

Al Dur Phase II IWPP  
(Independent Water  
and Power Project)  
Kingdom of Bahrain



Environmental and Social  
Impact Assessment (ESIA)

Volume 1 - Non-Technical  
Summary

Prepared for:



February 2019

## DOCUMENT INFORMATION

Project Name	Al Dur Phase II IWPP, Kingdom of Bahrain
5Cs Project Number	1305/001/063
Document Title	Environmental and Social Impact Assessment Volume 1 – Non-Technical Summary
Client	ACWA Power
5Cs Project Manager	Max Burrow
5Cs Project Director	Ken Wade

## DOCUMENT CONTROL

Version	Version Date	Description	Author	Reviewer	Approver
(v1)	13/01/2019	ESIA-NTS	EMK	MKB	KRW
(v2)	24/01/2019	ESIA-NTS	EMK/EFO	KRW	KRW
Issue 1	15/02/2019	ESIA-NTS for Issue	EFO	KRW	AJJB



1	Financial Capital	Regardless of location, mode of delivery or function, all organisations are dependent on <i>The 5 Capitals of Sustainable Development</i> to enable long term delivery of its products or services.
2	Social Capital	
3	Natural Capital	
4	Manufactured Capital	Sustainability is at the heart of everything that 5 Capitals achieves. Wherever we work, we strive to provide our clients with the means to maintain and enhance these stocks of capital assets.
5	Human Capital	

## DISCLAIMER

5 Capitals cannot accept responsibility for the consequences of this document being relied upon by any other party, or being used for any other purpose.

This document contains confidential information and proprietary intellectual property. It should not be shown to other parties without consent from the party which commissioned it.

This document is issued for the party which commissioned it and for specific purposes connected with the above-identified project only. It should not be relied upon by any other party or used for any other purpose

# CONTENTS

1	INTRODUCTION	1
2	PROJECT SUMMARY	2
2.1	Project Location	2
2.2	Project Description	3
2.2.1	Power Plant	3
2.2.2	Desalination Plant	3
2.2.3	Project Construction	4
3	OVERVIEW OF LOCAL ENVIRONMENT	4
4	STAKEHOLDER CONSULTATIONS	4
5	ENVIRONMENTAL & SOCIAL ISSUES	5
5.1	Air Quality	5
5.1.1	Continuous Ambient Air Monitoring	6
5.1.2	Diffusion Tube Ambient Air Monitoring	6
5.1.3	Construction and Operational Impacts and Mitigation	6
5.1.4	Air Dispersion Modelling	7
5.1.5	Greenhouse Gases	7
5.2	Noise and Vibration	8
5.2.1	Noise Baseline Survey	8
5.2.2	Construction and Operational Impacts and Mitigation	9
5.2.3	Noise Modelling	9
5.3	Marine Environment, Hydrodynamics, Water & Sediment Quality	10
5.3.1	Marine Ecology and Water Quality Baseline	10
5.3.2	Marine modelling	10
5.4	Biodiversity (Terrestrial)	12
5.5	Geology, Soils and Groundwater	13
5.6	Solid and Liquid Waste Management	14
5.7	Chemicals	15
5.8	Navigation	15
5.9	Tourism and Recreation	15
5.10	Traffic and Access	16

---

5.11	Socio-Economics	16
5.12	Cultural Heritage and Archaeology	17
5.13	Landscape & Visual Quality	17
5.14	Health and Safety	18
6	ENVIRONMENTAL & SOCIAL MANAGEMENT & MONITORING	18
7	CUMULATIVE IMPACTS	19

# 1 INTRODUCTION

This document is the Environmental and Social Impact Assessment (ESIA) Non-Technical summary for the Al Dur IWPP Phase II (the Project), a proposed Combined Cycle Gas Turbine (CCGT) natural gas fired power plant of 1,524 MW net power capacity with Seawater Reverse Osmosis (SWRO) desalination plant of 50 million gallons/day (MIGD) net capacity, located in Al Dur, Bahrain. This project is being developed in line with Bahrain 2030 National Plan.

An ESIA has been prepared in accordance with ACWA Power's HSSE Policy which includes compliance with World Bank/IFC environmental and social Performance Standards and EHS guidelines. In addition, the Project will also comply with the specific Environmental Regulations and standards of The Supreme Council for Environment (SCE) in the Kingdom of Bahrain.

The primary aim of the ESIA is to identify and categorise predicted impacts that may occur as a result of the projects construction and operational phases, and to specify mitigation and management measures in order to avoid or minimise these impacts wherever possible.

The process of completing the ESIA has comprised the following stages:

- Collation of baseline information through desk-top review, and compilation of relevant environmental and social data for the project site.
- Design, execution and analysis of scientifically robust field survey data and modelling of proposed project emissions and effluent discharges.
- Identification, assessment and categorisation of impacts.
- Identification of appropriate mitigation, management and monitoring measures to appropriately control identified impacts.
- Identification of any residual significant effects.

The ESIA has been divided into several volumes, in accordance with best practice as follows:

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

The ESIA includes feedback received from SCE at both the Project Screening and Environmental Scoping (ESS) stages, with support from locally registered consultants in Bahrain. The ESS identified preliminary potential impacts associated with the project and defined the level of assessment required in the ESIA, including specific methodologies.

The outcome of the scoping confirmed the primary assessment requirements of the ESIA to include the following aspects of Air Quality, Noise and Vibration, Marine Environment,

Hydrodynamics, Water & Sediment Quality, Biodiversity (Terrestrial), Geology, Soils & Groundwater, Solid & Liquid Waste Management, Chemicals, Navigation, Tourism & Recreation, Traffic & Access, Socio-Economics, Cultural Heritage & Archaeology, Landscape & Visual Quality and Community and Occupational Health & Safety.

## 2 PROJECT SUMMARY

### 2.1 Project Location

The proposed project has a footprint of approximately 192,500m<sup>2</sup>, and is located immediately south of the existing Al Dur Phase I IWPP Plant, adjacent to the Arabian Gulf coastline in the Southern Governorate of the Kingdom of Bahrain.

The satellite image below presents the proposed location, footprint and boundaries of the proposed Project site, as well as the adjacent Al Dur Phase I and existing facilities to the north. The figure also shows the existing facilities i.e. gas station, substation, intake and outfall.

**Figure 2-1 Proposed Project Location**



Map Source: Google Earth



## 2.2 Project Description

### 2.2.1 Power Plant

The Electricity and Water Authority (EWA) (the Project Proponent) requires approximately 1500MW of power and 50 MIGD of desalinated water. The power generation units will consist of four Gas Turbine Generators (GTG), four Heat Recovery Steam Generator (HRSG) and two steam turbines (ST). The plant will operate on natural gas only in either simple or combined cycle modes. The first power and water production ("early power" and "early water") is planned for late summer of 2020 and completion of the project by 2022.

The clean natural gas, supplied by Tatweer will be delivered via the existing gas receiving station in place at Al Dur IWPP Phase I. There will be no emissions of sulphur dioxide (SO<sub>2</sub>) and particulates from the burning of the gas. The GTGs will also be equipped with low NO<sub>x</sub> burners and will have Continuous Emissions Monitoring System (CEMS) on both the main and bypass stacks, for monitoring NO<sub>x</sub> and CO emissions. The Power Plant GTG technology will be among the most efficient in the world with an efficiency of at least 59%.

It is anticipated that RLNG fuel will be utilised in the future, which would also be delivered via the same existing gas receiving facility. In addition, the project will incorporate emergency power supplies through smaller diesel generating units to ensure the safe shutdown of all components in the event of emergency.

The power block cooling will be provided on a closed loop basis by mechanical induced draft counterflow cooling towers with either 40 or 48 cooling cells. The use of the closed loop system will minimise the need for water and reduce the influence of thermal effluent on the receiving marine environment.

### 2.2.2 Desalination Plant

The Reverse Osmosis desalination plant component will consist of 2 blocks, each configured with multiple independent process/filtration units. Each unit will consist of a series of pressure vessels, a cartridge filter, a high-pressure pump, an energy recovery device and one or two booster pumps to facilitate energy recovery.

A pre-treatment system will be incorporated to ensure that the necessary volume of seawater is available for the RO membranes and that specific requirements in relation to chemical / biological parameters are maintained at all times. The wastewater streams will be treated on site and no sludge will be spread for drying or discharged to the sea.

To ensure that the minimum requirements for potable water quality are met, three analysers will be installed to monitor quality. The first analyser will be at the Potable Water storage tank located immediately after the potabilization process. The other two analysers will be located

after the storage tank and prior to the Al Dur Forwarding Station (Water Delivery Point) in order to check the final quality of the drinking water.

The Project will make use of several existing shared facilities (which are in use by the Al Dur Phase I) such as the seawater intake, screening, chlorination and pumping, seawater outfall and gas supply/receiving station.

### 2.2.3 Project Construction

The construction will be led by SEPCO3 (the EPC Contractor) who will employ just under 1,000 workers at the peak, whilst SIDEM will employ their own specialist staff for the construction of the desalination plant. The SEPCO3 workers will be housed in a camp adjacent to the Al Dur site, whilst SIDEM will use facilities in Askar. All accommodation will comply with IFC standards for worker accommodation and welfare. Subcontractors will be housed at their own camps and will travel to the site in buses. The Project will provide employment to Bahraini nationals (5% of the workforce) in compliance with Bahrain Labour Law.

## 3 OVERVIEW OF LOCAL ENVIRONMENT

The Ministry of Finance (MOF) is the land owner and they will offer a 30-year lease for the main project site and a separate lease for the temporary areas in use during the construction phase. The site is undeveloped with no identified formal or informal land uses, such as access routes or grazing uses and is unfenced. It is situated adjacent to Al Dur IWPP Phase I and the King Hammad Highway. It is also located in close proximity to the Arabian Gulf, set back from the shoreline, with a steady slope of land from west to east towards the coastline.

The project site is situated near some low density residential, commercial and industrial receptors, with areas of open land. The nearest receptors include the Al Dur IWPP Phase I directly adjacent to the north of the project boundary, a Tourism Boat Jetty approximately 800m north east and respectively, as well as Al Dur residential area approximately 550m south east. The future Al Dur IWPP Phase II temporary worker accommodation camp will be located approximately 200m south of the Project site and only active during construction.

## 4 STAKEHOLDER CONSULTATIONS

Consultation letters have been sent to stakeholders (agreed with SCE) that might be affected by the Project or may have an interest in the outcome of the ESIA process. Three replies have been received to date (see those underlined) with advice, but no concerns have been raised. The SCE has responded with comments to the Environmental Screening Form and these were included in the subsequent Scoping Report.



- The Supreme Council for Environment (SCE);
- Central Planning Office (CPO);
- Bahrain Cultural Antiquities
- The Agricultural, Engineering and Water Resources Directorate (AEWRD);
- Marine Resources Directorate (MRD);
- Ports and Maritime Affairs (PMA);
- Southern Tourism Company;
- Al Dur IWPP Phase I;
- Ministry of Municipality Affairs & Urban Planning;
- National Oil and Gas Authority (NOGA);
- The Bahrain Defence Force (BDF)/Ministry of Defence;
- The Southern Governorate;
- The Southern Area Municipality; and
- The Southern Area Municipal Council.

## 5 ENVIRONMENTAL & SOCIAL ISSUES

### 5.1 Air Quality

The Project area within a 5km radius of the project site is characterised by mixed land uses including industrial, commercial and residential areas to the north and south of the Project site. Emission sources include the adjacent Al Dur IWPP Phase I, traffic using King Hammad Highway, local roads, the harbour, and military airbase. Diffuse emissions from the nearby Askar landfill may also be discernible upon migration via the prevailing wind to the Project site. Wider influence upon the airshed may also include other far-field industries outside of this area. These influences are typically related to the combustion of hydrocarbons and as a result are expected to include pollutants emissions of NO<sub>x</sub>, SO<sub>2</sub>, CO, Particulate Matter and VOCs. A secondary result of such emissions may include increase of ground level Ozone (O<sub>3</sub>) due to photochemical reactions between NO<sub>2</sub> and VOCs in the presence of sunlight. Regional contributions to air quality at Al Dur may also arise from cities on the east coast of Saudi Arabia such as Dammam and Al Khobar which would be carried on prevailing winds.

In order to provide a baseline upon which to assess the potential for construction based impacts of dust generation & dispersion to nearby sensitive receptors; and to better understand baseline air quality conditions within the vicinity of the Project site, short and long term ambient air quality monitoring was undertaken at locations surrounding the proposed Project site.

### 5.1.1 Continuous Ambient Air Monitoring

Short-term ambient air quality monitoring was undertaken continuously for 3 days at 3 locations (selected at local receptors in consultation with Bahrain SCE), providing 9 completed days of monitoring data that could be used to identify diurnal trends, influences by varied meteorology and be used in comparison to 1-hour and 24-hour average standards (where applicable). This included data for a range of parameters, including ammonia, carbon monoxide, hydrogen sulphide, methane, nitrogen dioxide, ozone, sulphur dioxide, volatile organic carbons (VOCs), benzene and particulate matter (PM<sub>2.5</sub> & PM<sub>10</sub>). The results indicated elevated concentrations of NO<sub>2</sub> above the Bahrain ambient standards for 24-hour averaging periods (note: these concentrations were slightly over the IFC EHS Guideline values for NO<sub>2</sub> at two of the monitoring stations). Concentrations of SO<sub>2</sub> were variable and also indicated some exceedances of 24-hour Bahrain standards. Other pollutants were detected, but generally within SCE limits.

### 5.1.2 Diffusion Tube Ambient Air Monitoring

Medium-term ambient air quality monitoring was undertaken at four (4) locations between 2<sup>nd</sup> January 2019 and 27<sup>th</sup> January 2019 using diffusion tubes to monitor the concentration of NO<sub>2</sub>, SO<sub>2</sub>, H<sub>2</sub>S & the 5 most common VOCs. The results obtained throughout this period demonstrate that the concentration of NO<sub>2</sub> was compliant at three out of the four monitoring locations in relation to Bahraini and WHO annual NO<sub>2</sub> standards. An elevated concentration of NO<sub>2</sub> was recorded at the monitoring location in close proximity to the Al Dur Residences while SO<sub>2</sub> concentration was also elevated at this location and by the King Hamad Highway. Other pollutant concentrations recorded in the diffusion tubes i.e. H<sub>2</sub>S and top 5 VOCs were either within the threshold limit or could not be compared with an established standard. The H<sub>2</sub>S levels were significantly lower than the odour detection threshold.

### 5.1.3 Construction and Operational Impacts and Mitigation

Project impacts to air quality are expected during construction and operational phases, but will be managed through mitigation and monitoring measures. The construction impacts will be localised dust emissions and minor gaseous emissions from construction vehicles and equipment. The release of VOCs from paints and solvents and odour from temporary sanitation facilities will be controlled by suitable storage facilities. Dust impacts will be

controlled by damping down construction roads etc and will be largely controlled within the fenceline boundary to protect nearby residential receptors, Al Dur IWPP Phase I and harbour.

Operational impacts will primarily relate to the combustion of natural gas (the only fuel, as there is no diesel back up fuel), which will result in the emission of NO<sub>x</sub> and CO to the airshed. Operational impacts have been modelled using the US-EPA approved AERMOD software for both simple and combined cycle modes on natural gas fuel, using data provided by the EPC Contractor and local meteorological data.

#### 5.1.4 Air Dispersion Modelling

Air Dispersion modelling using AERMOD (a US-EPA approved model) was undertaken to predict the dispersion of NO<sub>2</sub> and carbon monoxide (CO) from the proposed 60m high stacks. For Simple Cycle operations, the predicted long-term and short-term NO<sub>2</sub> and CO process contributions arising from the plant are less than the relevant significance criteria at all 13 receptor locations tested. The impact of the emissions from the plant when operating in Simple Cycle mode is therefore considered to be insignificant with regards to both NO<sub>2</sub> and CO concentrations. For Combined Cycle operations the predicted long-term and short-term NO<sub>2</sub> process contributions arising from the plant are less than the relevant significance criteria at all but one receptor with relevant exposure.

The results demonstrate that the Project's contribution of NO<sub>2</sub> to receptors (including residential) will be less than 2% of the standards under worst case meteorological conditions. The only exception is at Al Dur South where the maximum levels of NO<sub>2</sub> may reach up to 10% of the most stringent ambient standard under worst case meteorological conditions. Contributions of CO will be very small (up to 1%) of the standard under worst case conditions.

Alternative stack heights were modelled to test the suitability of the 60m high stacks. This demonstrated that increasing the stack height from 55m to 60m results in a significant lowering of the emissions on site.

Acidic deposition rates were tested at sensitive receptor location including The Tree of Life, Marine seagrass habitat close to Al Dur site and the protected Hawar Islands. All sites had low deposition rates within the range of 0.001 to 0.007 keq/ha/yr, with the exception of the closest marine site adjacent to Al Dur site which predicted 0.067 keq/ha/yr.

#### 5.1.5 Greenhouse Gases

Greenhouse Gas Contributions (GHG) is a measure of the quantity of carbon dioxide released from the burning of gas in what is one of the world's most efficient gas-fired power plants. Based on 100% loading 365 days per year, the total amount of CO<sub>2</sub> that will be released to the atmosphere for RLING Gas will be 37.46Kg/s, which is equivalent to 1.18 million tonnes of CO<sub>2</sub>

/annum. If Khuff gas is supplied to the plant, the emission rate for CO<sub>2</sub> will be 40.56Kg/s which is equivalent to 1.28 million tonnes of CO<sub>2</sub>/annum.

## 5.2 Noise and Vibration

The project site is located adjacent to the south of the existing Al Dur Phase I IWPP and approximately 800m to the south of the Al Dur IWP. These industrial facilities consist of operational CCGT and SWRO processes. Such processes are observed to result in continual humming noises which propagate to the local areas. This type of noise is expected to be steady without noticeable variations in pitch, frequency or magnitude. Such noise influences are apparent on a 24-hour basis due to the continual operational nature of these facilities.

Approximately 450m west of the Project site is a major road link; the King Hamad Highway along the eastern coastline of Bahrain linking areas in the north to those in the south. Although the highway is well used, it is not near capacity. This results in the frequent passing of vehicles and related noise impacts to the local project area. Besides noise from the industrial facilities and highway, local noise influences also include noises from vessels at the harbour and aircraft operating at or flying to and from the nearby air base.

### 5.2.1 Noise Baseline Survey

Noise monitoring was undertaken at 5 local receptor locations surrounding the proposed Al Dur IWPP Phase II site in November 2018 (consulted on with Bahrain SCE) to ascertain the baseline environment and at 1 location in December 2018 to provide worst case noise level data at the nearest residential receptor location. The monitoring survey was carried out during the day, evening and night times continuously for 1-hour at each location.

Noise levels were lowest at 3 of the locations in the morning and highest noise levels consistently being observed in the evening times at all locations. The increase in noise levels during the evening time monitoring was partly attributed to sporadic passing of aircraft from the nearby air base.

When compared to applicable WHO noise standards, all morning and evening monitoring data is in compliance with the applicable daytime standard of 55dB(A) at residential receptors. With regard to night time noise monitoring, slight exceedances (<1dB(A)) were recorded at residential receptors.

No noticeable vibrations were encountered at any time during the site visits or site survey undertaken to date.

### 5.2.2 Construction and Operational Impacts and Mitigation

Construction activities will likely result in temporary and short duration increases in the noise and vibration levels emanating from the project site, access road and the laydown areas; dependant on the type of works being undertaken. Noise will be generated by construction and propagated to the surrounding areas via a range of processes. This has been assessed under guidance by BS 5228-1:2009 for the 'Code of Practice for Noise and Vibration on Construction and Open Sites'. The assessment predicts that an increase of noise (up to a 9.6dB(A) increase from the existing baseline) will likely be noticeable at the nearest existing residential receptors; although these are expected to remain below WHO daytime noise standards. The Project's temporary worker accommodation area (located south of the Project site) will be controlled through good practice construction methods.

Operational noise impacts were assessed using modelling software IMMI2018, to assess the potential impacts at the nearest noise sensitive receptors. A noise barrier along the south eastern corner of the Project site was included in the modelling as a possible mitigation measure if required. The modelling was undertaken both with and without this barrier.

### 5.2.3 Noise Modelling

During operation of the project, the modelling study predicts compliance with WHO residential, institutional and educational noise standards of 55dB(A) at all modelled residential/institutional receptor locations for daytime monitoring periods with or without the proposed noise barrier during both simple and combined cycle operations. With regards to commercial receptors, the model also predicts compliance with WHO commercial noise standards of 70dB(A) at all modelled commercial & recreational receptor locations for daytime and night time monitoring periods with or without proposed noise barrier during both simple and combined cycle operations.

During night time, the model predicted compliance with WHO night time noise standards of 45dB(A) for residential & institutional receptors at majority of the modelled residential & institutional receptor locations with the exception of the residences located to the south east of the Project site. This cluster of residences (which already experience night time noise from the nearby airbase) may experience noise levels of up to 49.1dB(A) with or without noise barrier for both operational scenarios in combination with the current baseline. However, the effects at the building façade are likely to be slightly reduced due to the presence of a solid perimeter boundary of these properties, which will likely further reduce noise by between 5-10dB(A); depending on whether the buildings are partially or fully blocked at the façade.

## 5.3 Marine Environment, Hydrodynamics, Water & Sediment Quality

### 5.3.1 Marine Ecology and Water Quality Baseline

Detailed marine surveys in the Project area were undertaken in 2008 (pre-AI Dur IWPP Phase I development) and in 2018 (pre-AI Dur IWPP Phase II development) respectively. The September 2018 is a comprehensive marine ecology and water quality study, with samples collected for water and sediment analysis, plankton, benthic invertebrates, fish, seagrass and habitat mapping. The results for the water quality analysis indicated good water quality ambient conditions meeting relevant GCC environmental standards while the sediment quality was within the limits set for Australian Sediment Standards. These standards have been used as a benchmark as good practice standards. The ecological surveys revealed low densities and abundance of benthic fauna and flora. The dominant marine habitat types observed during the 2018 survey included sand and macroalgae beds.

### 5.3.2 Marine modelling

Three dimensional hydrodynamic and water quality marine modelling using TELEMAC software was undertaken by H R Wallingford to assess the effects of the discharge including reject thermal and brine effluent (from the power plant cooling and desalination process, respectively) and residual chlorine used for anti-fouling of the cooling water and intake pipes. The present study was based on the hydrodynamic model established and validated during recent studies for the Electricity & Water Authority.

The AI Dur II Project will utilise shared intake and outfall facilities with the existing AI Dur Phase 1 Plant and as such there will be no further marine construction works., reclamation or dredging.

Predicted dispersion patterns have been analysed to determine thermal, saline and residual chlorine mixing zones, for interpretation with respect to the mixing zone standards of Bahrain's Supreme Council for Environment (SCE) and the International Finance Corporation (IFC).

#### **Phase 1 Mixing Zone – key findings:**

- The plume moves offshore from the discharge channel under its own momentum before being deflected to the north and south by the alongshore currents.
- As the plume is negatively buoyant, the seabed footprints are larger than those at the surface, and the plume tends to flow offshore down the bed gradient.
- The maximum extent of the +3°C mixing zone for Phase 1 is 1.5-2 km from the outfall.

- On average the predicted  $\Delta T$  falls to within  $3^{\circ}\text{C}$  of the ambient seawater temperature a few hundred metres from the outfall.
- The largest predicted extents of the excess salinity mixing zones are around 2-2.4 km from the outfall.
- The IFC residual chlorine mixing zone extends to about 2 km from the outfall for Phase 1.
- Residual chlorine concentrations are predicted to remain below the SCE mixing zone threshold.

#### **Phase 1+2 Mixing Zones combined:**

- The two discharge streams will merge close to the outfalls to form a combined plume.
- The Phase 2 discharge excess temperatures are lower than those assumed for Phase 1, and the additional heat loads for Phase 2 are only about one tenth of those assumed for Phase 1.
- Therefore, in summer, the maximum extents of the  $+3^{\circ}\text{C}$  mixing zones are similar to Phase 1.
- In winter, as the Phase 2 discharge  $\Delta T$  is below the mixing zone threshold, the combined mixing zone extent is actually reduced by a few hundred metres, due to the effects of dilution.
- The predicted salinity mixing zones are larger, with the largest extents up to 3 km from the outfall.
- The IFC residual chlorine mixing zone extends to slightly more than 2 km from the outfall.
- Residual chlorine concentrations are predicted to remain below the SCE mixing zone threshold.

#### **Sensitive sites Excess temperatures:**

- Peak  $\Delta T$  predictions at each of the seagrass sites are generally below about  $0.7^{\circ}\text{C}$ , with only small changes predicted due to the addition of Phase 2 (within  $0.2^{\circ}\text{C}$ ).
- Site F2 (in the sheltered bay near the outfalls) is an exception, with peaks up to about  $+3^{\circ}\text{C}$  for both Phase 1 and Phase 1+2. (Averages here are lower, around  $0.5^{\circ}\text{C}$ , for both Phase 1 and Phase 1+2).

#### **Sensitive sites Excess salinities:**

- For Phase 1, peak  $\Delta S$  predictions at each of the sites are generally below about 2.2 ppt, and averages are generally below 1 ppt.



- Again, the exception is at site F2, where the peak  $\Delta S$  is above 8 ppt, and the average  $\Delta S$  is above 1 ppt.
- The Phase 2 discharge increases the  $\Delta S$  predictions at each of the sites.
- Peak and average values at F2 are increased by around 3.1 ppt and 0.8 ppt, respectively.
- Increases in the average salinities at the other sites are generally predicted to be below 0.5 ppt, but peak increases are higher.

### Recirculation

- The addition of Phase 2 is predicted to make small increases to summer recirculation temperatures.
- For the winter parameters assumed, predicted levels of thermal recirculation are similar for both Phase 1 and Phase 1+2.
- Peak excess salinities at the seabed near the intake are increased from about +2 ppt for Phase 1 to around +4 ppt with the combined Phase 1+2 discharges. However, the depth-average excess salinities typically remain below +2 ppt.

It can be concluded from the key findings that the modelling demonstrates that average changes in temperature, salinity and residual chlorine from Phase 1 to Phase 2, are moderate. In addition there is little change in recirculation temperature from Phase 1 to 2, whilst excess salinities typically remaining below +2 ppt which is manageable by Operations. The sensitive receptor location also remain protected with the exception of one site (F2) which is close to the coastline (in the sheltered bay near the outfalls).

## 5.4 Biodiversity (Terrestrial)

Historical satellite imagery (Source: Google Earth) shows that a large proportion of the Project site has been used previously as a temporary construction laydown area for the Al Dur IWPP Phase I project and possibly prior to this. As such, the habitats and ecology in this location would have been impacted by removal of vegetation and compaction of the ground. Based on the same satellite imagery, the site however appears to have remained largely unused since mid-2012 which has led to the re-establishment of some vegetation in this modified environment.

The Project site has reduced links to neighbouring habitats due to industrial, infrastructure, residential & military developments locally. This includes the Al Dur IWPP Phase I (to the north), the Arabian Gulf (to the east), local roads and the military airbase (to the south) and the King Hammad Highway (to the west). This limits the availability and access to the Project site (and

immediate connected areas) for ground dwelling fauna as these areas are fenced, or act as barriers to movement.

Due to the factors above the baseline surveys for terrestrial ecology and biodiversity included a combination of Phase I habitats survey, walkover transects and other observations from the Project site in terms of faunal presence and potential.

The surveys identified that the project area consisted of two principal habitat types:

- Coastal sand sheets interspersed with low-lying vegetation sporadic in nature mainly at the western and southern region of the Project.
- Sabkha type soil interspersed with sandy areas and very sparse vegetation.

A number of common flora species were identified to be present within the project site which included *Salsola imbricate*, *Limonium axillare* and *Zygophyllum qatarense* within the sand sheet habitat and algal mats, *Sargassum* and fine plant matter observed along the coastline. Evidence of some fauna species such as reptiles, dog tracks and some burrows were observed.

Construction works will result in the loss of habitat in the Project footprint and the temporary loss of habitat in the temporary construction working areas to the south of the Project. It is proposed that there is habitat restoration of temporary working area following demobilisation. Impacts during construction may also result in the disturbance and direct mortality of fauna due to the removal of all the vegetation and use of heavy plant. Such impacts can potentially be mitigated by implementing good practice construction techniques at the site.

The operational phase is not expected to result in further direct impacts to terrestrial ecology at or around the Project site which will be fenced. No exotic or alien plant species will be used in the landscaping of the site and any unused areas with soil covering will be allowed to restore naturally. The use of herbicides will not be permitted on the project site or laydown areas.

## 5.5 Geology, Soils and Groundwater

The Project site has previously been used as a temporary construction laydown area for the Al Dur IWPP Phase I development and potentially previous to this. As such there is the potential for historic contamination of the soil quality and potentially groundwater quality within the Project's footprint. Although no visual or olfactory signs of contamination were observed from the site walkovers and visits, a precautionary approach has been applied to confirm the quality of soils and groundwater at the project site in terms of sampling and analysis.

Surface soil samples were analysed for pH and heavy metals and compared against a good practice standard; the Dutch Soil Intervention Standards. This showed that the soil quality is compliant with established standards and shows no signs of contamination.

Given the presence of nearby industry within the Project area (with particular reference to the Al Dur IWPP Phase I Project) and the storage of large volumes of fuels, there is a potential source-pathway receptor linkage with underlying groundwater. As a precautionary approach, a groundwater quality survey was conducted at three borehole locations around the Project site to confirm the existing quality of the groundwater. Analysis of the groundwater sample confirmed compliance with Dutch Groundwater Standards for heavy metals.

The construction works has the potential to affect soil and potentially impact groundwater quality prior to mitigation. Such potential impacts may result from spills and leaks of hazardous liquids and materials, inadequate waste & wastewater management, as well as any impacts relating to cross-contamination. Such impacts will be mitigated by the implementation of a robust CESMP in accordance with the provisions set out in the ESIA and the risk of soil or groundwater contamination will be minimal.

During the operational phase, potential risks to soil & groundwater will be managed and mitigated via the design of effective materials and waste storages areas and implementation of an effective Waste Management Plan.

## 5.6 Solid and Liquid Waste Management

Waste materials generated during construction are expected to include aggregate, wood, steel, packaging wastes, and other unused materials. As per the mitigation stated in the ESIA, these will be segregated for re-use or recycling wherever possible. The small quantities of hazardous wastes (such as paint, used oil cans, chemicals and contaminated materials such as oily rags and any affected soils) will be temporarily stored inside impermeable bunded areas in accordance with the mitigation and management measures stated in the ESIA, for collection by licensed waste transporters.

Sanitary wastewater generated during construction will be stored in septic tanks prior to removal by a licensed wastewater contractor. The commissioning phase activities (including hydrotesting, steam cleaning and acid cleaning) will generate other streams of wastewater that may contain heavy metals, oils and greases or have pH imbalance. These will be managed separately according to their wastewater stream. No wastewater or contaminants will be discharged or allowed to drain to the coastal waters.

During operations, there will be relatively small quantities of solid waste arising from planned maintenance works, administration facilities and activities of the employees which are not directly associated with the production processes. Waste segregation for re-use or recycling will be undertaken where practical. Domestic, sanitary, oily and other chemical wastewater will be treated on-site in dedicated treatment plants (with their treated effluents monitored for

quality) prior to mixing with the brine and thermal effluent streams and discharged at the project outfall in compliance with applicable discharge standards.

The ESIA outlines appropriate mitigation and management measures that will be implemented to ensure effective management of waste & wastewater during both construction and operation phases.

## 5.7 Chemicals

The construction and operation phases of the project will include the transportation, handling and storage of chemicals and other hazardous materials/liquids in relatively small quantities. Hazardous materials and chemicals to be utilised during construction will include diesel fuel for generators and mobile equipment, lubricants, paints etc. while oils and lubricant will be required for CCGT components and chemicals for water dosing and treatment for the SWRO components during the operation phase. A small volume of storage of diesel fuel will be stored during operations in the unlikely event that the emergency generators are required.

To minimise the potential for accidental spills and leaks to the environment from chemicals, fuels and other hazardous materials, mitigation has been stated in the ESIA. This includes (but is not limited to) the storage of such substances in designated chemical storage areas with bunded impermeable surfaces to ensure secondary containment in the event of a total leak.

## 5.8 Navigation

Since Al Dur IWPP Phase II project will connect to the existing Al Dur IWPP Phase I intake and outfall facilities no major offshore construction works will be undertaken and the existing marine structures will remain unchanged. In addition, any requirements for survey boats to inspect sub-surface/underwater facilities condition and connection requirements are not expected to disrupt existing navigational routes or ongoing harbour activities and neither will maintenance work or environmental monitoring surveys during operation. All marine movements will be subject to Bahrain Coastguard approval and any required conditions.

## 5.9 Tourism and Recreation

Observations made during site visit and secondary research did not identify tourism and recreational activities in the immediate project footprint. A harbour (where boats are understood to take people to the Hawar Islands) is located to the northeast and will not be directly impacted by the Project. Even though no potential significant impacts have been identified for the construction and operational phases, it is proposed that channels of communications with the local boat owners carrying tourists, expat residents and Bahrainis to

the Hawar Islands should be maintained to address any direct/indirect issues that may arise. This will be outlined in the Stakeholder Engagement Plan (SEP).

## 5.10 Traffic and Access

The proposed Project site can be accessed via the King Hamad Highway which is located approximately 450 m to the west of the Project site. An unnamed paved route currently links the Project to the highway. The construction phase will include the construction of a new four lane (two-way dual carriageway) short access road link from the site to King Hamad Highway.

It is anticipated that the majority of construction materials & equipment will first be shipped to Khalifa bin Salman Port before being transported via road to the project site by trailers. Required heavy equipment such as gas turbines, steam generators and steam turbines will be offloaded to a barge then delivered to a jetty in Askar area of Bahrain before being transported to the project site via road. Such movements will all follow the EPC Contractor's Traffic Management Plan.

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. Impacts related to additional vehicular transportation are not expected to be significant due to the observed existing low traffic flows and the large carrying capacity of the King Hamad Highway.

Transportation impacts during the operational phase of the project are not expected to be significant, as the operation of the CCGT and SWRO will only require a relatively small number of commuting operational staff, and periodic removals/deliveries as part of the operation and maintenance programme.

## 5.11 Socio-Economics

The Project and the wider Al Dur Power and Water complex forms a key part of the Bahrain 2030 National Plan. The Project will therefore be instrumental in providing additional water and power generation capacity which will give rise to various socio-economic benefits. In addition, the Project will provide various positive socio-economic benefits such as direct employment creation, which will further stimulate the local economy via the multiplier effect. 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 skills from expatriate workers into the local labour force.

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. As such, there are no direct impacts relating to any existing land uses and there will also be no economic displacement as the project site is not used formally or informally by the local community. .

## 5.12 Cultural Heritage and Archaeology

Based on the observations made during the site visits and through secondary research, there are no features of cultural value or evidence suggesting the presence of archaeological features within the proposed Project footprint.

However, as the potential for encountering buried archaeological remains or artefacts during excavation and earthworks activities cannot be completely ruled out, the ESIA states that a 'Chance Find Procedure' shall be developed alongside the Construction Environmental & Social Management Plan (CEMP) to address this in the unlikely event of discovering any historical finds.

During the operational phase of the project, there will be no further excavations on the project site so the risk of uncovering or disturbing any further historical finds is considered highly unlikely.

## 5.13 Landscape & Visual Quality

The landscape within the Project site is characterised by a mixture of small residential clusters, commercial & industrial facilities, open spaces (such as the Project site), and major infrastructure. The Arabian Gulf frames the eastern extent of the development and several existing structures are visible offshore, including the harbour wall/causeway.

The proposed Project will be constructed on undeveloped land immediately south of the existing Al Dur IWPP Phase I project. The landscape typology within the Project footprint is characterised by low level undulations of sand (sand sheets) with sparse low-lying vegetation, which gently slopes from the King Hammad Highway eastwards towards the coastline.

Due to the relatively flat nature of the site, grading and levelling activities are not expected to be extensive, or result in major topographical changes to the local area. In addition, the development of the CCGT and SWRO plant within this area designated for power and water complexes in the Bahrain National Plan 2030 is not expected to result in significant changes to the future landscape character, as the new structures to be constructed will not be unprecedented next to the existing industrial facilities in close proximity to the site. Differences at night-time may be discernible where lighting is required for Project operations, however, mitigation measures have been included in the ESIA to limit these effects.

## 5.14 Health and Safety

An Occupational Health and Safety (OHS) management system will be prepared at the start of the construction phase by the EPC Contractor to address the H&S risks that occur on a construction site. These will include physical risks such as traffic on site, working at height, movement of heavy machinery, excavations, scaffolding etc. other risks may include handling of fuels, chemicals, paints and solvents, noise and emissions from machinery and generators etc.

Health and safety risks to the site workforce will be managed effectively through specific risk assessments, development of appropriate method statements and procedures, emergency and disaster planning and the communication of specific health and safety planning requirements and training sessions. The project will also implement a grievance mechanism which will be clearly defined, transparent and accessible to the identified stakeholders.

An OHS management system will also be prepared at the start of the operation phase by the O&M Company to address relevant H&S issues for workers during the routine management, maintenance and possible emergency scenarios that could arise on the Project site.

# 6 ENVIRONMENTAL & SOCIAL MANAGEMENT & MONITORING

Volume 3 of the ESIA provides a framework for the development of the Environmental and Social Management System (ESMS) for the construction and operational phases of the project. The framework has been developed to ensure that all Environmental & Social impacts identified for both construction and operational phases are appropriately identified and controlled through the development of a robust construction and operational phase ESMS and associated Management Plans.

Both the construction and operational phase of ESMS will need to incorporate mitigation and monitoring requirements established within Volume 2 of the ESIA as well as requirements set out by SCE and the Lenders.

The primary documents guiding the environmental and social management of the construction and operational phases will be the Construction Environmental and Social Management Plan (CESMP) and Operational Environmental & Social Management Plan (OESMP) respectively.



## 7 CUMULATIVE IMPACTS

The assessment of cumulative impacts with reference to this Project relate to cumulative impacts upon specific receptors as a result of the proposed project and existing impacts from other local facilities. This is also based upon the feedback received from the consultation process with a wide range of stakeholders and will be updated should there be any additional feedback or concerns that have not already been addressed. As a result, the ESIA has assessed cumulative impacts of several environmental and social parameters in Volume 2, which includes air quality, noise impacts and operational marine discharges (in combination with the existing discharges from AL Dur IWPP Phase I). These have all considered the measured baseline conditions in combination with the predicted process impacts of the Project.

At this stage, there is no confirmation on other 'committed' development in the local project area.