with Light Traffic	40-50	30-40
Residential Areas in Downtown	45-55	35-45
Residential Areas with some workshops & Commercial or near highways	50-60	40-50
Commercial areas & Downtown	55-65	45-55
Industrial Areas (Heavy Industry)	60-70	50-60

Source: Cabinet Decree No. 12 of 2006 concerning Protection of Air from Pollution, Annex (6)

9.1.2 Lender Requirements

The projects lenders are expected to require compliance with the IFC Performance Standards and IFC EHS Guidelines. The IFC EHS General Guidelines (2007) reference the World Health Organisation (WHO) noise standards that indicate the maximum allowable noise levels to be received at nearby receptors, which depends on receptor classification.

It is stated within the WHO noise standards that noise impacts should not exceed the levels which are presented in the table below or result in a maximum increase in background levels of 3dB at the nearest off-site point of reception.

Table 9-2 WHO Noise Standards (At off-site receptors)

Receptor	One Hour L_{eq} (dB(A))	
	Daytime 07:00 – 22:00	Night time 22:00 – 07:00
Residential, Institutional, Educational	55	45
Industrial, Commercial	70	70

Furthermore, the following requirements have also been specified in the IFC EHS noise guidelines:

- No employee should be exposed to a noise level greater than 85 dB (A) for duration of more than 8 hours per day without hearing protection. In addition, no unprotected ear should be exposed to a peak sound pressure level (instantaneous) of more than 140 dB(C).
- The use of hearing protection should be enforced actively when the equivalent sound level over 8 hours reaches 85 dB (A), the peak sound level reaches 140 dB(C), or the average maximum sound level reaches 110 dB (A). Hearing protective devices provided should be capable of reducing sound level at the ear to at least 85 dB (A).
- For every 3 dB(A) increase in sound levels, the allowed exposure period or duration should be reduced by 50%.
- Where feasible, use of acoustic insulating materials isolations of the noise source and other engineering controls should be investigated and implemented prior to the issuance of hearing protection devices as the final control mechanism.
- Medical hearing checks on workers exposed to high noise levels should be performed

9.1.3 FEWA Requirements

In addition to the above regulations, FEWA provides more guidelines for guaranteed maximum noise pressure levels as shown in the table below.

Table 9-3 Guaranteed Maximum Noise Pressure Levels

Description	Unit	Limit
At 1-meter outside the RO plant fence during the operation of all equipment	dB(A)	60
At 1-meter distance of open air installation	dB(A)	85
Within the RO Plant control room	dB(A)	50
Within other machine rooms, RO membrane hall and workshops	dB(A)	85

Source: FEWA Volume III Form Sheet 6: Part 1-2

9.2 Observation and Baseline Conditions

9.2.1 Noise

Noise

Field observations and review of satellite imagery as shown in the figure below have not identified any notable sources of noise that specifically propagate noise to the proposed location of the SWRO Plant. There are no specific industrial facilities or other large-scale commercial activities in the local project area that have the potential to generate noise. Despite this, the proposed project sites 1& 2 and laydown areas 1 & 2 are affected by the E 11 highway and the vehicles using the semi-tarmacked road connecting the south bound E11 carriageway to the north bound carriage way. There is also an untarmacked road south of the laydown area 2 which connects the north bound E11 carriageway to Umm Al Quwain municipality construction and demolition waste plant and a waste water treatment plant approximately 3.3 km from the laydown area 2.

Figure 9-1 Local Noise Sources (E 11 Highway)

Noise Monitoring Survey Methodology-September & November 2018

In order to quantify existing noise levels at the project site and at receptor locations, noise measurements were taken at five (5) representative locations of the project sites between 5th and 7th September and between 19th and 20th November 2018. This was to make sure that the noise survey was aligned with the Federal Ambient Noise Standards and the WHO Noise

Standards timelines (Day, Evening/Night): Peak (07:00-07:30), Inter-peak (10:00-10:30) and night (22:00-22:30).

Ambient noise levels were monitored continuously for a period of 30-minutes at each location during day, evening and night time. The noise meter was arranged at a height of 1.5 m above the ground level and 3.5m away from any obstructions. The microphone sensor was directed towards the perceived highest magnitude source of noise received at each location in order to allow for an assessment of the worst-case noise impacts acting upon the monitoring locations. A wind muffler was placed over the microphone to minimise the recording of background wind and air turbulence.

The monitoring was undertaken by a certified laboratory and the calibration certificate is provided in the Appendix L. The noise meter was calibrated in the field before each measurement cycle.

The noise monitoring survey locations are as shown in the figure below and presented in the following table.

Figure 9-2 Noise Monitoring Locations

Table 9-4 Noise Monitoring Locations-September 2018

ID	Co-ordinates		Photo
	Northing	Easting	
N-1	25.655813	55.746862	
N-2	25.655233	55.747661	
N-3	25.654581	55.748800	

ID	Co-ordinates		Photo
	Northing	Easting	
N-4	25.653974	55.753592	
N-5	25.660494	55.750476	

Table 9-5 Noise Monitoring Locations-November 2018

ID	Co-ordinates		Photo
	Northing	Easting	
N-1	25.655813	55.746862	

ID	Co-ordinates		Photo
	Northing	Easting	
N-3	25.654581	55.748800	

Table 9-6 Noise Monitoring Results (September & November 2018)

ID	Date	Measured Noise Level dB(A)				
		Lmin	Lmax	LAeq	L10	L90
Detection limit		30 dB(A)				
Peak Traffic-07:00-07:30						
N-1	20th November 2018	47	64	55	58	49
N-2	07th September 2018	42	56	48	51	44
N-3	20th November 2018	41	64	53	57	45
N-4	6th September 2018	44	54	48	50	46
N-5	8th September 2018	45	70	55	57	47
Inter-Peak Traffic-10:00-10:30						
N-1	19th November 2018	42	62	52	56	45
N-2	6th September 2018	39	54	46	48	42
N-3	19th November 2018	45	65	54	56	46
N-4	5th September 2018	43	57	48	50	44
N-5	8th September 2018	44	70	56	58	47
Night-22:00-22:30						
N-1	19th November 2018	49	63	**54**	57	51
N-2	6th September 2018	45	69	**53**	54	47
N-3	19th November 2018	43	67	**54**	57	46
N-4	5th September 2018	45	52	46	47	45
N-5	7th September 2018	50	72	**58**	60	52

The results obtained from the above ambient noise monitoring survey ranged between LAeq 48dB(A)-55dB(A)for peak hours (07:00-07:30), 46dB(A)-56dB(A) for inter-peak hours (10:00-10:30) and 46dB(A)-58dB(A) for night time (22:00-22:30). When compared to the Federal daytime and evening/night residential areas with some workshops and commercial or near

highway ambient noise levels, the daytime (peak & inter-peak) are within the Federal requirements of 50dB(A)-60dB(A). On the other hand, the evening/night results are above the maximum allowable limits of 40 dB(A)-50 dB(A) for all stations (N-1, N-2, N-3 & N-5) apart from N-4 at 46dB(A). This can be explained by the fact that N-1, N-2, N-3 and N-5 were located near the E11 highway which is the main route connecting Abu Dhabi to Ras Al Khaimah and the access roads to and from Marjan island.

The noise survey results obtained above for daytime (07:00-22:00) and night time (22:00-07:00) are in compliance with the WHO requirements of 70dB(A) for day and night time.

Noise Monitoring Survey Methodology-June 2019

Due to the increase in the project footprint, 5 Capitals commissioned a 3rd noise monitoring survey in June 2019 at two (2) representative locations at the project site (2). The noise survey was conducted to align with the Federal Ambient Noise Standards and the WHO Noise Standards timelines: Peak 07:00-09:00, Inter-peak 10:00-16:00 and night 22:00-07:00. The same methodology used for the noise monitoring survey carried out in September and November 2018 was employed for the June 2019 noise monitoring survey.

The noise monitoring location for N-6 and N-7 undertaken in June 2019 are shown in the figure below and represented in the following table.

Figure 9-3 Noise Monitoring Locations

Table 9-7 Noise Monitoring Locations-June 2019

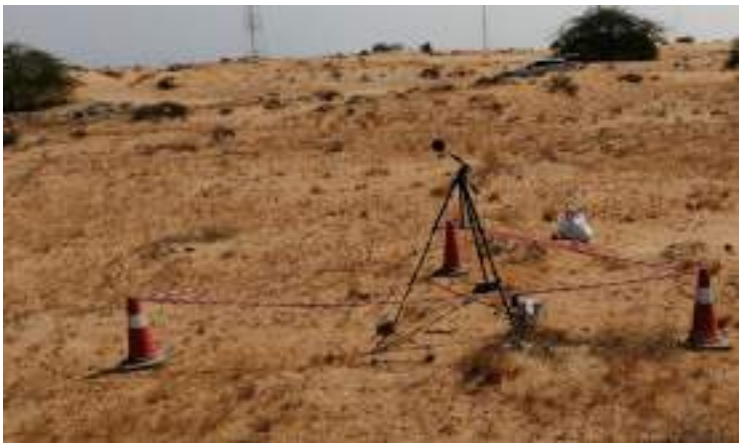
ID	Co-ordinates		Photo
	Northing	Easting	
N-6	25.647107	55.752147	
N-7	25.653060	55.752821	

Table 9-8 Noise Monitoring Results

ID	Date	Measured Noise Level dB(A)				
		Lmin	Lmax	LAeq	L10	L90
Detection limit		**30 dB(A)**				
Inter-Peak Traffic-14:00-14:30						
N-6	5th July 2019	47	80	**61**	59	48
Night-22:00-22:30						
N-6	5th July 2019	47	50	48	49	48
Peak Traffic-08:00-08:30						
N-6	6th July 2019	47	81	**62**	62	48
N-7						
Inter-Peak Traffic-12:00-12:30						
N-7	24th June 2019	45	55	48	50	46
Night-23:00-23:30						
N-7	24th June 2019	33	49	42	46	35
Peak Traffic-08:00-08:30						
N-7	25th June 2019	44	48	45	46	45

The results obtained from the monitoring exercise ranged between LAeq 61dB(A)-48dB(A) for interpeak hours, 48dB(A)-42dB(A) for night hours and 62dB(A)-45dB(A) for peak hours. When

compared to Federal daytime and evening/night residential areas with some workshops and commercial or near a highway ambient noise levels the day time (peak & inter-peak) for N-6 recorded a slight exceedance with a recording of 62dB(A) and 61 dB(A) respectively. This is above the federal requirement of (50dB(A)-60dB(A). The evening/night results at N-6 were recorded as 48 dB(A) while it was 42dB(A) at N-7. This is within the maximum allowable limits of 40 dB(A)-50 dB(A).

The complete noise monitoring results from September and November 2018 and June 2019 are provided in Appendix M.

9.2.2 Vibration

In terms of a baseline, no noticeable vibrations were encountered during the initial site visit whilst at the project sites in September, November 2018 and June 2019. Equally, there are no current facilities or processes in the vicinity of the proposed project site that are likely to result in vibrations at or around the area.

Localised vibration may be encountered adjacent to the E11 highway; however, these will typically be dependent on vehicle flows, and vehicle classification (e.g. ratio of HGV's to LGV's and private vehicles). The dissipation of any such vibration is expected to occur over a short distance due to the low magnitude of the vibrations.

9.3 Receptors

Findings from site visits and satellite imagery identified few receptors within 500 m of the project boundary that maybe vulnerable to changes in ambient noise levels as a result of construction activities within the project site.

Construction workers will be vulnerable to changes in ambient noise levels particularly during construction activities involving earthworks, movement of vehicles, compaction works and piling.

The project boundary is located approximately 106.3m from the wastewater treatment plant. Therefore, the workers are considered to be sensitive to potential noise and vibration impacts especially during the construction period. However, it is recognised that these workers may already be exposed to noise and vibration impacts from the processes at the wastewater treatment plant.

The workers at the camel holding area approximately 128m from the project site are also considered as sensitive receptors but they are already impacted by the constant traffic from the untarmacked road connecting the E11 highway to the UAQ Construction and Demolition Waste Plant and the Waste Water Treatment Plant.

On the other hand, Ras Al Khaimah Tourism Development Authority, Rixos Bab Al Bahr resort and commercial compound 2 are approximately 430 m away from the project boundary. While these receptors may be exposed to noise and vibration associated with construction activities, the noise levels will largely be attenuated due to propagation over distance.

Receptors beyond 500 m from the project boundary have not been considered to be in the range of influence of the project noise and vibration impacts due to the attenuation of noise and vibration by distance propagation.

Figure 9-4 Noise Receptors

Table 9-9 Noise – Receptor Sensitivity

Receptor	Sensitivity	Justification
Project construction workers	**High**	Workers at the construction site will be particularly vulnerable to changes in ambient noise levels as they will be working on the project site during the construction activities.
Ras Al Khaimah Tourism Development Authority & Rixos Bab Al Bahr Resort, Commercial Compound 2	**Medium**	These receptors are located approximately 430 meters from the project boundary and as a working area and tourist resort and commercial areas they have relatively low vulnerability to construction noise.
Workers at the wastewater treatment plant	**Low**	The wastewater treatment plant is located approximately 106.3m from the proposed project boundary. Therefore, the workers are considered to be relatively vulnerable to potential noise and

Receptor	Sensitivity	Justification
		vibration impacts especially during the construction period.
Camel Holding Area Workers	**Medium**	Located 128m from the project site, the camel holding area workers are considered to be particularly vulnerable to potential noise and vibration impacts especially during the construction period.
SWRO Operation & Maintenance personnel	**Low**	O&M personnel will have a low vulnerability to changes in the ambient noise levels during project operation.

9.4 Potential Impacts

9.4.1 Construction Phase

Construction Noise

Construction activities normally result in temporary and short duration increases in the noise and vibration levels of a site. Noise will be generated by construction and emitted to the surrounding environment via a range of processes. Construction activities in relation to noise and vibration are likely to include earthworks, movement of vehicles, compaction works and piling. Other construction activities will include:

- Site Preparation
- Civil Works
- Construction and Installation; and
- Internal Road Paving/Compacting.

It is possible that initial earthworks for site preparation may result in higher magnitude impacts than other construction activities due to a lack of attenuation from intervening structures, a large number of heavy vehicle movements and excavation/grading noises.

In regard to the expected construction plant/machinery to be used at the site, noise data for the anticipated plant/equipment to be used at the site has been obtained from 'British Standards: Code of practice for noise and vibration on construction and open sites' and is listed below.

Table 9-10 Noise level of Typical Construction Equipment

Construction Activities	BS 5228-1:2009 Reference	Equipment	SPL dB (A)
Site clearance	Table C.2,4	Tracked Excavator (22t)	52
Earthworks	Table C.2,13	Dozer (11t)	78
	Table C.2, 20	Tracked Excavator (25t)	68

	Table C.6, 28	Wheeled Loader	76
Material Handling	C.2, 30	Dump truck (29t)	73
	C.2, 38	Roller (18t)	79
	C.2, 40	Vibratory Roller(3t)	73
	C.2, 42	Hydraulic compactor	78
	C.4, 20	Concrete mixer truck	80
	C.4, 22	Concrete mixer (26t)	76
	C.4, 41	Mobile telescopic Crane (100t)	71
	C.4.48	Tower crane (22t)	76
Stationary	C.4, 84	Diesel generator	74
	C.5, 21	Vibratory Roller (12t)	80
Road construction	C.5, 1	Hydraulic breaker (67kw)	88
	C.5, 32	Asphalt paver (18t)	84

The accumulation of noise from the above activities can introduce potential impacts for nearby receptors. In the assumed worst case with all of the above listed equipment operating at full power at the same time and at the same location (100% factor), the combined cumulative construction noise level as perceived at 10m distance from the source would be 91.5dB(A). The project construction workers would also be exposed to this noise levels during the construction phase.

Noise levels dissipate with distance and as such the potential for noise impacts will significantly decrease with distance from the noise source. Ras Al Khaimah Tourism Development Authority Rixos Bab Al Bahr resort and commercial compound 2 are approximately 430m from the northern boundary of the project site 1 and 2, a basic assessment of distance propagation and ground absorbance would reduce from 91.5dB(A) to 52.6dB(A), 44.6dB(A) and 51.6dB(A) respectively. Since the wastewater treatment plant is approximately 106.3m from the project site, a basic assessment of distance propagation and ground absorbance would reduce from 91.5dB(A) to 67.8 dB(A) while noise at the camel holding area would reduce to 65.8dB(A).

Under typical construction circumstances (where not all listed equipment is operating at the same time at the same location – 50% factor) impacts due to construction site noise from the SWRO desalination project will be below 49.6 dB(A) at Ras Al Khaimah Tourism Development Authority, 43.5dB(A) at Rixos Bab Al Bahr resort, 48.6dB(A) at commercial compound 2 while it will be below 64.8dB(A) at the wastewater treatment plant, 62.8dB(A) at the camel holding area and 88.5 dB(A) at the construction site.

The above represent the worst-case scenario with all the above listed equipment operating at the same time. However, this is an unlikely scenario because of the phasing of the project. In the event that the noise limits exceed the FEA standard or WHO requirements, the EPC Contractor will be required to implement the mitigation and management measures discussed below.

With regard to ecological receptors, noise associated with construction is likely to trigger a flight response from local fauna. Impacts due to noise on ecology are further assessed in Section 6 'Terrestrial Ecology'.

Vehicular Noise

The addition of temporary construction vehicles on E11 highway and within the site will likely result in temporary increases in traffic which will consequently result in an increase of noise levels at receptors. Impacts due to vehicular noise will vary due to the phasing of works and the timing of vehicular movements, which affect both vehicle flow and the percentage of heavy vehicles.

Even though the flow of traffic along the E11 highway section near the project site is not constant and busy there is a regular flow of vehicles resulting to sustained noise levels throughout the day. Discernible changes in noise levels may however be identified at times of peak flows on a daily basis. In addition, any increases in traffic during the construction phase may lead to increase in the noise levels, which could potentially propagate to off-site receptors.

Internal site roads will generate a new noise source from the movement of construction vehicles. Such noises will be predominantly experienced by the project construction workers and those at the wastewater treatment plant.

Vibration

Certain construction processes, particularly those involved with site preparation and civil works, e.g. breaking, piling, vibratory rollers etc. have the potential to create vibration within the vicinity of the works. Vibration to a lesser extent is also anticipated to occur around the construction site due to the movement of materials and equipment by vehicles.

Vibration dissipates rapidly as it spreads and loses energy from its source, hence impacts from vibration are not expected to be discernible at receptors located over 500 m away from the project site, although some vibration may be discernible at the boundaries of the project site.

With respect to the fauna, vibration associated with construction will likely trigger a flight response; this is assessed further in Section 6 'Terrestrial Ecology'.

Table 9-11 Noise and Vibration – Impact Significance, Mitigation & Management Measures and Residual Impacts – Construction

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
Construction site noise- Noise from general construction activities	**Minor Negative**	Project construction workers	High	**Minor to Moderate**	• Acoustic covers on machine engines to remain closed at all times. • The Contractor will, at all times, carry out all work in such a manner as to keep any disturbance from noise to a minimum (by phasing noisy works). • Vehicles/ equipment will be operated within manufacturers recommended guidelines so as to avoid causing excessive noise. • Where practical, eclectically powered plant will be preferred to mechanically powered alternatives. • All mechanically powered plant, diesel engine vehicles and compression equipment will be fitted with noise control equipment (exhaust silencers, mufflers) as available from the manufacturer. • Consideration shall be given to hours of works during normal day time working hours (between Saturday and Thursday) and on Fridays' or during official holidays. • Where possible, the highest noise emitting activities will be undertaken in a central area and away from boundaries. • Where appropriate, noise barriers/ attenuation to be employed (e.g. for generators) to ensure that the maximum noise level at 1 m distance from a single source will not exceed 85 dB(A). • Where noise levels exceed 85 dB(A), noise protection devices will be provided to personnel on site and the area marked as a high-noise zone where ear protection is mandatory. • The EPC Contractor will at all times, carry out all work in such a manner as to keep any disturbance from noise to a minimum (by phasing noisy works).	**Minor**
	Negligible Negative	Ras Al Khaimah Tourism Development Authority & Rixos Bab Al Bahr resort and Commercial Compound 2	Medium	**Negligible to Minor**		**Negligible to Minor**
	Negligible Negative	Workers at the wastewater treatment plant	Low	**Negligible to Minor**		**Negligible to Minor**
	Minor Negative	Camel Holding Area Workers	Medium	**Minor**		**Minor**

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
Vehicular Noise – Noise from the movement of construction vehicles	**Minor Negative**	Project construction workers	High	**Minor to Moderate**	• Limit unnecessary usage of vehicles/equipment - No idling- Equipment to be shut or throttled down when in intermittent use. • Delivery vehicles will be prohibited from waiting outside the site with their engines running (consideration of driver waiting room with air conditioning). • Ensure any appropriate permits are in place for delivers to the site and for any works performed outside normal working hours. • Review vendor specifications and accept site plant & vehicles, in particular heavy vehicles, based on noise emissions (as far as practical). • The movement of heavy vehicles during the night will be avoided where practical.	**Minor**
	Negligible Negative	Workers at the wastewater treatment plant	Low	**Negligible to Minor**		**Negligible to Minor**
	Minor Negative	Camel Holding Area	Medium	**Minor**		**Negligible to Minor**
Construction vibration impacts (including vehicle vibration)	**Minor Negative**	Project construction workers	High	**Minor to Moderate**	• The Contractors will, at all times, carry out all works in such a manner to keep any disturbance from vibration to a minimum. • Operators of vibrating hand-held machinery (if any) will be provided with appropriate PPE (e.g. protective gloves and ear muffs/plugs) and be given suitable breaks from using such equipment to reduce the impacts of vibration. • Wherever practical, all vibratory generating equipment and activities shall be sited away from the project boundary.	**Minor**
	Negligible Negative	Workers at the wastewater treatment plant	Low	**Negligible to Minor**		**Negligible to Minor**
	Minor Negative	Camel Holding Area Workers	Medium	**Minor**		**Negligible to Minor**

9.4.2 Operational Phase

Project Noise

Principle noise sources are anticipated to be associated with seawater pumping house, which will be housed and afforded additional attenuation from the walled structures. The reverse osmosis components of the project are typically low noise components and will be housed within internal structure therefore further attenuating any generated noise.

According to SIDEM (EPC Contractor in charge of water technology for the project), all the equipment to be used during the operation phase of the project have a supplier guarantee of a maximum of 85dB(A).

However additional noise mitigation and management measures during the operational phase of the project are included in the table below.

Vibration

As the SWRO plant will not contain rotating, vibrating, or other major moving parts, impacts from vibration are not expected.

Table 9-12 Noise and Vibration Impact Significance – Operation

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
Operational Noise	**Negligible Negative**	SWRO Operation & Maintenance personnel	Low	**Negligible to Minor**	• All noise generating industrial components will be housed in appropriate shelters with suitable noise attenuating enclosures. • All O&M workers shall be provided with PPE (e.g. Ear muffs/plugs) • Where noise levels are in exceedance of 85db(A), noise insulation will be considered within building structures, or noise barriers provided. • Consider noise source screening structures to attenuate equipment over 85db(A) at 1m • Prior to conducting any unavoidable noisy activities beyond normal operations, notify receptors and keep them informed and updated with the work that is to be undertaken including the expected duration. • Noise will be monitored quarterly during the operational phase of the project and specific maintenance to reduce noise will be undertaken on equipment and vehicles where necessary.	**Negligible**

9.5 Monitoring

The EPC Contractor and the O&M Company will undertake noise monitoring on a periodic basis during both the construction and operational phases of the project respectively. The minimum expected requirements for the noise monitoring are outlined table below. The final monitoring methodology with methodology with specific monitoring details (i.e. locations, frequencies, durations, parameters etc.) will be developed in the specific 'Environmental Monitoring Plan'

Table 9-13 Noise Monitoring Requirements

Monitoring	Parameter	Frequency & Durations	Location	Responsibility
Construction				
Day time noise	Leq(A)	Weekly	Nearest receptor locations to the project site and at the project boundaries	EPC Contractor
Night time noise				
Operation				
Operational Noise	Leq(A)	Quarterly	Nearest receptor locations to the project site and at the project boundary	O&M Company

10 WASTE AND WASTEWATER MANAGEMENT

This chapter outlines the projects expected generation of waste and wastewater at the construction and operational phases. It does not consider the significance of impacts with respect to a specific receptor; as such impacts with respect to waste and wastewater have been assessed in the respective section of this ESIA (Section 7 Geology, Soils and Groundwater). The primary purpose of this chapter is to identify specific management measures in regard to waste and wastewater generation in order to ensure compliance with applicable regulations and standards.

10.1 Standards and Regulations

10.1.1 National Standards

The UAE's commitment to the prevention of pollution associated with waste management is well established within the principal objectives of Feral Law No. (24) of 1999 for the Protection and Development of the Environment, namely:

- Protection and conservation of the quality and natural balance of the environment.
- Control of all forms of pollution and avoidance of any immediate or long-term harmful effects resulting from developments.

10.1.2 Lender Requirements

International financial institutions will require adherence to IFC General EHS Guidelines. These guidelines require that projects undertaken to:

- Establish waste management priorities at the outset of activities.
- Identify EHS risks and impacts with regards to waste generation and its consequences.
- Establish a waste management hierarchy that considers prevention, reduction, reuse, recovery, recycling, removal and finally disposal of wastes.
- Avoid or minimize the generation waste materials, as far as practicable.
- Identify where waste generation cannot be avoided but can be minimized or where opportunities exist for, recovering and reusing waste.
- Where waste cannot be recovered or reused, identify means of treating, destroying, and disposing of it in an environmentally sound manner.

10.2 Local Conditions

Waste is an undesired by-product of every development, contributing to a number of environmental problems, for example, emissions of greenhouse gases, heavy metals and other

environmentally hazardous chemicals. With proper management, a large amount of materials discarded can be recovered and either reused directly or disassembled and their components reutilised.

Solid waste generation in Umm Al Quwain is bound to increase significantly due to industrial and economic growth. Consequently, responsible waste management is essential to minimise direct and indirect impacts upon the environment as a result of waste generation and resource use. Rapid economic development often precedes the required infrastructure to handle the waste generated. Consequently, it is important for Umm Al Quwain to consider the methods of handling, storing and managing waste in order to achieve sustainable development.

10.3 Observation and Baseline Condition

During the site walkovers conducted by 5 Capitals in 2018 and 2019, general waste and plastic waste was observed in project sites 1 & 2, laydown area 1&2 and at the project site intertidal habitat. In addition, construction waste was observed in project site 2 which includes aggregate, concrete blocks and broken glasses.

Plate 10-1Waste observed at the project site laydown area and along the intertidal habitat

10.4 Potential Impacts

10.4.1 Construction Phase

The construction phase can often be the one that poses the most environmental challenges particularly in terms of the volume of waste generated if not properly managed.

Solid Waste

Solid waste generated from construction activities at the project will include the following;

- Domestic waste generated by the construction workforce (e.g. food/organic waste, paper trash, cardboard, aluminium, plastics);
- Non-hazardous waste such as paper/cardboard, plastics, packaging, plastic bottles, glass, scrap metal, excess fill materials, sand, gravel, excess construction materials, concrete, subsoil and rock (not contaminated);
- Hazardous waste such as batteries, spent filtration cartridges, chemical drums, oil filters, aerosol cans, contaminated metals, empty containers, expired and unused chemicals, adhesives, machinery lubricants clean-up materials such as rags, containers and tins with remains of hazardous substances, used spill kits and clean-up materials; and
- Medical Waste in small quantities from any site based medical clinics during construction.

The amount of solid waste generated will require management planning through the CESMP and a Waste Management Plan to document the appropriate processes for handling, storing, transporting and/or disposing solid waste. Solid waste has the potential to pollute the surrounding environment (i.e. soil, groundwater, marine resources), cause odour and visual nuisance, encourage pests or result in occupational health and safety issues.

Non-hazardous construction waste is typically inert and does not pose any threat to human health or the environment. However, proper management is required in order to reduce associated secondary impacts such as increased pressure upon local landfills.

The hazardous waste generated during construction can potentially cause significant adverse impacts on human health and the environment if not properly managed. Inappropriate handling through lack of personnel training on site may cause accidental spills or leaks to the soil and groundwater leading to a contamination even. This can result into a potential health risk to workers at the site and environmental impacts.

Contamination may also occur arise if the project contractor/ sub-contractor uses waste contractors that are not approved by Umm Al Quwain Municipality or disposal of waste to unlicensed landfills. Increased pressure may also be placed on local hazardous waste landfills resulting into reduced capacity for handling waste from municipal sources.

It is therefore important to have a waste management strategy and planning in place in order to minimise potential significant effects on sensitive receptors such as soil and groundwater. Where applicable, sub-contractors will be responsible for their own waste management but they will be required to adhere to the prescribed requirements in the CESMP and/ or in the site waste management plan which will be enforced and updated by the contractor.

Waste streams anticipated to be within the project site during the construction phase are as listed in the table below.

Table 10-1 Typical Waste Streams Associated with the Project

Subject	Construction
Inert	Subsoil and rock
	Glass
Non-Hazardous	Marine sediment
	Scrap metal
	Wood
	Plastic
	Packaging and food waste
Hazardous	Contaminated soil and oily rags
	Resins and paints
	Concrete washout
	Asphalt/bitumen
	Waste oils
	Waste solvents and thinners
	Waste fuel and chemicals
	Used spill kits and clean up materials.
Wastewater	Sanitary wastewater
	Backwash from the filters
	Oily wastewater
	Chemical wastewater

Liquid Waste/ Wastewater

Waste generated from construction activities at the project site will include the following.

- Sanitary and domestic wastewater;
- Groundwater dewatering effluent (discussed in marine section);
- Wastewater from vehicles or equipment washing/cleaning;
- Liquid hazardous waste such as fuels, chemicals, paints, lubricants, solvents, waste oil, hydraulic fluid, resins, waste solvents and thinners;
- Concrete washout;
- Storm water runoff events on site; and

- Commissioning wastewater (e.g. hydrotesting, steam and possibly acid cleaning).

The site will require on site sanitation facilities for the construction workers (expected to be toilets with collection septic tanks). Such wastewater will be stored in bunded septic tanks on-site, prior to removal by a licensed contractor. Improper handling, storage and transportation of sanitary and domestic wastewater could potentially cause contamination to soil or groundwater recourses.

10.4.2 Operational Phase

Solid Waste

The operation of the proposed project will generate small amounts of non-hazardous domestic waste from the operation of the administration facilities and activities of the employees, which are not directly associated with the production processes. This waste can be classified as both recyclable and non-recyclable, although this is reliant upon suitable re-processing facilities.

Recyclable waste may include steel scrap, wood, paper, aluminium cans, plastic and glass, while non-recyclables generally consists mainly of food residues and other organic waste, although these are recyclables subject to there being a composting plant. The quantity of domestic waste will be small given the few personnel required to run the plant and the number of personnel employed onsite.

The hazardous fraction of solid waste, which can potentially cause significant adverse impacts, include the following:

- Used chemical containers and drums;
- Soil contaminated by potential spills and leaks of hazardous materials/liquids and used spill kits and clean up materials;
- Used RO filters;
- Waste oils, oily sludge and waste chemicals; and
- Miscellaneous wastes such as batteries, waste cables, oily rags etc.

Safe handling of hazardous waste streams will be achieved through training on site to avoid accidental release of hazardous waste contaminating soil or groundwater. Contamination may potentially arise as a result of poor-quality waste transporters and waste management facilities, or lacking capacity of these services locally. Consequently, these risks may result in illicit waste disposals (e.g. fly-tipping, or waste disposal at unlicensed locations), or the engagement of unlicensed contractor/facilities.

Liquid Waste

The operational phase of the project will result in the production of the following wastewater streams:

- Brine discharge (discussed in the marine section)
- Sanitary and domestic wastewater;
- Backwash water (organic waste particles from the initial filter process); and
- Chemical wastewater.

When in operation, the project will use seawater to generate potable water. In order to generate portable water, the reverse osmosis process will separate the saltwater component, hence resulting in a residual volume of brine wastewater.

The brine wastewater will discharge directly into the Arabian Gulf where it will mix and dilute with seawater to background concentrations within the UAE prescribed 300 m Mixing Zone. Given that the brine wastewater is denser than the ambient seawater, it will likely sink through the water column as mixing takes place; such impacts of brine are assessed fully in Chapter 5 Marine Environment of this ESIA report.

In addition to this, sanitary and domestic wastewater will be generated from O&M staff at the SWRO desalination plant. This wastewater will either be stored on site and removed by tanker to an approved Municipal site or treated at the on-site sewage treatment plant prior to being reused for landscaping and industrial purposes within the site.

Improper handling and storage of domestic wastewater could potentially cause contamination to soil and groundwater resources. On the other hand, improper handling, transportation and disposal of hazardous wastes such as waste oils and waste chemicals could lead to potential localised contamination of soil and groundwater resources.

Storm water has the potential to runoff into areas containing hazardous materials and either leach these into the soil or carry these off the site, potentially contaminating soil and groundwater resources. However heavy rainfall is rare and only a small number of rainy days per year occur in the UAE.

10.5 Mitigation and Management Measures

10.5.1 Waste Characterisation

Waste can exhibit certain characteristics according to the process stream from which it is generated and any pre-treatment processes that are undertaken. Different types of waste require different management and disposal techniques according to the potential risk that the material poses to human health or the environment. For the purpose of this project, waste has been classified into four categories as in the table below.

Table 10-2 Waste Characterisation

Waste Classification	Description
Domestic	Household, commercial, agricultural, governmental, industrial and institutional wastes, which have chemical and physical characteristics similar to those of household such as garbage, paper, cardboard, plastic, cans, etc. Disposal of such waste can generally be routed to municipal recycling or disposal facilities
Non-Hazardous	Non-hazardous wastes that have physical and chemical characteristics that are different from domestic wastes such as construction waste, glass, scrap metal, wood, used containers, tyres etc. This waste generally poses little risk to the environment and can be disposed to normal municipal facilities after waste minimisation options are exhausted and prior obtaining approval
Hazardous	Waste is classified as being hazardous because of its concentration; physical, chemical or infectious characteristics, which may pose a present or potential threat to human health or the environment and/or may cause an increase in serious irreversible or incapacitating reversible illness or contribute to an increase in mortality. In accordance with UAE regulations and Basel Convention, hazardous waste is considered as any waste (i.e. solid, liquid or gaseous) having the following properties: • Explosive; • Radioactive (which includes NORM (LSA) scale); • Ignitable or flammable substances; • Poisons with acute and chronic (delayed) toxicity; or • Substances that by interaction with water might become spontaneously flammable or give off flammable gases. • Hazardous waste must be segregated, stored, transported and ultimately treated and disposed by approved waste services provider.
Medical	Type of hazardous waste for which classification and disposal requirements are defined in the document the UAE Regulation for 'Handling of Hazardous Substances, Hazardous Wastes and Medical Wastes', under Ministerial Decree No. 37 of 2001

10.5.2 Waste Management Hierarchy

The waste management hierarchy illustrates best practice for waste management considerations by ensuring consideration of the most sustainable available application for waste management in preference of disposal and eventual contribution to adverse environmental and economic impacts associated with landfill. The hierarchy as illustrated below should form a key element of any waste management strategy and if implemented effectively will achieve maximum reductions on waste quantities combined with the limited use of resources and fill space. The waste management hierarchy also has the potential to reduce costs that may be incurred by the main contractor or the proponent for handling, transportation and the disposal of waste.

Figure 10-1 Waste Hierarchy

Source: UNEP (2011), Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication

Initially, options to prevent or reduce waste will be considered. Where waste generation cannot be avoided or further reduced at source, opportunities for reuse of materials will be explored, either for use for the same or a different purpose. Disposal to landfill is the least favoured option in the waste hierarchy and is the last resort after all other options have been considered.

Table 10-3 Waste & Wastewater Mitigation and management Measures – Construction

Impact	Mitigation and Management Measures
Inappropriate handling, storage transport and disposal of solid non-hazardous waste	• Contractor to develop and implement a project specific Construction Waste Management Plan (CWMP) in line with the waste hierarchy and mitigation measures in this ESIA report and the provisions of the CESMP. • A training programme for employees to increase their awareness of waste management protocols including proper handling and storage of waste, and emergency response and contingency plans. • Where appropriate waste concrete slabs and masonry may be sent to an approved crushing yard for future reuse in construction of road base for temporary or permanent roads. • Waste segregation will be undertaken to facilitate recycling of clean aggregate, wood and metal. Domestic solid wastes will also be segregated to facilitate recycling. • Waste containers/skips will be clearly labelled and placed in designated waste storage locations. Labels will be waterproof, securely attached, and written in English, Arabic and other languages as required. • Food wastes will be stored in closed bins to minimise pests and odour and emptied daily.

Impact	Mitigation and Management Measures
	• On-going housekeeping training will be provided to all staff. • Heavy waste may be contained within an open skip, provided that segregation occurs effectively enough to remove all light weight material that could be blown away by the wind. • Waste generated during construction will only be transported off-site for disposal by an Umm Al Quwain Municipality licensed waste contractor. • The Contractor will maintain copies of the waste management license and delivery notes and landfill receipts on site. • Completed waste manifests are required to show the chain of custody of the waste generated on site, its transportation and treatment/disposal. All records will be monitored on site.
Inappropriate un/controlled handling, storage, transport and/ or disposal of solid hazardous waste	• Develop and maintain a hazardous waste inventory to document and track hazardous wastes generated, and their disposal routine. • Segregate and identify hazardous waste from the other waste streams into separate waste containers/skips clearly signed and labelled. • Store hazardous, waste in bunded storage areas clearly labelled with sun/rain shelter, separate drainage system, good ventilation and equipped with spill kits & spill response procedures with MSDS sheets. Alternatively store the waste in skips on impervious hard standing areas for regular disposal from site by specialist waste management contractors. • Waste containers will be clearly marked with appropriate warning labels to accurately describe their contents and detailed safety precautions. Labels will be waterproof, securely attached, and written in English, Arabic, and other languages as required. Wherever possible, waste chemicals will be kept in their original container.
Improper handling, storage, transport and/or disposal of wastewater	• Contractor to develop and implement a project specific Construction Waste Management Plan (CWMP) in accordance with committed mitigations measures in this ESIA report and provisions of the CESMP. • Develop and maintain a hazardous waste inventory to document and track sanitary waste, oily wastewater and any other kind of liquid wastes. • Sanitary wastewater tanks to have a secondary bund with bunding capacity to hold 110% of the volume and be emptied at a frequency to ensure tanks do not overflow. • Engage an Umm Al Quwain Municipality approved waste contractor for daily emptying of the septic tanks and the periodic removal of waste oils or chemicals.
Improper storage, transport, disposal and handling of liquid hazardous chemicals and materials.	• Storage of all fuel tanks on an impermeable base with liners and/ or secondary containment with enough capacity to hold 110% of the maximum volume stored. • Store all chemicals/materials according to manufacturer's instructions and Material Safety Data Sheets (MSDSs); MSDSs for all chemicals to be readily available on site. • Single oil drums to be stored on spill containment trays, but multiple drums must be inside a constructed impervious bund with a capacity of 110% of the maximum volume stored. • Maintain an inventory of all potentially hazardous materials and chemicals used and stored on site.

Impact	Mitigation and Management Measures
	• Availability of suitable containment and spill clean-up materials/equipment at specific locations within the project site (e.g. where fuelling is to take place). • Contractor to develop and implement an Emergency Preparedness and Response Plan (EPRP) and Spill Response and Contingency Plan. • Relevant personnel to be trained in emergency and spill response containment, material handling and storage procedures. • Emergency drills to be undertaken to practice major spill response. • Availability of suitable containment and spill clean-up materials/equipment at specific locations within the site. • All spills and leaks to be reported promptly to the Environmental Manager and to be investigated to confirm the cause and put in place appropriate corrective/ preventative actions. • Transfer of fuel to and from the storage tanks facilitated through the provision of devices such as dry break couplings, automatic flow cut off devices and tank overflow controls. • Fuel transport vehicles an equipment to be maintained and routinely inspected to ensure the tank, pumps, pipe work and the vehicle itself are free from leaks and fit for purpose – No equipment will be placed in service until deficiencies are corrected. • Implement regular maintenance program of vehicles and equipment to minimise leaks or mechanical failures and keep documentary evidence. • Equipment to have drip trays to avoid leaks or spills onto the soil surface. • Refuelling and maintenance of vehicles/ equipment will be within a designated area at the site on impermeable hard surface.
Medical Waste	• Stored in a container conforming to applicable regulation or best practices for temporary storage of medical waste.

NB: The EPC Contractor will be required to remove and dispose the general, plastic and construction waste currently on the project site, laydown areas and the intertidal zone before any construction works such as site clearance, levelling can commence.

10.5.3 Operational Phase

Table 10-4 Waste & Wastewater Mitigation and Management Measures – Operation

Source	Mitigation and Management Measures
Inappropriate handling, storage transport and disposal of solid non-hazardous waste	• Contractor to develop and implement a project specific Operation Waste Management Plan (OWMP) in line with committed mitigation measures in this ESIA report and provisions of the OESMP. • Training will be provided to employees to ensure awareness of waste management including proper waste; training and orientation on waste minimisation, segregation and good housekeeping practices. • Domestic solid wastes to be segregated and identified from the other waste streams into separate waste containers/skips to facilitate recycling.

Source	Mitigation and Management Measures
	• Waste containers/skips will be clearly labelled and placed in designated waste storage locations. Labels will be waterproof, securely attached, and written in English, Arabic and other languages as required. • Food waste must be stored within sealed bin, in order to prevent pests gaining access and odour and frequently emptied. • Segregated waste such as aggregate, wood or metal may be contained within an open skip, although lightweight packaging materials will have a cover or net to avoid being blown around the site. • Only licensed waste transporters and waste management facilities will be engaged. • General household and domestic waste generated by project O&M staff will be stored in clearly marked containers. Colour-coded and labelled waste bins will be provided at several locations throughout the project site.
Sanitary wastewater and backwash	• Sanitary wastewater will be treated on site together with backwash water for reuse in landscaped areas or industrial use on site. Should there be a requirement for temporary storage in septic tanks, these will have secondary containment and properly maintained and inspected to ensure tanks do not overflow. • Sanitary water treated for re-use will comply with Umm Al Quwain Municipality requirements for irrigation and will be tested on a regular basis to confirm compliance.
Inappropriate/un controlled handling, storage, transport and/or disposal of hazardous waste	• Develop and maintain a hazardous waste inventory to document and track hazardous wastes generated, and its disposal route. • Segregate and identify hazardous waste from the other waste streams into separate waste containers/skips clearly signed and labelled. • Store hazardous waste in designated area only, on impervious hard standing areas in sealed containers, sufficient containment and separation capacity, sun/rain shelter, separate drainage system, good ventilation and equipped with spill kits & spill response procedures. • Waste containers will be clearly marked with appropriate warning labels to accurately describe their contents and detailed safety precautions (MSDS). Labels will be waterproof, securely attached, and written in English and other languages as required. Wherever possible, chemicals will be kept in their original container.
Storage of fuel & chemicals	• Store all fuels, oils and chemicals/materials according to the OESMP and OWMP, manufacturer's instructions and hazardous Material Safety Data Sheets (MSDs).

11 TRAFFIC AND TRANSPORTATION

11.1 Observation and Baseline Condition

The proposed project sites 1 & 2 and the laydown areas 1 & 2 will be accessed through the E11 highway which is directed to both north and south. The E11 highway is a key arterial route throughout the UAE and links Abu Dhabi to Ras Al Khaimah. Near to the site location, it splits to a separate 2-way carriageways (with hard shoulders) that flow north and south bound respectively. Even though the traffic flow along this section is not constant and busy there is a regular flow of vehicles (including passenger cars, HGVs and LDVs) though traffic congestion is highly unlikely near the project site.

During the site visit, street lights and road signage were observed as well as evidence of vehicle tracks on and off the project sites used by vehicles connecting to the E11 highway on the eastern and western extents of the project site.

During the visit to the project site laydown areas, a semi-tarmacked road connecting the south bound E11 highway to the north bound carriageway was observed to cut through the laydown area 1. In addition, an untarmacked road was also observed south of laydown area 2 connecting the north bound E11 carriageway to a Construction & Demolition Waste Plant and a Waste Water Treatment Plant (UAQ) 3.3 km east of laydown area 2 as shown below. During the site visit, approximately 50 trucks and waste water tankers were observed using these roads to and from the waste plants.

The proximity of the proposed project site to the E11highway will ease the transportation of supplies and materials into the project site. However, an access road will need to be constructed into the site.

Figure 11-1 Access Routes to the Project Site (E11 Highway and Semi-Tarmacked and Untarmacked Roads)

Plates 11-1 E11 Highway Adjacent to the Project Site & Laydown Areas

Plates 11-2 Semi-Tarmacked & Untarmacked Roads Adjacent to the Laydown Areas

11.2 Receptors

Table 11-1 Traffic & Transportation – Receptor Sensitivity

Receptor	Sensitivity	Justification
E 11 Highway	**Low**	Even though the traffic along the E11 highway is not busy near the project site it is expected to be slightly busy during peak hours. However, this receptor is not significantly impacted and still has a large spare carrying capacity to accommodate the construction vehicles.

11.3 Potential Impacts

11.3.1 Construction Phase

Increased Vehicular Flow

The volume of traffic will vary over the course of construction, in accordance to the phases of construction and the demand for materials, removals and construction personnel on site. The main factors that will affect the number of vehicles on the roads will be related material usage manpower needs and waste generation. Construction vehicles will include a variety of vehicle classifications, e.g. HGV's, LDV's, trucks, excavators and other heavy/light equipment

(Reference Appendix O for the full list of vehicle composition during the construction phase of the project).

Impacts due to additional vehicular transportation are not expected to be significant due to the existing traffic flows and the carrying capacity of the E11 highway, but it may be noticeable. It is noted that the project sites and laydown areas will be primarily accessed through the north and south flowing E11 carriageways. The E11 highway near the project site can be accessed through the Sheikh Mohammed Bin Zayed road, Emirates road which are located to the east and an unnamed road north of the project site.

Figure 11-2 Access Routes into the Project Site and Laydown Areas

Importation of construction materials will be through the Port of Jebel Ali in the Emirate of Dubai and the port of Umm Al Quwain before the materials are transported to the project site via the roads shown in the figure above. The EPC Contractor will be required to apply for the necessary permits with the Road Transport Authority and other relevant authorities in the Emirates in order to be able to transport heavy loads.

During the construction phase of the project, intake and outfall pipes have been designed to go under the E11 highway through tunnelling including other project facilities between site 1 & 2 i.e. pipelines. This and other construction works may lead to traffic management on one or both the carriageways which may include temporary lane closures, diversions and reduced speed limits. This may result in reduced speed of vehicles going past the site though it is not expected to result into congestion.

Table 11-2 Traffic & Transportation Impact Significance, Mitigation 7 Management Measures and Residual Impacts – Construction

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
Increased vehicle flow on E11 highway and other local roads	**Minor Negative**	E11 Highway	Low	**Negligible to Minor**	• A traffic Management Plan will be developed to confirm the designated access routes, site entrance points, waiting and parking areas etc. The plan will outline how construction traffic will be managed to limit impacts upon local communities, personnel, and other road users. • The impact of existing tankers to UAQ WWTP and waste area via the track through laydown area must be assessed and mitigated prior to any works. • Construction access roads to be clearly signposted from the E11 highway into the project sites and laydown areas. • The EPC will obtain all relevant NOCs from the Ministry of Infrastructure and Umm Al Quwain Municipality before any tunnelling work under E11 can commence. • Buses will be used to transport labourers. • Route directions and speeds limit will be placed from the E11 highway to the access roads connecting the site • Deliveries of construction materials will be coordinated to reduce congestion on local roads and to reduce the waiting time for the drivers. • Where applicable the EPC Contractor will obtain the relevant permits to transport heavy loads into the project site and adhere to the stipulated conditions (i.e. delivery routes and timings). • Heavy load vehicle's drivers will be competent and legally authorised to operate such vehicles in the UAE.	**Negligible to Minor**

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
					• Where practicable waste removal from the project sites and laydown areas will be scheduled outside of peak hours. • No construction vehicles will be allowed to use the access roads leading into Al Marjan Island.	

11.3.2 Operational Phase

Transportation impacts during operations are not expected to be significant, as the operation of the SWRO will not require continuous delivery of materials, or other equipment in order to operate.

Occasional deliveries and waste removals are not expected to result in noticeable increases in vehicle traffic along the E11 highway due to its spare carrying capacity. Staff movements will also contribute to a minimal additional vehicle flows on the E11 highway and internal site roads.

Table 11-3 Traffic and Transportation Impact Significance, Mitigation & Management Measures and Residual Impacts

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
Increased vehicle flow on E11 highway	**Negligible Negative**	E11 Highway	Low	**Negligible to Minor**	• A Traffic Management Plan will be prepared identifying preferred access routes to the site. • Wherever possible deliveries and waste removals will be scheduled outside of the traffic peak hours on E11.	**Negligible**

12 ARCHAEOLOGY AND CULTURAL HERITAGE

12.1 Standards and Regulatory Requirements

12.1.1 National Standards

The UAE passed into law the Federal Law No 11 of 2017 on Antiquities which aims to:

- Protect monuments and artefacts from sale, damage and being defaced.
- Promote national identity and preserve cultural heritage for the purpose of enriching the national heritage of the country.

12.1.2 Lenders Requirements

Where funding of the project is from International Financial Institutions, the lenders will require the project to adhere to IFC Performance Standard 8, which requires the identification and protection of features of cultural heritage value and "*… recognise the importance of cultural heritage for current and future generation and aims to ensure that clients protect cultural heritage in the course of their project activities*".

12.2 Observations and Baseline Conditions

12.2.1 Archaeological Sites in the UAE

An examination of existing literature on archeologically and historically relevant sites in the UAE shows a selection of significant sites, which include ancient forts, trading camps, fishing villages and more. Archaeological artefacts have also been found within these sites. According to the UAE Ministry of Culture and Knowledge Development this can be attributed to the geographical location of the UAE which positioned it as one of the major trade destinations and commercial passage linking the three old continents (Africa, Asia and Europe).

This attracted many civilisations to the area that in turn marked it with historical landmarks and remains that have shaped the history of the country. Archaeological excavations in the UAE began in the 1950's with the first archaeological discoveries made in the Emirate of Abu Dhabi. In 1958, a settlement from the second half of the 3rd millennium BC was discovered on Umm Al Nar, a small island offshore Abu Dhabi Island. Since then, many more archaeological discoveries from the Bronze Ages until the Islamic period have been made. These discoveries have extended human habitation and cultural heritage in the UAE back to 3,000 years or more.

12.2.2 International Cultural Heritage Sites in the UAE

Al Ain (Hafit, Hili, Bidaa Bint Saud and Oases Areas) is the only UNESCO World Heritage site in UAE since 2011. The Cultural Sites of Al Ain (Hafit, Hili, Bidaa Bint Saud and Oases Areas) testifies to sedentary human occupation of a desert region since the Neolithic period with vestiges of many prehistoric cultures. Remarkable vestiges in the site include circular stone tombs (ca 2500 B.C.), wells and a wide range of adobe constructions: residential buildings, towers, palaces and administrative buildings. This site features one of the oldest examples of the sophisticated aflaj irrigation system, which dates back to the Iron Age. The site provides important testimony to the transition of cultures in the region from hunting and gathering to sedentarisation.

The project sites are approximately 200 km from the proposed project site and will therefore not be impacted by any of the project activities.

12.2.3 Cultural Sites in Umm Al Quwain

There are numerous sites of archaeological and cultural importance in the UAE and preservation and protection of such resources is vital. Sites of cultural and archaeological importance include ancient forts, trading camps, fishing villages, cemeteries and tombs. Some of these sites are found in Umm Al Quwain and are briefly discussed below.

Ed-Dur Site

Ed-Dur is one of the largest archaeological sites in the UAE. The periods of human settlement on the site include: Obeid, the Bronze Age, Stone Age, Iron Age, and Pre-Islamic periods. Site excavations revealed a square Fort, large number of funeral configurations and local stones residential buildings and a rectangle temple.

Alakaab Island site

This site dates back to the Neolithic period dating back to 5000 B.C. The archaeological excavations showed the presence of a patch of land which turned out to have been used for the slaughter of Dugongs.

12.2.4 Project Site

An examination of existing literature on archeologically and historically relevant sites within Umm Al Quwain did not show specific sites or activities of relevance regarding the immediate terrestrial or marine area of the project site. Site visits undertaken in July and November 2018 further confirmed this with no surface features of potential archaeological importance identified within the project footprint. However, a boundary marker between Umm Al Quwain (UAQ) and Ras Al Khaimah (RAK) which was approximately 16m north east of the proposed project site 1 boundary was identified which may be considered of political significance to the two Emirates.

To determine the significance of the boundary marker, a consultation meeting was held on 13th November 2018 between 5 Capitals and Umm Al Quwain's Department of Urban Planning. During the meeting, the Director and Assistant Director confirmed that the boundary marker is of political importance for UAQ and RAK and must be preserved during the construction and operation phases of the project. In addition, the Department of Planning and Survey requires that a 30 m buffer zone is maintained between the project site boundary and the boundary between UAQ and RAK (including the boundary marker).

Additional Site Survey July 2019

Due to the increase in the project footprint and capacity, 5 Capitals conducted additional site surveys where a second boundary marker was observed 175m north east of project site 2. This necessitated additional consultation meetings with Umm Al Quwain Planning and Survey Department to discuss their conditions in relation to the preservation of the boundary markers during the construction and operational phases of the project.

Table 12-1 Boundary Marker Coordinates

ID	Co-ordinates		Photo
	Northing	Easting	
Boundary Marker 1	25.655623	55.748278	
Boundary Marker 2	25.654056	55.756694	

Due to the increase in the project footprint and capacity, 5 Capitals arranged for additional meetings (between June to July 2019) with the Umm Al Quwain Planning and Survey Department and ACWA Power to discuss the location of the project sites 1 & 2 in relation to the boundary and markers between the Emirates of Umm Al Quwain and Ras Al Khaimah. After the review of the project boundaries and Affection Plan, the department instructed ACWA Power for the project boundaries to be shifted 14 m south of the Umm Al Quwain and Ras Al Khaimah boundaries in order to adhere to the 30 m buffer zone. This was facilitated by the issuance of a new site Affection Plan by the department with new coordinates reflecting a 30 m buffer zone between the project boundary and the UAQ & RAK boundary.

12.3 Receptors

Table 12-2 Archaeology and Cultural Heritage – Receptor Sensitivity

Receptor	Sensitivity	Justification
UAQ & RAK Boundary Marker 1 & 2	**High**	The boundary markers are in close proximity to the project boundary and is particularly vulnerable to the impacts associated with construction activities (e.g. excavations and earthworks)
Unknown below ground archaeological artefacts or remains	**Low**	The SWRO project area is generally not known to be of archaeological importance. There is therefore a low risk of encountering buried archaeological artefacts within the project site.

12.4 Potential Impacts

12.4.1 Construction Phase

Excavation and earthworks activities can potentially result into the damage of the boundary markers between UAQ and RAK. In addition, there is also a potential of encountering buried archaeological remains or artefacts. While the risk of this is low, this could lead to damage, destruction and loss of archaeological artefacts of conservation value. However, given the evidence of no previous land use, the presence of archaeological features within the project footprint is likely to be very low.

A "Chance Find Procedure" will however be prepared and incorporated in the project CESMP such that in the unlikely event any items of archaeological significance are discovered, there is a clear procedure on stopping work and reporting immediately to the Construction and Environmental Managers so that the appropriate specialists from UAQ Municipality can be contacted to come to site to confirm the finds and ensure they are formally recorded, protected and conserved.

12.4.2 Operational Phase

The operational phase will not result in further impacts to cultural heritage, as the site will be static and excavations will not be required.

Table 12-3 Archaeology & Cultural Heritage Impact Significance, Mitigation & Management Measures and Residual Impacts

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
Damage to the UAQ & RAK boundary marker 1 & 2	**Moderate Negative**	UAQ & RAK boundary Marker 1 & 2	High	**Moderate to Major**	• Strictly adhere to the 30 m buffer zone between the project boundary and the boundary between UAQ and RAK (including the boundary markers) as per the requirements stipulated by the UAQ Department of Urban Planning. • The boundary markers will be fenced off before the commencement of any construction activities. • Site workers shall be briefed on the location of the boundary markers and their significance during toolbox talks. • In case of any accidental damages to the boundary markers, the EPC Contractor will notify the UAQ Department of Planning and Survey immediately. • Restore the boundary markers to their original state at the end of the construction phase i.e. repaint or wash off any dust accumulated during construction.	**Minor**
Accidental damage to unknown archaeological resources buried within the project site	**Minor Negative**	unknown below ground archaeological artefacts or remains	Low	**Negligible to Minor**	• An archaeological Chance Find Procedure will be developed prior to construction and the start of site earthworks, as part of the CESMP. This will include protocols and procedures to stop work and report any finds immediately to the Construction Manager and Environmental Manager who will alert the Authorities for specialists to come to site. • Where artefacts or archaeological remains are encountered, the site shall be clearly signed/delineated with high visibility flagging to	**Negligible**

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
					prevent further access which may damage the artefacts which have just been found. • Any finds must not be removed from the location or cleaned in anyway and must be left in situ until the specialists from UAQ Municipality come on site. • Toolbox talks will include a session on the procedure to be followed should any suspected archaeological finds be discovered on site. • Removal of any archaeological artefacts from the site by site workers will be strictly prohibited.	

Table 12-4 Archaeology & Cultural Heritage – Monitoring Requirements

Monitoring	Parameter	Frequency & Durations	Location	Responsibility
Construction				
UAQ & RAK boundary Markers 1 & 2	UAQ & RAK boundary Marker 1 & 2	Daily visual observations by site workers involved in excavations	At boundary marker location	Site staff EPC Contractor – Environmental Manager.
Archaeological resources & artefacts	Undiscovered archaeological remains within the project site		The SWRO project area requiring excavations, earthworks or grading during construction and operation	

13 SOCIO-ECONOMICS

13.1 Standards and Regulations

Neither UAE nor Umm Al Quwain have legislations or guidelines that regulate the socio-economic aspects of developments.

13.2 Observations and Baseline Conditions

13.2.1 Land Ownership and Land Use

The land ownership has been transferred by the Emir of Umm Al Quwain to FEWA which will allow FEWA to grant lease over the site to the Project Company.

The proposed sites (1 & 2) and laydown areas 1 & 2 are undeveloped and there is no evidence of any historical use apart from project site 2 which was observed to be used as an illegal dumping site for construction waste. During the site visit, evidence of vehicle tyre tracks were identified on and off the project sites used by vehicles connecting to the E11 highway located at the eastern and western extents of the project sites including semi. In addition, there was evidence that animals go through the site based on the observation of animal faeces and a camel skeleton. It was also observed that the proposed project site 2 which is located on the eastern extent of the E 11 has been used as an illegal dumping site for construction waste.

13.2.2 Economy

Fishing is considered to be a key economic contributor in Umm Al Quwain with export of seafoods to Europe and the Middle East. Efforts towards the diversification of the economy have led to the construction of the Ahmed Bin Rashid Port and the Free Trade Zone which are supposed to expand the commercial and investment base of Umm Al Quwain.

In addition to this, the economy is also based on tourism, agriculture and breeding of livestock. The emirate has rich coastal mangroves along the Arabian Gulf and islands that lie to the east of the mainland. The biggest of the islands, Al Senniah, is home to the Arabian gazelles, falcons and turtles.

13.2.3 Social Development & Infrastructure

Using the United Nations Human Development Index as a guide, the UAE as a whole is ranked at 42, with an index score of 0.840 (2015). This compares favourably with the regional average (0.652), and places the UAE within the global top of 50 at an overall level. Within the key indicator areas of Health & Education, the UAE index ranks as "High" and "Medium" respectively.

13.2.4 Population

Umm Al Quwain is the smallest and the least populated emirate in the UAE. According to the UAE government census in 2005, Umm Al Quwain has a population of 49,159 people. The Federal Competitiveness and Statistics Authority estimated the population of Umm Al Quwain nationals at 17, 482 people in 2010 with 8,671 males and 8, 811 females. Umm Al Quwain is the only emirates where the female population outnumber the male. Based on the population growth rate of + 3.35% between 1995-2005, the current population is estimated to be around 75, 441 people.

13.2.5 Al Marjan Island

Al Marjan is a man-made island located in the Emirate of Ras Al Khaimah approximately 430m north of the proposed project site 1. The island extends 4.5km into the sea covering an area of 2.7 million square meters and is home to residential and commercial developments which are mainly centred in the tourism sector (i.e. hotels and spas). The main commercial developments in the island include:

- Ras Al Khaimah Tourist Development;
- Rixos Bab Al Bahr;
- Marjan Island Resort and Spa; and
- Double Tree by Hilton Resort & Spa Marjan Island.

Plate 13-1 View of the Al Marjan Island north of the project site

During the site visits conducted by 5 Capitals on 19th and 20th June 2019, it was determined that the majority of the Al Marjan Island facing the project site is made up of breakwater rock revetment as shown in plate 13-2 below.

Plate 13-2 Parts of the Al Marjan Island facing to the project site (mostly rock revetment)

The tourist beaches are located towards the extreme north of the island facing away from the project site and towards Ras Al Khaimah.

Plate 13-3 Al Marjan Toursit beaches on the northern part of the island (away from the Project site)

During the ESIA consultation and stakeholder engagement process, consultation letters were sent to the Ras Al Khaimah Tourist Development on 18th June 2019 requesting them to submit any comments or feedback including any available data in regards to the proposed project. However, no response has been received by 5 Capitals from the Tourist Authority at the time of updating this ESIA.

Plate 13-4 Ras Al Khaimah Tourist Development Offices at the Al Marjan Island (431m from the Project Site 1)

It should be noted that development and construction works are still ongoing in the Al Marjan island and therefore the receptors at this location are already exposed to impacts related to construction.

13.2.6 Existing Infrastructure near the Project Site (1 & 2)

During the consultation meetings held between Umm Al Quwain Department of Planning and Survey, ACWA Power and 5 Capitals on 30th June 2019, it was revealed that the following infrastructure exists near the project site:

- Fibre optic cable belonging to the army is located on the side of E11 between project site 1 & 2;
- High Voltage and Medium Voltage level power transmission lines;
- 400 mm diameter water pipeline belonging to FEWA; and
- Du fibre optic cable between the shoreline and project site 1 running parallel to the E11.

13.2.7 Recreational Activities near the Project Site (1& 2)

During the dusk survey conducted by 5 Capitals on 19th June 2019, several paragliders were observed flying across the south of the project site 1 & 2. This can be attributed to the Al Jazira Aviation Club located near the Ras Al Khaimah Industrial Zone which provides scenic flights over the Arabian Gulf using microlight aircraft and powered parachutes (Al Jazirah Aviation Club, 2019).

Plate 13-5 Paraglider flying across the project site

13.2.8 Camel Holding Area

The development of the project will not give rise to any involuntary resettlement of local population or direct displacement as no ethnic minorities, indigenous peoples or internally displaced people in the project area, or nearby. However, during the site visits, camels from the camel holding area approximately 128m from the project site were observed grazing near the laydown area 2 where majority of the existing vegetation has been eaten back by the camels. Consultations with the Municipality and/or camel holding area owners will be required before the commencement of the construction phase of the project in order to inform them about the project and restrictions from accessing the site. This is not envisioned to create a shortage of grazing land for the camels since the areas surrounding the project site 1 & 2 to the south and east are open and undeveloped.

Plate 13-6 Camel holding area adjacent to laydown area 2

A camel grazing near laydown area 2

13.3 Receptors

Table 13-1Potential Socio- Economic Receptors

Receptor	Sensitivity	Justification
Welfare of local population	**High**	Any change to infrastructure, population or regional inputs is likely to have positive effects for the welfare of the local population.
Local/ Regional Economy	**Low**	The proposed project is likely to influence regional businesses. Not only local contractors and those involved directly in the construction, but also for local commercial operations such as accommodation, food retailers.
Employment Market	**Low**	The structure of the labour market in the UAE provides a relatively flexible labour supply coupled with low rates of unemployment. Therefore, the employment market is not susceptible to major changes arising from the project.
Existing Infrastructure	**Medium**	The proposed project may result to the relocation of existing infrastructure i.e. fibre optic cables, water pipeline and electricity power lines. This may result to disruption of services to the consumers.
Paragliders	**Medium**	The construction phase of the project may involve the change of flight path for the paragliders in order to avoid any high construction equipment such as cranes.
Camel Herding Area Workers	**Medium**	The construction phase of the project may lead to the loss of grazing land for the camel owners
Ras Al Khaimah Tourist Authority & Rixos Bab Al Bahr resort residents	**Medium**	The receptors are located approximately 430m from the project boundary and as a tourist resort and commercial areas they have relatively low vulnerability arising from the construction and operational phase impacts of the project.

13.4 Potential Impacts

13.4.1 Construction Phase

Employment & Economics

The primary economic impact during construction is likely to result from employment creation during construction. In addition to the direct monetary gain to the families of those working in the project, money paid to the workers will also stimulate the local economy via multiplier effect, whereby money earned on the project expended locally will re-circulate within the local economy.

Past experience shows that UAE lacks readily available construction workforce among its populace. Therefore, it is expected that a large proportion of workforce on the site will be undertaken by expatriate workers. This in return, might result in the repatriation of wages and a reduction in the benefit of the local economy of wage expenditure.

In addition to the direct monetary impact of employment created during construction, there also exists the potential for the project to promote the dissemination of construction and construction support skills from expatriate workers into the local labour force.

Given the nature of development, and specialised nature of required materials, additional impact of the local economy is likely to arise from the procurement of specialised kind of materials internationally excluding construction materials (e.g. concrete, cabling, etc.)

During the construction phase of the project, it is anticipated that equipment such as cranes will be used which may potentially pose a safety risk to the paragliders flying over the project site. This is dependent on the height of the cranes and the flight path used by the paragliders. However, this represents a worst-case scenario since the SWRO buildings are not expected to be high rise and the cranes will be equipped with warning lights and flags in order to alert the paragliders. In addition, consultations are ongoing with the Al Jazirah Aviation club regarding the change in their flight path so that it is not above ongoing construction works.

Existing Infrastructure

The construction of the project intake and outfall including project infrastructure between project site 1 and 2 will result in tunnelling under E11. This may lead to disruption of services provided by the army, du and FEWA due to the relocation of the fibre optic cables, power transmission lines and the water pipeline. However, through the coordination of the EPC Contractor and these parties, the disruption of the services is expected to be minimal.

Land Use

The development of the project will not give rise to any involuntary resettlement of local population or direct displacement as no ethnic minorities, indigenous peoples or internally displaced people in the project area, or nearby.

Tourist Activities on Al Marjan Island

The construction phase of the project is expected to have negligible socio-economic impacts on tourist activities in the Al Marjan island if any. In addition, constructions works are ongoing in different locations in the island. Impacts relating to environmental aspects such as noise, air quality, transportation and landscape etc have been discussed in the relevant sections of this ESIA.

Table 13-2 Socio – Economics Impacts Significance, Mitigation & Management Measures and Residual Impacts – Construction

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
Employment Opportunities	**Minor Positive**	Employment Market	Low	**Negligible to Minor Positive**	• Contractor will employ local workers where possible. • The EPC Contractor and the sub-contractor HR Policy will be in line with local labour laws and international ILO and UN conventions. The EPC Contractor is to ensure that this is applied as an overarching policy for all sub-contractors	**Negligible to Minor Positive**
Purchase of construction materially locally	**Minor Positive**	Local/ Regional Economy	Low	**Negligible to Minor Positive**	• Contractor to purchase goods and materials from the local/regional economy where possible	**Negligible to Minor Positive**
Training and Dissemination of skills to workforce	**Minor Positive**	Welfare of Local Population	High	**Minor to Moderate Positive**	• All project workers will receive induction training at the project, as well as vocational specific training for on-site construction works. • All workers will receive training in regard to health and safety, as well as environmental awareness. • Toolbox talks will be conducted before work on each day to ensure workers are reminded of key topics. • Cultural awareness training will be conducted for all foreign workers.	**Minor to Moderate Positive**
Disruption of services	**Minor Negative**	Existing Infrastructure	Medium	**Minor**	• The EPC Contractor will obtain all the relevant NOCs from the Ministry of Infrastructure, Ministry of Interior, du and FEWA and Umm Al Quwain Municipality before any tunnelling work can commence under E11 • The EPC Contractor will consult with the relevant stakeholders to determine the depth of the fibre optic cables and the water pipeline vs the depth of the tunnelling to determine whether the	**Negligible to Minor**

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
					relocation of these infrastructure is necessary and explore other alternatives. • The EPC Contractor will coordinate with all the stakeholders involved to ensure that consumers are provided notices regarding the disruption of services before work can begin. • The relocation of the existing infrastructure close to the project site, will take place during the hours likely to cause least disruption to the consumers.	
Change of flight paths for the paragliders	**Negligible Negative**	Paragliders	Medium	**Negligible or Minor**	• The EPC Contractor will consult with the Municipality and/or Al Jazarah Aviation Club to discuss the project construction details and the existing flight path close to the project site including the option to change the flight path. • The EPC Contractor will ensure that all cranes and towering project machinery are equipped with warning lights and signals to alert paragliders flying close to the project. • Training will be provided to crane operators on spotting paragliders and the safety precautions to be observed and the reporting protocol in the event they fly too close to the construction project.	**Negligible**
Loss of camel grazing land	**Moderate Negative**	Camel Herding Workers	Medium	**Moderate**	• The EPC Consultant will hold consultations with the UAQ Municipality and/or camel owners in order to inform them about the project and restrictions from accessing the project site. • The project site and laydown areas will be fenced in order to prevent camels from wondering into active construction areas. • Training of project drivers will include how to be on the lookout for camels	**Negligible to Minor**

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
					• The EPC Contractor will put up signs warning construction drivers on the presence of camels in the area and the speed limit.	
Disruption of tourist activities in parts of Al Marjan island	**Negligible Negative**	Ras Al Khaimah Tourist Authority & Rixos Bab Al Bahr resort residents	Medium	**Negligible or Minor**	• The EPC Contractor will implement the mitigation and management measures and conduct the required monitoring as in this ESIA in order to mitigate against any impacts to the residents of Al Marjan Island. • The EPC Contractor will implement the project Stakeholder Engagement Plan including its grievance mechanism. • No construction vehicles will be allowed to use the access roads leading into Al Marjan Island. • The EPC Contractor will be required to give prior notice regarding any road closure or diversions in the area as a result of the project construction. This will be in coordination with the relevant authorities. • The EPC Contractor will be required to obtain all the relevant NOCs and permits from the UAQ Municipality and adhere to their requirements. • If any construction works are to be conducted during night time, the EPC Contractor will be required to apply for a night permit and ensure that noisy activities are only carried out during the day where practicable. • The project site and laydown areas will be fenced to ensure that the sensitive receptors including the users of E11 do not have a full view of the construction works.	**Negligible**

13.4.2 Operational Phase

The development of the SWRO plant will support the continued growth of local and national economy of Umm Al Quwain, through the ability to meet the growing demand for potable water and commercial uses. This will be done through the existing FEWA network.

As with the construction phase, a significant positive economic impact during construction will result from any local employment created by the project. While the size of the required workforce is significantly smaller, the type of work and the increased time-scale involved offer an opportunity for greater dissemination of skills. A targeted system of local recruitment and investment in human capital of the local workforce will enhance this process and consequently increase the benefit to the local economy.

Table 13-3 Socio-Economic Impacts Significance, Mitigation & Management Measures and Residual Impacts – Operation

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
Employment Opportunities, training and dissemination of skills to workforce	**Minor Positive**	Employment Market	Low	**Negligible to Minor Positive**	• Employment and training of UAE nationals, wherever possible. • It is recommended that key supply chains are monitored periodically during operations to ensure that materials, goods and services providers comply with ILO and UN requirements for employment and ensuring the suppliers have a suitable occupational health and safety record. • All project personnel will receive induction training at the project, as well as vocational specific training for their duties. • All workers will receive training in regard to health and safety, as well as environmental awareness. Training will be updated on a yearly basis as a minimum. • Workers will be encouraged to develop their careers and maybe provided with opportunities to attend training courses and other career development processes. • The O&M company will be required to implement the requirements of the SEP.	**Negligible to Minor Positive**
	Minor Positive	Welfare of local population	High	**Minor to Moderate Positive**		**Minor to Moderate Positive**
Supply of portable water	**Moderate Positive**	FEWA	Medium	**Moderate Positive**	• The plant will be operated by an experienced O&M company to ensure the appropriate operation and maintenance of the SWRO desalination plant to enable a secure supply of potable water for Umm Al Quwain and other northern Emirates.	**Moderate to Major Positive**

14 LANDSCAPE AND VISUAL AMENITY

There is no specific legislation in UAE or Umm Al Quwain in regards to landscape and visual impact. As a result, this assessment has been undertaken with reference to the guidelines set out by the UK Landscape Institute 'Guidelines for Landscape and Visual Impact Assessment'. As such, the 'Landscape and Visual Assessment' assessment will be presented herein will distinguish between:

- Effects on landscape as a resource in its own right as a public good; and
- Effects on specific views and general visual amenity experienced by people

In addition, if the project will receive funding from International Financial Institutions (IFIs), they will require adherence to IFC Performance Standard 6 on Biodiversity Conservation and Sustainable Management of Living Natural Resources. PS 6 considers direct and indirect project-related impacts on biodiversity and ecosystem services and the differing values attached to biodiversity and ecosystem services by Affected Communities such as landscape and seascape.

14.1 Observation and Baseline Conditions

14.1.1 Landscape

Landscape character could be defined as "a distinct, recognisable and consistent pattern of elements, be it natural (soil, landform) and/or human (for example settlement and development) in the landscape that makes one landscape different from another, rather than better or worse" (Natural England, 2014).

Due to the varied nature of developments undertaken in the local project area, several landscape character types have been established or are natural features. These include the following:

- The desert;
- The coastline;
- The open sea;
- E11 highway;
- Marjan Island including Ras Al Khaimah Tourism Authority and Rixos Bab Al Bahr resort;
- Umm Al Quwain beach;
- Wastewater treatment plant;
- Umm Al Quwain and Ras Al Khaimah boundary markers;
- Wind masts

- Ras Al Khaimah industrial zone
- Camel holding area

Plates 14-1 View of the Project site 1 from the E11

Plates 14-2 View of the project area beach habitat (with Al Marjan Islands in the background)

Plates 14-3 View of the E11 highway from the project site 1 (day and night)

Plates 14-4 View of the Al Marjan Island from the project site 1 (day and night)

Plates 14-5 View of the wastewater treatment plant from the project site 1 (behind the wind mast)

Plates 14-6 View of the Ras Al Khaimah industrial zone (in the distance) from project site 2 (day & night)

Plates 14-7 View of power transmission lines along the E11 road west of project site 2

14.1.2 Visual Amenity

When establishing the value of views and visual amenity, the inter-relations between or groups of people and landscape will be considered such as the change of views that people have of the effects of change on their visual amenity. The visual baseline has therefore been established by:

- Identify views, viewpoints and extent of possible visibility;
- Identify people who may be affected.

As described in the landscape section above, there is a varied nature of developments undertaken in the local project area including several landscape character types that have been established or are natural features. The developments in the area have led to an amount of disturbance to the visual envelope of the receptors near the project site.

The proposed project will be visible from the from the E11 highway which is located at the eastern and western extents of the project sites 1 & 2. The project sites will also be visible from the wastewater treatment plant, camel holding area and Marjan Island but the buildings will be low rise and will not be prominent in terms of impacting the open visual amenity as seen in distance from Marjan island.

14.2 Receptors

The potential landscape and visual receptors and its sensitivity are presented in the table below:

Table 14-1 Potential Landscape and Visual Amenity Receptors

Receptor	Sensitivity	Justification
Landscape character of project site	**Low**	The landscape across the project site is characterised by low sand dunes and beach sand which typical of the landscape present in the UAE. It is therefore of low/medium importance and rarity on a local scale.
Users of E11 Highway	**Low**	The sensitivity of E11 highway users is considered to be low because the view of the project site and buildings will be incidental and their tolerance to change is considered high.
Ras Al Khaimah Tourist Authority & Rixos Bab Al Bahr resort residents	**Medium**	The project site and its low-rise buildings will be partially visible to the residents of Marjan Island.
Workers at the wastewater treatment plant	**Low**	The wastewater treatment plant workers will not be significantly impacted by the project and their vulnerability is considered to be low.

Receptor	Sensitivity	Justification
Paragliders	**Medium**	The construction and the operational phase of the project will lead to the change in the landscape for the paragliders flying over the Gulf.
Camel holding area workers	**Medium**	The project site and its low-rise buildings will be partially visible to the workers at the camel holding area.

14.3 Potential Impacts

14.3.1 Construction Phase

One of the first stages of construction activities will result in the levelling, grading and preparation of the site, before the commencement of construction. The proliferation of such activities throughout the construction period and across the site will eventually result in land use changes, with the subsequent construction of small buildings and the construction of the SWRO Plant.

The movement of heavy construction vehicles and earthworks on sandy surfaces could potentially result in dust generation and a resulting temporary haze causing disturbance to the current visual envelope of receptors. However, this will be prevented by implementing the requirements set out in the CESMP and associated Management Plans, including dust suppression undertaken on a daily basis.

Impacts to landscape character and the visual envelope of surrounding receptors will also occur at night where the addition of lighting during construction will illuminate this area that has previously been free of any light sources apart from the street lights. The addition of light and eventual widespread use of lighting across the project construction site will result in an increased night time light haze being emitted in the air above the general site area. Potential impacts due to light may impact upon local receptor at night including the fauna in the area.

Table 14-2 Landscape and Visual Amenity Impact Significance, Mitigation & Management Measures and Residual Impacts- Construction

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
Changes in Landscape Character	**Minor Negative**	Landscape character of the project site	Low	**Negligible to Minor**	• Land clearance will be limited to the area within the project boundary of the projects site. • The design of the RO plant is low rise buildings which will not be intrusive to the landscape. • Where appropriate, construction work areas will be screened with stockpiles to reduce the visual intrusion to the off-site receptors. • All temporary construction facilities will be removed once this phase is complete unless there is an agreement between the Project Company for use during the operation phase. • The laydown areas will be restored to or close to their original condition after the completion of the construction phase.	**Negligible to Minor**
	Negligible Negative	Users of E 11 Highway	Low	**Negligible to Minor**		**Negligible**
	Minor Negative	Ras Al Khaimah Tourist Authority & Rixos Bab Al Bahr resort residents	Medium	**Minor**		**Negligible to Minor**
	Negligible Negative	Workers at the wastewater treatment plant	Low	**Negligible to Minor**		**Negligible**
	Minor Negative	Camel holding area workers	Medium	**Minor**		**Negligible to Minor**
	Minor Negative	Paragliders	Medium	**Minor**		**Negligible to Minor**
Disturbance to the visual envelope of receptors due to the	**Negligible Negative**	Users of E 11 Highway	Low	**Negligible to Minor**	• All marine structures such as pipelines will be buried in the seabed which will prevent visual impacts with users of E11 highway and Ras Al Khaimah Tourist Authority & Rixos Bab Al Bahr resort residents.	**Negligible**
	Negligible Negative	Ras Al Khaimah Tourist	Medium	**Negligible to Minor**		**Negligible**

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
presence of new features		Authority & Rixos Bab Al Bahr resort residents			• The beach habitat will be restored after the pipelines have been laid to retain the visual and landscape amenity. • Daily dust suppression measures will ensure no loss of amenity or visual impacts during construction works. • Where practicable security fencing or screening will be installed to reduce the views from the sensitive receptors. • Any flood lights required during night time construction activities will be directed onto the working areas, with a maximum position of 30° from vertical, to avoid unwanted light spill, glare and sky glow. • When not in use, cranes and other construction plants will be lowered, so they are at minimum height and do not protrude unnecessarily within the visual envelope of local receptors.	
	Negligible Negative	Workers at the wastewater treatment plant	Low	**Negligible to Minor**		**Negligible**
	Minor Negative	Camel holding area workers	Medium	**Minor**		**Negligible to Minor**
	Minor Negative	Paragliders	Medium	**Minor**		**Negligible to Minor**

14.3.2 Operational Phase

Following the impacts of construction and establishment of project features, the operational phase will not result in changes to the landscape character or visual envelope of receptors overlooking the project site i.e. the site will not change its form or shape. However, impacts due to lighting may result in minimal changes to the night-time views of the site. This will be minimised through the compliance with CIBSE Lighting Guidance to avoid unnecessary sky glow glare or light spill into dark areas.

Table 14-3 Landscape and Visual Amenity Impact Significance, Mitigation & Management Measures and Residual Impacts – Operation

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
Disturbance to Visual Envelope of Receptors	**Negligible Negative**	Users of E 11 Highway	Low	**Negligible to Minor**	• Lighting provisions shall not be excessive or unnecessary and not result in sky glow, light spill and glare effect. • Light fittings shall be directional as deemed appropriate for their use and intended areas of illumination. • Lighting column and lighting head design should be chosen to limit back spill and any unwanted light spill to other site areas or areas off the site.	**Negligible**
	Negligible Negative	Ras Al Khaimah Tourist Authority & Rixos Bab Al Bahr resort residents	Medium	**Negligible to Minor**		**Negligible to Minor**
	Negligible Negative	Workers at the wastewater treatment plant	Low	**Negligible to Minor**		**Negligible**
	Negligible Negative	Camel holding area workers	Medium	**Negligible to Minor**		**Negligible**
	Negligible Negative	Paragliders	Medium	**Negligible to Minor**		**Negligible**

15 COMMUNITY HEALTH, SAFETY & SECURITY

This chapter has been specifically included to outline and assess the impacts relating to the safety and security of the local community who live and work in surrounding area and may be subject to project related impacts.

The majority of secondary impacts relating to community in terms of air quality, noise, wastewater, waste etc., have been addressed in previous chapters of this report. This chapter therefore concentrates more specifically on the potential emergency impacts that could relate to the project and the security of the project to avoid instances of trespass, malicious intrusions or other misdemeanours.

The primary purpose of this chapter is to therefore identify specific management measures in regard to community health, safety and security.

15.1 Standards and Regulations

International Financial Institutions (IFIs) will require adherence to IFC Performance Standard 4 on Community Health, Safety and Security. The objectives of PS 4 are to:

- To anticipate and avoid adverse impacts on the health and safety of the Affected Community during the project life from both routine and non-routine circumstances;
- To ensure that the safeguarding of personnel and property is carried out in accordance with relevant human rights principles and in a manner that avoids or minimises risks to the Affected Communities.

15.2 Observations and Baseline Conditions

The Ras Al Khaimah Tourism Development Authority and Rixos Ban Al Bahr resort and commercial compound 2 are located approximately 430 m from the proposed project site. In addition, there is a waste water treatment plant and a camel holding area approximately 106.3m and 128m from the project site respectively. Given the nature of the project, associated construction and operation activities and distance from the project site, these receptors will not be directly affected by the project and therefore they are not considered as 'Affected Communities'.

Even though the exact location of the workers' labour camps has not been confirmed other than it will be in existing labour camps within a 10km radius from the project site, it is expected that they will be located near local residential and commercial facilities. These local communities close to the labour camps are therefore considered as sensitive receptors.

Impacts relating to the community in terms of air quality, noise, wastewater, waste etc., have been addressed in specific chapters of this ESIA. Project related activities might result in risks associated with those who may visit areas around active project sites.

15.3 Receptors

The potential community health, safety and security receptors and their sensitivity are presented in the table below:

Table 15-1 Potential Community Health, Safety and Security Receptors

Receptor	Sensitivity	Justification
Local Communities Near the workers labour camps	**High**	The workers labour camps will be located close to residential and commercial areas and will be particularly vulnerable to the influx of workers.
Ras Al Khaimah Tourist Authority, Rixos Bab Al Bahr resort residents & Commercial compound 2	**Medium**	These receptors are located approximately 430m from the project boundary and as are considered to have relatively low vulnerability to potential health, safety and security risks associated with the project construction and operation activities.
Workers at the wastewater treatment plant	**Medium**	The wastewater treatment plant is located approximately 106.3m from the proposed project boundary. Therefore, the workers are considered to be relatively vulnerable to potential health, safety and security risks associated with the project.
Camel holding area workers	**Medium**	Located 128m from the project site, the camel holding area workers are considered relatively vulnerable to potential health & safety risks associated with the project construction activities i.e. operation of heavy machinery.

15.4 Potential Impacts

15.4.1 Construction Phase

Community Health

The construction phase of the project will require suitable accommodation areas for this workforce. As confirmed, the worker accommodation will be located off-site within a 10km radius from the project site. Since the majority of site staff workers including sub-contractor workers will be accommodated in the local area, they may come into contact with the local populations which poses a potential risk for the spread of diseases to the local communities.

Community Safety

All construction projects have potential risks relating to public safety that could arise, particularly in regard to the use of high-powered equipment, heavy construction equipment, excavations, transportation amongst others, including fire and pollution releases.

Public risks during construction have the potential to result in isolated incidents, which could be of a devastating magnitude to a person or group of people in the wrong place at the wrong time; however, this rarely occurs. Unlike the operations phase, there is a low probability of widespread risks that could potentially affect the public and the environment as a single event (e.g. large-scale pollution incidents, dust dispersion, explosions etc.).

Risks to the public will be appropriately addressed and prepared for in the construction phase 'Emergency Preparedness and Response Plan' and training regarding this plan. Construction personnel should be trained in emergency procedures and the potential affected receptors should be notified of procedures to follow by means via relevant communication channels.

Security

The construction phase of the project will require site-based security at the gates and on patrol around the site in order to prevent the public from trespassing to the construction site. This is so as to minimise the potential for construction site incidents from occurring. Project security will need to adhere to the security plan prepared by the EPC Contractor in line with UAE National Standards.

In addition to this, security personnel will receive internal training in regard to grievances, reporting such grievances and dialogue with any members of the local communities.

Table 15-2 Community Health, Safety and Security-Impact Significance & Mitigation & Management Measures & Residual Impacts-Construction

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
Potential for community exposure to diseases as a result of worker influx in the local area	**Minor Negative**	Local communities near the workers labour camps	High	**Minor to Moderate**	• All project workers will be required to undertake medical check-ups as part of the UAE visa requirements. • The Health and Safety Teams will provide training/inductions on exposure to diseases and how to observe cleanliness i.e. management of waste, washing hands after using the toilets or before eating food etc. • During construction, staff will have access to medical professionals and suitable medical facilities, which will aim to prevent the spread of diseases internally and externally. • Any reportable disease shall be diagnosed by the authorised occupation and health centre doctor. Diagnosis will include identifying any new symptoms or any significant worsening of existing symptoms. • Any external or internal spreading of diseases will be diagnosed and precaution taken as per the instructions from the national/local medical authority. • The potential for exposure to water-borne, water based, vector borne disease and communicable diseases as a result of the project activities will be	**Minor**
	Negligible Negative	Ras Al Khaimah Tourist Authority, Rixos Bab Al Bahr resort residents & Commercial compound 2	Medium	**Negligible or Minor**		**Negligible**
	Minor Negative	Workers at the wastewater treatment plant	Medium	**Minor**		**Negligible to Minor**

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
	Minor Negative	Camel holding area workers	Medium	**Minor**	avoided or minimised through provision of clean potable water, clean sanitary facilities with toiletries etc. • Any diagnosis of communicable diseases that may pose a threat to the local community will be reported to the local authorities immediately.	**Negligible to Minor**
Emergency situations in regard to the use of high-powered equipment, heavy construction equipment	**Moderate Negative**	Camel holding area workers	Medium	**Moderate**	• Risk to public safety will be appropriately addressed and prepared for in the operational phase 'Emergency Preparedness and Response Plan' and training. • The plan will include the appropriate procedure to respond to any such incidents, as well as site specific contact details and details of external agencies who may be required. • All high-risk areas including fuel storage areas will be secured with internal fencing and patrolled by security throughout the day and night. • Appropriate mechanisms for emergency control (e.g. firefighting equipment) will be placed at accessible positions around the site. • Active construction sites will be restricted to authorised project personnel only. • Visitors at the project site will not be allowed into the construction unaccompanied and a site induction must be carried out before access is granted.	**Minor**
	Minor Negative	Ras Al Khaimah Tourist Authority, Rixos Bab Al Bahr resort residents & Commercial compound 2	Medium	**Minor**		**Negligible to Minor**
	Moderate Negative	Workers at the wastewater treatment plant	Medium	**Moderate**		**Minor**
Security	**Minor Negative**	Local communities near the workers	High	**Minor to Moderate**	• The project will employ its own security staff who will provide 24/7 security control across the	**Minor**

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
		labour camps			project site and dedicated security staff at the gate house. • All vehicles entering the site will require pre-approved clearance and will need to be registered. • The project's security will record all instances of incoming vehicles. • CCTV will be installed at key locations around the site and at the gatehouse. • Appropriate lighting will be provided at the gatehouses to allow proper screening of personnel at night. • Project personnel will only be provided access to the construction site with valid ID cards and permits to work in line with EHS requirements. • The project will implement an appropriate system to allow external parties to raise grievances in regards to the project in accordance with the SEP • The EPC Contractor will ensure that there is 24/7 security at the workers accommodation camps and only authorised personnel are allowed in. • Any incidences that pose insecurity to the local population at the project site or accommodation camps will be recorded and where necessary reported to the local authorities. • Emergency numbers will be provided across the project site and accommodation camps including at the main entrances.	
	Minor Negative	Camel holding area workers	Medium	**Negligible to Minor**		**Negligible to Minor**
	Minor Negative	Ras Al Khaimah Tourist Authority, Rixos Bab Al Bahr resort residents & Commercial compound 2	Medium	**Negligible to Minor**		**Negligible to Minor**
	Minor Negative	Workers at the wastewater treatment plant	Medium	**Negligible to Minor**		**Negligible to Minor**

15.4.2 Operational Phase

Community Safety

The project will carry out various risks that could result in impacts to public safety where such impacts are transferred or received outside of the project site. Such impacts are unlikely to occur and may relate to fire, VOC fumes, explosions, spills of back up fuels and unwarranted/ accidental releases of wastewater.

The extent of such impacts may go beyond the projects boundaries and require the involvement of outside agencies to help manage and abate such impacts (e.g. Civil Defence, Police).

Although public risks during operation of the SWRO are expected to be limited, there may be significant risks to receptors if realised such as an unwarranted release of wastewater to the Arabian Gulf. Risks to the public safety will be appropriately addressed and prepared for in the operational phase 'Emergency Preparedness and Response Plan' and training. This will include monitoring provisions to ensure that outgoing product water is of suitable quality for potable use and consumption.

Security

The project constitutes a facility of high importance due to the generation of potable water for consumption. The project will include site-based security at the project site access road entrance and at the project gates, who will patrol the site in order to prevent the public from trespassing to the site and any malicious intrusion during operation of the SWRO plant.

Security arrangements will be in line with the UAE National standards. In addition to this, security personnel will receive internal training in regard to grievances, reporting such grievances and dialogue with any members of the local communities.

Transportation

Transportation impacts during operation are not expected to result into any changes, as the operation of the SWRO desalination plant may not require continuous delivery of materials, or other equipment in order to operate.

There will be occasional deliveries and waste removal from the site, which is not expected to result in a noticeable increase in the amount of traffic on the road. Staff movements may also contribute to minimal additional vehicle flows on local roads.

Table 15-3 Community Health, Safety and Security-Impact Significance & Mitigation & Management Measures & Residual Impacts-Operation

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
Community Safety (Emergency Situations)	**Moderate Negative**	Camel holding area workers	Medium	**Minor to Moderate**	• Risks to public safety will be appropriately addressed and prepared for in the operational phase 'Emergency Preparedness and Response Plan' and training. • The plan will include appropriate procedure to respond to any such incidents, as well as site specific contact details and details of external agencies who may be queried. • All high-risk areas including fuel storage areas will be secured with internal fencing and will be patrolled by security throughout the day. • Appropriate mechanisms for emergency control (e.g. firefighting equipment) will be placed at suitable positions around the site. • The plant will have various mitigation controls to protect against spillage of hazardous liquids and materials, including fuels. • Emergency contact details will be provided and clearly displayed at strategic locations in the SWRO plant and at the entrance.	**Minor**
	Minor Negative	Ras Al Khaimah Tourist Authority, Rixos Bab Al Bahr resort residents & Commercial compound 2	Medium	**Minor**		**Negligible to Minor**
	Moderate Negative	Workers at the wastewater treatment plant	Medium	**Minor to Moderate**		**Minor**

Potential Impacts	Magnitude of Impact	Receptor	Sensitivity	Potential Impact Significance	Mitigation and Management Measures	Residual Impacts
Security	**Minor Negative**	Camel holding area workers	Medium	**Negligible to Minor**	• The project will employ its own security staff who will provide 24/7 security control across the project site and dedicated security staff at gatehouses. • All vehicles entering the site will require pre-approved clearance and will need to be registered. Project security will record all instances of incoming vehicles. • CCTV will be installed at key locations around the site and at gatehouses. • Appropriate lighting will be provided at gatehouses for security personnel to prevent unauthorised access. • Project personnel will only be provided access to the site with valid ID cards and permits to work in line with HSE requirements. • Any insecurity incidences that pose a risk to the operation of the plant will be reported to local authorities in line with the O&M company internal security procedures.	**Negligible to Minor**
	Minor Negative	Ras Al Khaimah Tourist Authority, Rixos Bab Al Bahr resort residents & Commercial compound 2	Medium	**Negligible to Minor**		**Negligible to Minor**
	Minor Negative	Workers at the wastewater treatment plant	Medium	**Negligible to Minor**		**Negligible to Minor**

15.5 Monitoring

Monitoring of Community Health, Safety & Security will be undertaken as is required via the management measures outlined above. For instance, monitoring of the security plan will form part of the wider Environmental and Social Management System (ESMS) internal audits to be undertaken monthly during construction and quarterly during operations. Incoming grievances will be monitored as they come in and will be managed and recorded in accordance with the provisions to be established in the Stakeholder Engagement Plan (SEP) for the grievance mechanism.

16 WORKERS CONDITION & OCCUPATIONAL HEALTH & SAFETY

There are health and safety risks associated with the use of plant, machinery and construction processes of any project. Risks can be severe depending on the type of activities required, materials used and site condition.

For projects in isolated locations or where the local population/skill sets require influx of people from other regions/countries consideration will need to be given associated with accommodation, welfare, sanitary provision, health care, hygiene, food and potable water etc.

16.1 Standards and Regulations

Federal Law No. 8 of 1980 concerning Regulation of Working Relations, the 'Labour Law' is a comprehensive law that regulates all aspects of labour relations between employers and employees ranging from employee entitlements to industrial safety, preventive measures, health and social care for workers and its Ministerial Orders or Decrees (see Chapter 3)

The IFC Performance Standards that aim to identify and ensure that social and economic impacts of a project are addressed in the relevant areas is the IFC Performance Standard 2: Labour and Working Conditions.

In line with PS 2, the following conventions must be complied with:

- ILO Convention 29 on Forced Labour;
- ILO Convention 105 on the Abolition of Forced Labour;
- ILO Convention 138 on Minimum Age (of Employment);
- ILO Convention 182 on the Worst Forms of Child Labour;
- ILO Convention 1000 on Equal Remuneration;
- ILO Convention 111 on Discrimination (Employment and Occupation);
- UN Convention on the Rights of the Child, Article 32.1; and
- UN Convention on the Protection of the Rights of all Migrant Workers and Members of their Families.

16.2 Potential Impacts

16.2.1 Construction Phase

Occupational Health and Safety

It is estimated that there will be approximately 80 management staff members and 1200 workers during construction phase peak time. These workers will undertake common construction activities such as operation of heavy machinery, excavation, handling of chemicals, working at height etc. All these activities can introduce risk to the health and safety for the associated workforce. In particular, risks are more likely to be apparent for those who are not familiar with the type of works undertaken and/or the associated hazards.

The type of hazards attributable to a construction site will vary significantly dependent on the construction methods employed and the degree of control implemented by the EPC Contractor and affiliated sub-contractor(s). it is therefore of the outmost importance that the EPC and affiliated sub-contractor(s) demonstrate consideration of health and safety risks as part of their chosen construction methods and that these risks are appropriately mitigated.

Note: *Due to occupational health and safety being a risk rather than a potentially defined impact, its significance is not assessed further in this ESIA. Health and safety risks to the site force will be managed through effective risk assessment, development of appropriate methods statements, emergency and disaster planning and the communication of specific health and safety requirements relative to specific work/access requirements.*

Workers Conditions

Labour exploitation on construction site unfortunately cannot be ruled out. An inequality in income, education and opportunities has led to opportunistic immoral practices with labourers and site staff suffering as a consequence.

To ensure the wellbeing of the staff associated with the project, the EPC and associated sub-contractor(s), will need to plan for necessary provisions relative to the requirement of the required workforce. The EPC Contractor has confirmed that the workers accommodation sites will be located within a 10km radius from the project site. To this effect, the EPC Contractor will be required to put a mechanism in place that will allow for the inspection of these facilities and corrective actions to be taken.

Note: *As worker conditions are defined aspect of site planning rather than a potentially environmental impact, its significance is not assessed further in this ESIA. Risks associated with worker welfare during construction will be managed through effective project planning, and the enforcement of fair and just treatment throughout the construction phase.*

Table 16-1 Workers Condition & Occupational Health & Safety Mitigation & Management Measures -Construction

Potential Impact	Mitigation and Management Measures
Occupational Health and Safety	• The EPC Contractor will provide the workers with a safe and healthy work environment, considering inherent risks and specific classes of hazards associated with the project. • The EPC Contractor will implement and maintain and OHS management system considering specific risks associated with the project, legal requirements and duty of care. • The EPC Contractor will be responsible for ensuring that all affiliated sub-contractors comply with the OHS management system. The OHS management system will be in-line with recognised international best practice and as a minimum, this plan will include; – Means of Identifying and minimising, so far as reasonably practicable, the cause of potential H&S hazards to workers. – Provisions of preventive and protective measures, including modification, substitution, or elimination of hazardous conditions or substances. – Provision of appropriate equipment to minimise risks, and requiring and enforcing its use. – Training of workers, and provision of appropriate incentives for them to use and comply with H&S procedures and protective equipment. – Documentation and reporting of occupational accidents, diseases and incidents. – Emergency prevention, preparedness and response arrangements.
Workers Conditions-Terms of Employment, Non-discrimination and equal opportunities, Working Relationships	• The EPC Contractor will provide a plan detailing how working conditions and terms of employment are compliant with national labour, social security and occupational health and safety laws. • Employment relationships will be on the principle of equal opportunity and fair treatment, and will not discriminate with respect to any aspects of the employment relationship including recruitment and hiring, compensation (including wages and benefits), working conditions and terms of employment, access to training, promotion, termination of employment or retirement, and discipline. • The EPC Contractor will not make employment decisions on the basis of personal characteristics, such as gender, race, nationality, ethnic origin, religion or belief, disability, age or sexual orientation, unrelated to inherent job requirements. • The EPC Contractor will document and communicate to all workers their working conditions and terms of employment including their entitlement to wages, hours of work, overtime arrangements and overtime compensation, and any benefits (such as leave for illness, maternity/paternity, or holiday). • The EPC Contractor will base the employment relationship on the principle of equal opportunity and fair treatment, and will not discriminate with respect to all aspects of employment relationship, including recruitment and hiring, compensation (including wages and benefits), working conditions and terms of employment, accommodation, access to training, promotion, termination of employment or retirement, and discipline. *Special measures of protection or assistance to promote local employment opportunities or selection for a particular job based on the*

Potential Impact	Mitigation and Management Measures
	inherent requirements of the job, which are in accordance with national law, will not be deemed discriminatory
Workers Conditions-Forced Labour	• The EPC Contractor will not employ forced labour, which consists of any work or service not voluntarily performed that is exacted from an individual under threat of force or penalty. This covers any kind of involuntary or compulsory labour, such as indentured labour, bonded labour or similar labour-contracting arrangements. • HR policies and procedures will be adapted appropriately to the size of the workforce required for the project. Policies and procedures must be prepared to demonstrate consistency with the requirements of national legislation and IFC PS 2.
Workers Conditions-Child Labour	• The EPC Contractor will comply with all relevant national laws' provisions related to the employment of minors. • In any event, the client will not employ children in a manner that is economically exploitative, or is likely to be hazardous or to interfere with the child's education, or to be harmful to the child's health or physical, mental, spiritual, moral, or social development. • Young people below the age of 18 years will not be employed in hazardous work and all work of persons under the age of 18 will be subject to an appropriate risk assessment.
Workers Conditions-Wages, benefits, conditions of work and retrenchment	• Wages, benefits and conditions of work offered should, overall, be comparable to those offered by equivalent employers in the UAE or the sector concerned. • If the EPC Contractor anticipates collective dismissals associated with the proposed project, the EPC Contractor will develop a plan to mitigate the adverse impacts of retrenchment, in line with national law and good industry practice based on the principles of non-discrimination and consultation. Without prejudice to more stringent provisions in national law, such consultation will involve reasonable notice of employment changes to the workers' representatives and, where appropriate, relevant public authorities so that the retrenchment plan may be examined jointly in order to mitigate adverse effects of job losses on the workers concerned. The outcome of the consultations will be reflected in the final retrenchment plan.
Workers Conditions-Grievance Mechanism	• The EPC Contractor will provide a grievance mechanism for workers to raise reasonable workplace concerns. The client will inform the workers of the grievance mechanism at the time of hiring, and make it easily accessible to them. The mechanism will involve an appropriate level of management and address concerns promptly, using an understandable and transparent process that provides feedback to those concern without retribution. The mechanism should not impede access to other judicial or administrative remedies that might be available under law or through existing arbitration procedures, or substitute for grievance mechanisms provided through collective agreements.
Workers Conditions-Supply Chain	• The EPC Contractor will devise a supply management system to ensure the measures above are implemented by all sub-contractors. • The EPC Contractor will take reasonable steps to inquire about the use of child labour and forced labour in its supply chain.

16.2.2 Operational Phase

Occupational Health and Safety

The risk associated with the operational phase of the project are anticipated to be less than during the construction phase due to reduced site activity and requirements for heavy plant and machinery.

However, there will be incoming electrical connections on-site and movement of large volumes of water by high powered pumps, all of which pose a significant risk to worker health and safety. Maintenance and inspection will also require the use of site vehicles and activities that pose risks to human and safety.

The severity and likelihood of risks during the operation phase will be dependent on the frequency and requirements for planned and unplanned maintenance. The operation and maintenance will need to ensure that a robust plan is in place to appropriately manage these risks.

Note: *due to occupational health and safety being a risk rather than a potentially defined impact, its significance is not assessed further in this ESIA. Health and safety risks to the site force will be managed through effective risk assessment, development of appropriate method statements, emergency and disaster planning and the communication of specific health and safety requirements relative to specific work/access requirements.*

Workers Conditions

No long-term accommodation requirements are anticipated for the project. However, as with construction, operational activities will need to plan for and enforce just and fair treatment of operational and maintenance staff (including any engaged sub-contractors). Allowance will also be need to be made for site staff welfare facilities.

Note: *As workers conditions are defined aspect of site planning rather than a potentially environmental impact, its significance is not assessed int his ESIA. Risks associated with worker welfare during operation will be managed through effective project planning, and the enforcement of fair and just treatment throughout the operational phase.*

Table 16-2 Workers Conditions & Occupational Health & Safety Mitigation & Management Measures – Operation

Potential Impact	Mitigation and Management Measures
Occupational Health and Safety	• The O& M Company will provide the workers with a safe and healthy work environment, considering inherent risks and specific classes of hazards associated with the project. • The O&M Company will implement and maintain an OHS management system considering specific risks associated with the project, legal requirements and duty of care. • The O&M Company will be responsible for ensuring all affiliated sub-contractors comply with the OHS management system. The OHS management system will be in-line with recognised international best practice and as a minimum, this plan will include; – Means of identifying and minimising, so far as reasonably practicable, the causes of potential H&S hazards to workers. – Provisions of preventive and protective measures, including modification, substitution, or elimination of hazardous conditions or substances. – Provision of appropriate equipment to minimise risks, and requiring and enforcing its use. – Training of workers, and provision of appropriate incentives for them to use and comply with H&S procedures and protective equipment.
Workers Conditions- Terms of Employment, Non-discrimination and equal opportunities, Working Relationships	• The O&M Company will provide a plan detailing how working conditions and terms of employment are compliant with national labour, social security and occupational health and safety laws. • Employment relationship will be on the principle of equal opportunity and fair treatment, and will not discriminate with respect to any aspects of the employment relationship, including recruitment and hiring, compensation (including wages and benefits), working conditions and terms of employment, access to training, promotion, termination of employment or retirement, and discipline. • The O&M Company will document and communicate to all workers their working conditions and terms of employment including their entitlement to wages, hours of work, overtime arrangements and overtime compensation and any benefits such as sick leave for illness, maternity/paternity, or holiday). • The O&M Company will not make employment decisions on the basis of personal characteristics such as gender, race, nationality, ethnic origin, religion or belief, disability, age or sexual orientation, unrelated to inherent job requirements. *Special measures of protection or assistance to promote local employment opportunities or selection for a particular job based on the inherent requirements of the job, which are in accordance with national law, will not be deemed discriminatory*
Workers Conditions-Forced Labour	• The O&M Company will not employ forced labour, which consists of any work or service not voluntarily performed that is exacted from an individual under threat of force or penalty. This covers any kind of involuntary or compulsory labour, such as indentured labour, bonded labour or similar labour-contracting arrangements. • HR policies and procedures will be adopted appropriately to the size of the workforce required for the project. Policies and procedures must be prepared to demonstrate consistency with the requirements of national legislation and IFC PS 2.

Potential Impact	Mitigation and Management Measures
Workers Conditions – Child Labour	• The O&M Company will comply with all relevant national laws' provisions related to the employment of minors. • In any event, the client will not employ children in a manner that is economically exploitative, or is likely to be hazardous or to interfere with the child's education, or to be harmful to the child's health or physical, mental, spiritual, moral, or social development. • Young people under the age of 18 years will not be employed in hazardous work and all work of persons under the age of 18 will be subject to an appropriate risk assessment.
Workers Conditions- Wages, benefits, conditions of work and retrenchment	• Wages, benefits and conditions of work offered will, overall, be comparable to those offered by equivalent employers in the UAE and the sector concerned. • If the O&M Company anticipates collective dismissals associated with the proposed project, the Company will develop a plan to mitigate the adverse impacts of retrenchment, in line with national laws and good industry practice and based on the principles of non-discrimination and consultation. Without prejudice to more stringent provisions in national law, such consultation will involve reasonable notice of employment changes to the workers 'representatives and, where appropriate, relevant public authorities so that the retrenchment plan may be examined jointly in order to mitigate adverse effects of job losses on the workers concerned. The outcome of the consultations will be reflected in the final retrenchment plan.
Workers Conditions- Grievance Mechanism	• The O&M Company will provide a grievance mechanism for workers to raise reasonable workplace concerns. The Company will inform the workers of the grievance mechanism at the time of hiring, and make it easily accessible to them. The mechanism should involve and appropriate level of management address concerns promptly, using an understandable and transparent process that provides feedback to those concerned, without any retribution. • The mechanism should not impede access to other judicial or administrative remedies that might be available under law or through existing arbitration procedures, or substitute for grievance mechanisms provided through collective agreements.
Workers Conditions- Supply Chain	• The O&M Company will device a supply management system to ensure the measures above are implemented by all sub-contractors. • The O&M Company will take reasonable steps to inquire about the use of child labour and forced labour in its supply chain.

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