Alba Port Capacity Upgrade Project
Environmental and Social Impact Assessment

Aluminium Bahrain
July 2018

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Rev 01

Environment Arabia

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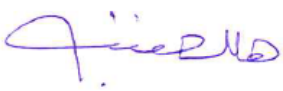
Initials/Date		3.7.18

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AAMR	Agricultural Affairs and Marine Resources
AEWRD	Agricultural, Engineering and Water Resources Directorate
Alba	Aluminium Bahrain
AOI	Area of Influence
APHA	American Public Health Association
ASRY	Arab Shipbuilding and Repair Yard
BACA	Bahrain Authority for Culture and Antiquities
Banagas	Bahrain National Gas
Bapco	Bahrain Petroleum Company
BDF	Bahrain Defence Force
BMP	Bapco Modernization Programme
CCC	Criterion Continuous Concentration
CCME	Canadian Council of the Ministers of the Environment
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CEO	Chief Executive Officer
CESMP	Construction Environmental and Social Management Plan
CLA	Construction Laydown Area
CMC	Criteria Maximum Concentration
CO	Carbon Monoxide
CoC	Chain of Custody
COP	Codes of Practice
CPC	Calcined Petroleum Coke
CPO	Central Planning Office
CSM	Conceptual Site Model
DDV	Drop Down Video
EACS	Environment Arabia Consultancy Services
EBRD	European Bank for Reconstruction and Development
ECA	Export Credit Agency
EER	Environmental Evaluation Report
EHS	Environment, Health and Safety
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPC	Engineering, Procurement and Construction
ESIA	Environmental and Social Impact Assessment
ESLR	East Sitra Link Road
ESMS	Environmental and Social Management System
ESSR	Environmental and Social Scoping Report
EQO	Environmental Quality Objectives
EWA	Electricity and Water Authority
GIS	Geographical Information System
GIIP	Good International Industry Practice
GPC	Green Petroleum Coke
GPIC	Gulf Petroleum Industries Company
GPS	Geographical Positioning System
H&S	Health and Safety
HGVs	Heavy Goods Vehicles
HSE	Health, Safety and Environment

IFC	International Finance Corporation
IMO	International Maritime Organisation
ISO	International Organisation for Standardization
ISQG	Interim Sediment Quality Guidelines
IUCN	International Union for Conservation of Nature
IV	Intervention Value
KSA	Kingdom of Saudi Arabia
LCS	Laboratory Control Samples
LOR	Limits of Reporting
LP	Liquid Pitch
MBGL	Metres Below Ground Level
MICT	Ministry of Industry and Commerce
MNMP	Marine Noise Management Plan
MPA	Marine Protected Area
MSDS	Material Safety Data Sheet
MTT	Ministry of Transport and Telecommunications
NAGD	National Assessment Guidelines for Dredging
NDLU	National Detailed Land Use
NEPM	National Environment Protection Measures
NOGA	National Oil and Gas Authority
NO_2	Nitrogen Dioxide
NOx	Nitrogen Oxides
OECD	Organisation for Economic Cooperation and Development
OESMP	Operation Environmental and Social Management Plan
OHSAS	Occupational Health and Safety Assessment Series
OSHA	Occupational Safety & Health Administration
PEL	Probable Effect Levels
PM_{10}	Airborne particulate matter less than 10 micrometres in aerodynamic diameter
PMA	Ports and Maritime Affairs
PPE	Personal Protective Equipment
PS	Performance Standard
PSA	Particle Size Analysis
PTS	Permanent Threshold Shifts
QA/QC	Quality Assurance/Quality Control
RCD	Reverse Circulation Drilling
RPDD	Roads, Planning and Design Directorate
RPMD	Roads Projects and Maintenance Directorate
SBL	Sea Bed Level
SCE	Supreme Council for Environment
SEL	Sound Exposure Level
SEP	Stakeholder Engagement Plan
SEPPD	Sanitary Engineering Planning and Projects Directorate
SHE	Safety, Health and Environment
SO_2	Sulphur Dioxide
SOPEP	Ship Oil Pollution Emergency Plan
SPL	Sound Pressure Level
STD	Sexually Transmitted Disease
TEL	Threshold Effect Levels

TMP	Traffic Management Plan
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TRP	Tactical Response Plan
TSS	Total Suspended Solids
TTS	Temporary Threshold Shifts
TV	Target Value
UPDA	Urban Planning Development Authority
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds
WBG	World Bank Guidelines
WHO	World Health Organisation
WMP	Waste Management Plan
WQO	Water Quality Objective

1 INTRODUCTION

1.1 Background

Environment Arabia Consultancy Services WLL (EACS) has been appointed by Aluminium Bahrain (Alba) to undertake an Environmental and Social Impact Assessment (ESIA) for its Port Capacity Upgrade Project. The upgrade is required to accommodate for the delivery of an increased amount of alumina and calcined petroleum coke which is needed for Alba's Potline 6 Expansion Project.

This document constitutes the ESIA Report. It follows the Environmental Screening (EA-2 Form) and ESIA Scoping Reports submitted to the Supreme Council for Environment (SCE) in January and March 2018 respectively. This study presents the environmental baseline conditions of the project area and identifies potential impacts of the project on the surrounding environment during both the construction and operation phases.

1.2 Scope of ESIA

Alba invited bids for the Engineering, Procurement and Construction (EPC) of the Port Upgrade and a preferred contractor was selected in April 2018. This ESIA has been prepared based on the preferred contractor's design and construction proposals for the port upgrade.

The ESIA has taken into consideration the construction (including commissioning), operation and demolition phases of the project.

1.3 Statement of Need

The aluminium smelter began operations in 1971 and has since been periodically upgraded and expanded with new units. Construction is currently ongoing for a new potline (Potline 6) and a power station (Power Station 5) together with required ancillary facilities. As a result of this current expansion, Alba need to increase the import of raw materials via the existing port, therefore, the port needs to be upgraded and expanded.

1.4 Consideration of the 'Do-Nothing' Option

Alba is one of the largest industrial companies in the Middle East and is one of the top producers of aluminium in the world. The current Alba smelter consists of five potlines supported by four onsite power stations which produced close to 1 million metric tonnes of aluminium in 2016. Line 6 Expansion Project will bring Alba's production, upon its completion in 2019, to around 1.5 million tonnes of aluminium per year.

The smelter is an important contributor to modern Bahrain, with over 2,500 employees of which over 80% are Bahraini. Employees undergo specific job-related training and development. The Line 6 Expansion Project will create an additional 500 jobs once constructed.

If the Port Upgrade does not go ahead, insufficient raw materials will be imported for the operation of the six potlines, which will have a major adverse impact on the profitability and competitiveness of the smelter. The Port Capacity Upgrade Project is essential to support the smelter expansion.

1.5 Engineering Team

The Port Upgrade will be constructed by FATA in cooperation with Reel Alesa and KHome International. FATA will act as the Engineering, Procurement and Construction (EPC) Contractor, Reel Alesa is the subcontractor for the materials handling solution and equipment and KHome International is the subcontractor for some of the detailed engineering works. The split of works can be summarised in broad terms as follows:

- FATA
  - Liaison with Alba
  - Overall project and site management;
  - Overall project HSE and QA/QC management;
  - Coordination of engineering works;
  - Detailed marine engineering works;
  - Supply of plant;
  - Construction works;
  - Mechanical and electrical work;
  - Commissioning.

- Reel Alesa
  - Definition of technical solution to be adopted;
  - Design and supply of material handling equipment, switchgear and computer control systems;
  - Supervision for erection;
  - Commissioning.

- KHome
  - Engineering works;
  - Participation in safety review meetings.

There will also be numerous other sub-contractors employed on the project, both international and local. Local companies will be utilised where possible for their experience of local conditions.

1.6 ESIA Consultants

1.6.1 Environment Arabia Consultancy Services

Environment Arabia was the first environmental consultancy in Bahrain to be registered with the SCE as an approved environmental consultant. In the seventeen years since the company was formed, Environment Arabia has gained extensive experience in the appraisal and assessment of development in Bahrain and the Middle East, most notably in the field of ESIA. To date, Environment Arabia has produced ESIAs for a significant number of Bahrain's commercial, residential and industrial developments. EACS is registered as a Category A Consultant under Ministerial Order No. 4 of 2014 with Respect to the Certification and Regulation of the Work of Environment Consultancy Offices in the Kingdom of Bahrain. Category A consultants are permitted to undertake all types of environmental studies.

The team of specialists from EACS is presented in **Table 1.1**.

Table 1.1 EACS's ESIA Project Team

Name	Role Within Project
Halel Engineer	Project Director: ESIA and Local Specialist
Kate Elsworth	Project Manager: ESIA Specialist
Andy Booth	Technical Director: Contaminated Land, Waste and Soil & Groundwater Specialist
Michael Arora	Technical Director: Marine Ecology, Water Quality, Sediment Quality
Sarah Ben Arfa	Senior Marine Consultant: Marine Ecology, Water Quality, Sediment Quality
Christopher Nacional	GIS/Mapping Specialist

1.6.2 Subconsultants

EACS will be supported by the following external specialists.

Royal HaskoningDHV UK

Royal HaskoningDHV will undertake the air quality impact assessment for the project. They are an independent, international engineering and project management consultancy with over 130 years of experience. The UK air quality team sits in a 100-strong Environment & Infrastructure Consenting service business unit which has been an active forerunner in pre- and post- application environmental support across a number of industries. There is a well-established and historical relationship between HaskoningDHV and Environment Arabia and several projects have been undertaken in partnership in the past: air quality modelling and impact assessment services were provided for a number of EIA projects in Bahrain, and elsewhere in the Middle East such as the Khuff Gas Development Program EIA, Bapco Refinery Gas Desulphurization Project EIA and the Lube Base Oil Project.

1.7 ESIA Report Structure

Reporting of the ESIA comprises four main documents:

i. Environmental and Social Impact Assessment Report (this report);
ii. Construction Environmental and Social Management Plan (CESMP);
iii. Operation Environmental and Social Management Plan (OESMP);
iv. Non Technical Summary (in Arabic and English).

This report, the ESIA contains the following sections:

1. Introduction
2. Project Description
3. ESIA Methodology
4. Policy and Planning Context
5. Stakeholder Engagement
6. Air Quality
7. Community Health, Safety and Security
8. Geology and Hydrogeology
9. Labour and Working Conditions

10. Marine Ecology
11. Marine Sediment and Water Quality
12. Occupational Health and Safety
13. Traffic and Access
14. Waste Management

Relevant legislation and guidance is contained in the Project Standards document which has been included as **Appendix 1A**.

2 PROJECT DESCRIPTION

2.1 Introduction

This section provides information on Alba's existing marine facilities and describes the proposals for the upgrade.

The Alba Calciner Plant and Port are located at what is locally known as the 'Sitra Marine Terminal' (**Figure 2.1**). The Marine Terminal is shared between Alba, Gulf Petrochemical Industries Company (GPIC), Bahrain National Gas (Banagas), National Oil and Gas Authority (NOGA) and the Bahrain Petroleum Company (Bapco). Alba's facilities comprise two jetties with ship unloading equipment, conveyors, storage, road vehicle loading silos, water treatment plant, offices and a calciner for processing 'green' petroleum (pet) coke (GPC). GPC is unprocessed coke. It is processed by calcining to remove residual volatile hydrocarbons and moisture.

2.2 Existing Infrastructure

2.2.1 Jetty 1

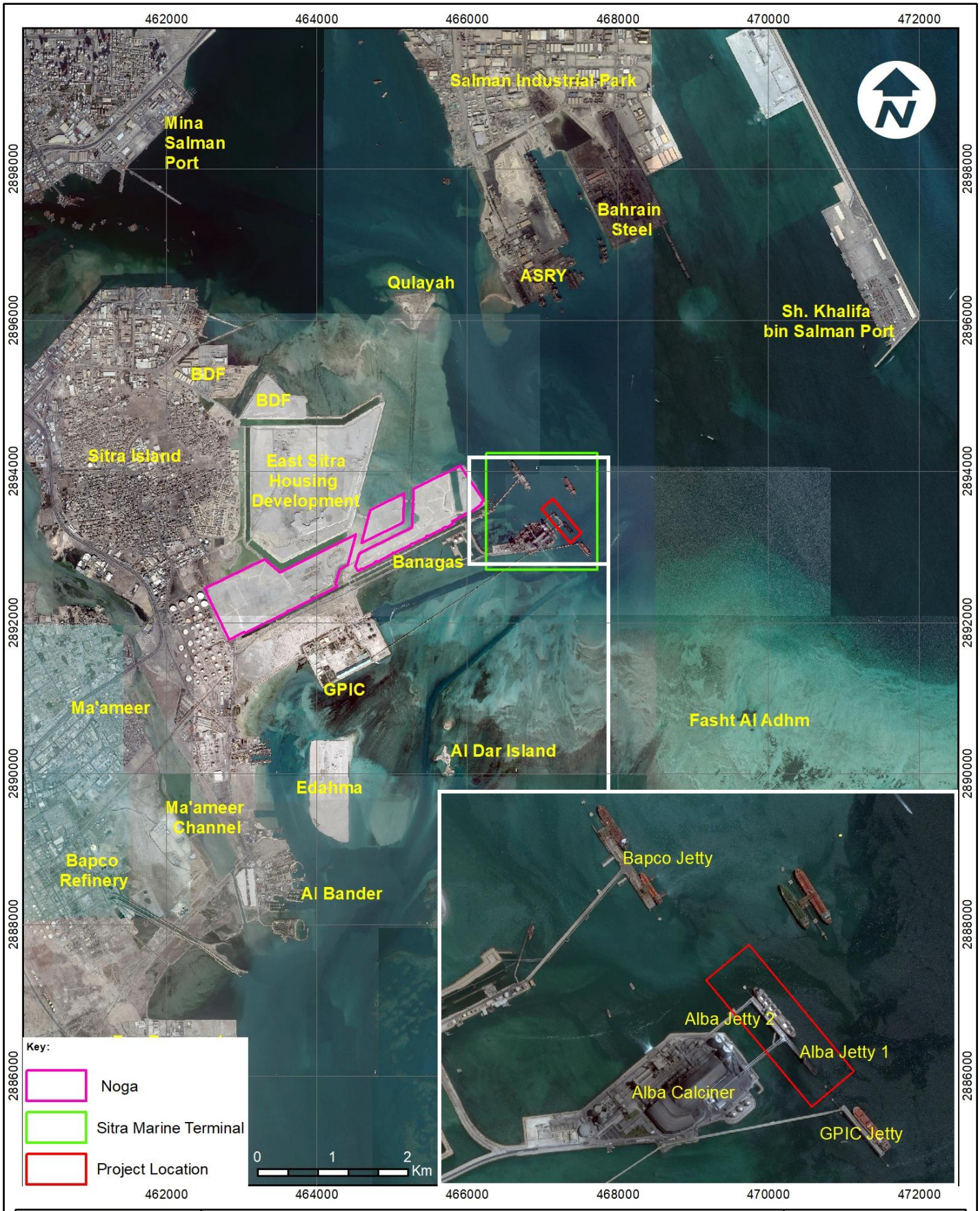
Jetty 1 was constructed in 1971 and is used for offloading green pet coke (GPC) and liquid pitch. This jetty is the southernmost jetty extending towards GPIC. The pet coke is unloaded by means of a grab unloader and the liquid pitch by means of a pump. From the ship, the coke is lifted into a hopper which feeds a conveyor which takes the coke to storage warehouses. Different types of coke are imported and these are blended in silos before proceeding to the calciner plant. The liquid pitch is conveyed via a pipeline to storage silos and then is taken to the Alba smelter in road tankers without any treatment.

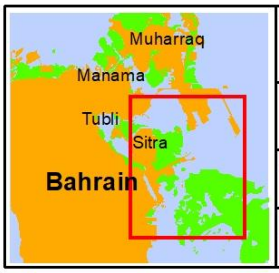
The grab on the unloader is open at the top and small quantities of coke dust escape during lifting. The conveyor alongside the jetty is open air, but across the water to the storage silos it is covered, although there are open ventilation holes. **Figure 2.2** provides some pictures of the jetty and the unloader.

2.2.2 Jetty 2

Jetty 2 was constructed in 1995 and is used for offloading alumina and exporting calcined petroleum coke. This jetty is the northernmost jetty extending towards Bapco. It is fitted with a dual-purpose vacuum unloader. The alumina is transferred to two silos via a pipeline. It is taken by road tanker to the smelter without any processing. **Figure 2.3** provides a photo of the vacuum unloader on Jetty 2.

During offloading, minor spillages of alumina occur onto the jetty. Alba employs a suction truck to suck up any spilt alumina.





Title: **Project Location**		Client:
Project: Alba Port Capacity Upgrade Project		
Date: January 2018	Figure No.: 2.1	Consultant: Environment Arabia
Datum: WGS 84 - UTM 39N	Scale: 1:65,000 (A4)	

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Figure 2.2 Aerial Images of Existing Port

Aerial shot looking westwards of vacuum unloader on Jetty 2

Aerial shot of calciner plant showing Jetties 1 & 2 in top left hand section of photo. Jetty on the right hand side of image belongs to GPIC.

Figure 2.3 Jetty 1

The top picture shows the length of Jetty 1 with a ship berthed. The bottom picture shows the grab in operation offloading petroleum coke. (The jetty in the distance belongs to GPIC).

2.3 Proposed Infrastructure

2.3.1 Overview

The information provided in this chapter is based on the technical documentation provided by the EPC Contractor FATA, Document No. R5707, Rev 0, 15.3.18.

The Line 6 Expansion Project requires an upgrade of Alba's marine facilities at the Sitra Marine Terminal to cope with the increased demand for raw materials. The upgrade needs to include the installation of a new ship unloader for alumina, additional facilities for offloading of calcined petroleum coke (CPC) (which is not currently possible) and new storage silos for alumina and CPC.

Figure 2.4 Existing Vacuum Unloader on Jetty 2

Under the preferred solution Jetty 2 will be extended towards the existing dolphin by 37.5m and a new ship unloader will be placed on the extension. This means that two ship unloaders will offload alumina simultaneously, thus reducing unloading time from approximately 6 days to 2-3 days. Jetty 1 will be extended by 65 m and will be dedicated to GPC, CPC and liquid pitch. New storage silos and conveyors will also be provided.

The design will conform to the requirements of the International Organization for Standardization, European Federation of Materials Handling, British Standards and International Electrotechnical Commission standards.

2.3.2 General Jetty Arrangement

Jetty 2 will be extended by 37.5 m to the north incorporating the existing dolphin (**Figure 2.5**). The extension will be 'L'-shaped to maintain the existing dolphin allowing normal operation and mooring of the vessels while the jetty extension works are taking place. This extension will allow the berthing of a 60,000 tonne ship on Jetty 2 and a 40,000 tonne ship on Jetty 1. Alba plans to extend Jetty 1 by 65 m once Jetty 2 has been completed to allow for 2 no. 60,000 tonne ships to dock. The arrangement will allow a minimum distance of 30m to be maintained between the vessels. A plan for the jetty extensions is provided in **Figure 2.6**.

Figure 2.5 Jetty 2 Extension

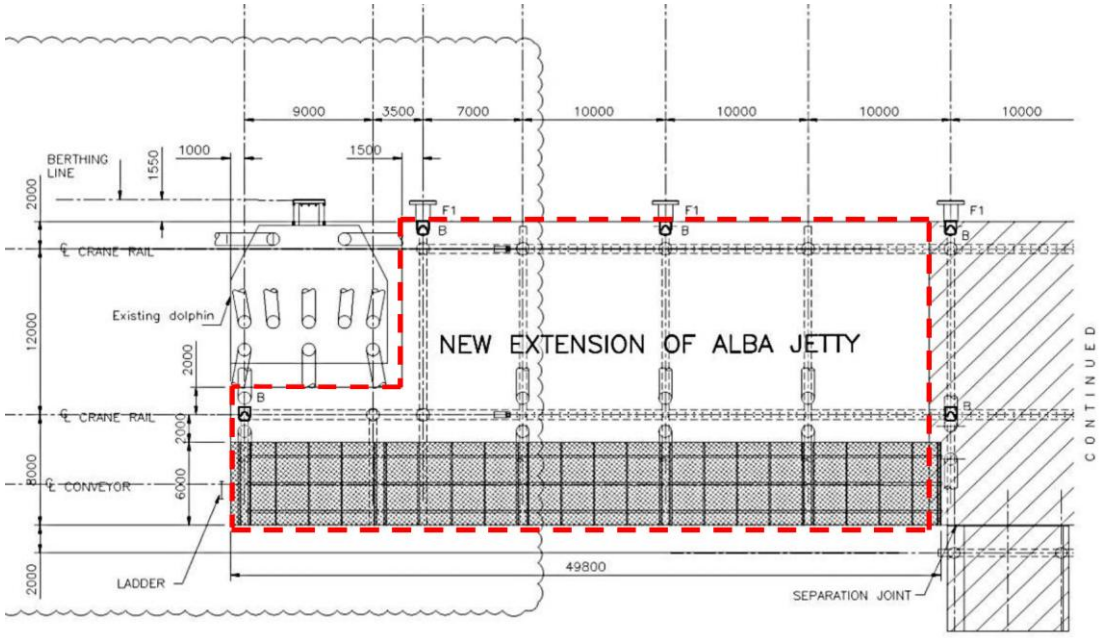


Figure 2.6 Area for Jetty Extensions

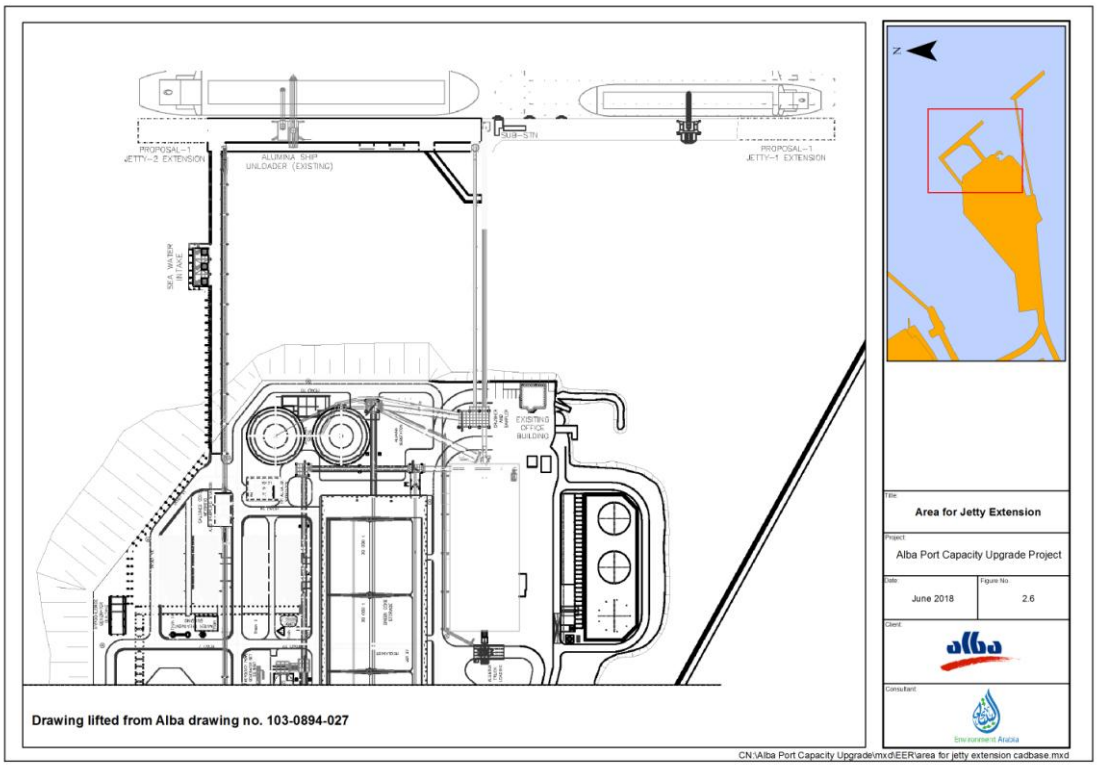


Figure 2.6A Location of Jetty Extension

2.3.3 Dual Purpose Vacuum Ship Unloader

The new ship unloader will be positioned on Jetty 2. It will consist of specialised equipment designed to unload alumina from Panamax vessels (up to 60,000 T capacity) and Calcined Petroleum Code (CPC) from a typical 30,000 T vessel.

It will be operated 24 hours a day and will be equipped to carry out the following:

- Unloading of alumina at a rate of 1,000 T/hr (free digging[1]), and an average of 15,000 T/day;
- Unloading of CPC at a rate of 650 T/hr and an average of 9,000 T/day.

The unloader will be designed to be mobile and will work simultaneously with the existing unloader. The ship will stay in one place and the unloaders will be moved from hold to hold.

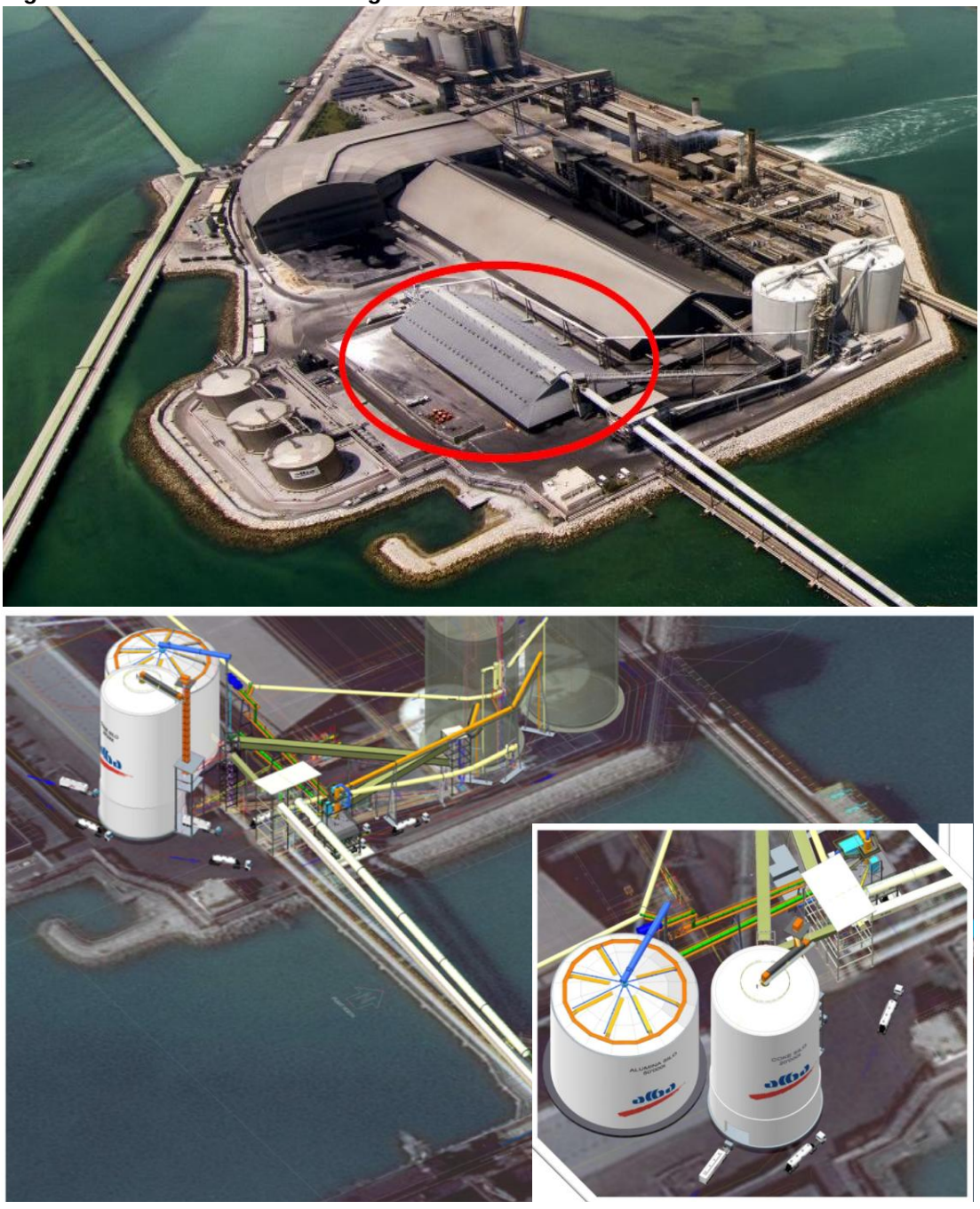
2.3.4 Storage Silo Location

A new 50,000 tonne alumina silo and a new 20,000 tonne calcined coke silo will be constructed within the footprint of the existing storage shed (**Figures 2.7 & 2.8**). This shed will be demolished.

Figure 2.7 Existing Coke Storage Shed

[1] Unloading rate which can be sustained for reasonable (defined) time interval, when digging from a specified point in the ship.

Figure 2.8 Location of Storage Silos



2.3.5 Alumina Import

Alumina will be unloaded from 60,000 tonne ships with two vacuum ship unloaders both at a nominal capacity of 1,000 tph. The existing alumina conveyor will be upgraded from 1,000 tph to 2,000 tph by increasing the width of the belt from 1.4m to 1.6m and inclining the idlers to 45^{o}. In addition, the existing transfer wagon, the dust collector at the transfer point between the existing jetty conveyor and existing import conveyor, and the dust collector in the existing crushing tower will be replaced to be suitable for the higher capacity.

New fully enclosed, box-type air gravity conveyors will be constructed to link the existing system to the new storage silos. These are air tight and water tight. From the conveyor, the alumina will be fed into a receiver by an air lift located on the ground level. The air lift will have two associated blowers: one duty and one standby and these will be located at the bottom of the silo.

From the air lift, the alumina will flow through an anti-segregation silo feeding system into the silo. The receiver and the conveyor will be de-dusted by one bag type dust collector located next to the silo at ground level. The dust will be fed back into the main material flow.

The alumina will be discharged from the silo via a reclaim system which will consist of an anti-segregation and blending system, reclaim air gravity conveyor and a discharge airlift. The reclaim system will have two associated blowers located in the basement of the silo. The new reclaimed air gravity conveyor will be tied-in with the existing air gravity conveyor which conveys the alumina to the existing truck loading station. This reclaim system will also be de-dusted by the bag type dust collector mentioned above.

There will also be the ability to off-load alumina into tankers via a loading station underneath the silo. This will be fitted with dust filters.

2.3.6 CPC Import

CPC will be unloaded by the existing grab unloader on Jetty 1 into a new mobile hopper. Dust emissions will be minimised through the introduction of the following:

- The inlet of the hopper will be fitted with a special grid;
- Rubber curtains will be installed which move to allow material in, then go back in place to prevent dust escaping; and
- A series of dust collectors will be installed on top of the hopper around the inlet opening to keep a pressure difference between the lower and the upper part of the hopper to prevent dust escaping.

The CPC will be conveyed at a capacity of 650 tph on the existing belt conveyor towards the new CPC silo. A new section of conveyor will be constructed to link the existing system to the new silo. The dust collection system along the existing conveyors will be upgraded and new dust collectors will be installed.

A bucket elevator located on a supporting structure will lift the CPC up to the silo roof where it will be discharged onto a roof belt conveyor. From this roof belt conveyor, the CPC will be discharged into the silo via an anti-segregation pot installed inside the silo roof. A dedicated dust collector located on the silo roof will de-dust the bucket elevator, belt conveyor and the transfer point of CPC into the silo.

The silo is equipped with 8 silo discharge cones. From these cones, the material is extracted by means of a vibratory conveyor. The vibratory conveyors from two cones together will feed into one truck loading spout and each spout is fitted with its own dust collector.

2.4 Upgrade of Existing Grab and Conveyor on Jetty 1

As part of the project, the existing grab which offloads GPC on Jetty 1 and the associated conveyor will be upgraded in order to minimise the potential for the fugitive release of dust emissions during ship offloading.

2.5 Construction Methodologies

2.5.1 Demolition Works for GPC Shed

At this stage in the design, a detailed method statement for the removal of the shed is not available, but before any demolition works are undertaken, the shed will be completely emptied and cleaned using water. The water will be allowed to evaporate *in-situ* and the remaining dust will be collected and disposed of.

The works are planned to progress with sequences of partial dismantling so that the potential for dust generation is further minimised.

2.5.2 Construction Methodology for Storage Silos

The overall works for the construction of the storage silos consists of the following main activities: earthworks, piling, silo foundations and bases, silo roof and wall assembly. The piling of both silos will be undertaken at the same time. Bored piles will be excavated to the rock bed. On the basis of the geotechnical survey undertaken for the project, the piles are expected to be 22-23 m deep (from surface level).

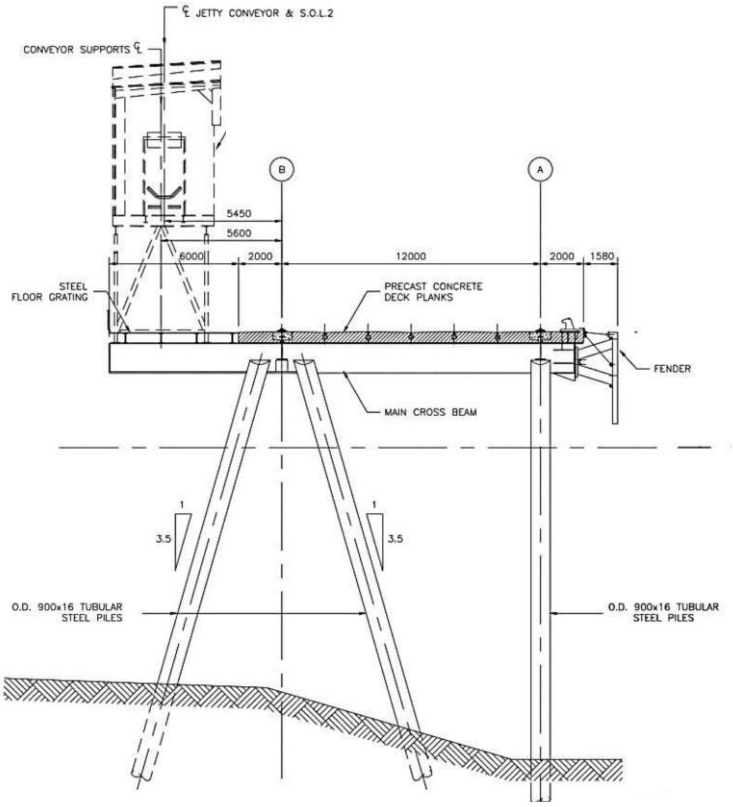
Excavation will be carried out by excavators. Deep excavation will be required for the airlift pit adjacent to the silo and so dewatering will be required. Where possible, maximum use will be made of excavated material in back fill operations for the silo base and pit wall.

2.5.3 Construction Methodology for Jetties

The extension to Jetty 1 will be undertaken after the construction of the storage silos & conveyors, and the extension of Jetty 2. A detailed method statement for the extension of Jetty 1 is not available at this stage of construction, although the methodology for piling will be the same. The jetty will be extended up to the existing dolphin and Alba will share GPIC's dolphin.

Before commencement of the jetty 2 extension, it will be necessary to dismantle the existing dolphin and walkway. The dolphin will be re-constructed to allow ships to be moored in the same location as currently. The new extension to Jetty 2 will realised by driven piles arranged on equidistant alignments of 10 m (with the exception of the last section towards the dolphin); for each alignment there will be a prefabricated steel beam that will stand on 3 piles (**Figure 2.9**).

Figure 2.9 Pile Arrangement



The piles will be driven in-situ and will be steel casing with an outside diameter of 900mm, filled with concrete with reinforcing caging in the bottom section of the pile. Several prefabricated concrete slabs will be placed on the transversal steel beams to form a contiguous floor between the existing jetty and the extension, for a length of 37.5m and a width of 16m.

The transversal beams will be connected by 2 longitudinal beams for the full length of the jetty and crane rails will be mounted on the longitudinal beam tops.

The floor under the conveyor will be a continuation of the existing Jetty 2; it will consist of grid panels resting on steel beams for a length of approximately 40 m and a width of 4 m.

2.6 Commissioning Activities

There will be very little commissioning activities associated with the Port Upgrade because the supplier of the ship unloader will deliver it fully assembled and pre-commissioned. There may be some limited mechanical and electrical testing of the new ship unloader and associated conveyors and silos. Water will not be used in the commissioning phase.

2.7 Decommissioning Activities

At the end of their useful life, the jetties will either need to be repaired/replaced or decommissioned. The activities associated with the decommissioning will be similar to the construction activities and will lead to similar impacts, e.g. release of suspended sediments into the water column, generation of airborne dust particles. There is also the

potential for component parts to fall into the marine environment during dismantling. A methodology should be derived which reduces the potential for material to be lost to the marine environment, and measures should be taken to inspect the seabed following decommissioning, and any fallen material removed.

The management measures that will be required during decommissioning are the same as described in Chapters 10 and 11 of this ESIA relating to marine ecology, & sediment and water quality. An Environmental Management Plan will be needed for any decommissioning activities.

2.8 Construction Programme

It is proposed to construct the upgrade in three phases:

- Phase 1 would involve:
  - Upgrading alumina belt conveyors from 1,000 tph to 2,000 tph;
  - Demolition of GPC shed;
  - Construction of alumina and CPC storage silos with feed and discharge systems;
  - Upgrading of existing green coke belt conveyors for CPC import;
  - Installation of new materials handling facilities for alumina;
  - Installation of mobile hopper for CPC on Jetty 1;
  - Installation of new ship unloader on Jetty 2;

- Phase 2 would involve the extension of Jetty 2 by 37.5 m.
- Phase 3 would involve the extension of Jetty 1 by 65 m.

Phase 1 is expected to take a period of approximately 19 months to complete. This includes 5 months for demolition, 8 months for piling activities, 6 months for the alumina silo, 10 months for the CPC silo, and one month for commissioning activities.

Phase 2 (the jetty extension) will take approximately 19 months. The programme for Phase 3 is unknown at this stage.

2.9 Traffic Movements

The traffic generated by the construction works will be mainly related to the transportation of material to and from Alba Port. Some materials will be sourced from the local marketplace, but some will be imported via Khalifa Bin Salman Port. Once the detailed design has been finalised, traffic movements will be known and a Construction Traffic Management Plan will be prepared.

Traffic movements for operation are contained in **Chapter 14**.

2.10 Shipping Schedules

In 2017 the number of ships berthing at the Alba jetties totalled 69 which included vessels for alumina, GPC, liquid pitch and CPC. The breakdown per month for each material is provided in **Table 2.1**.

In the future, once the jetties have been upgraded, an additional 38 ships are expected: 19 for alumina import and 4 for calcined coke import on Jetty 2; 10 for GPC import and 9 for liquid pitch import on Jetty 1. **Table 2.2** provides a summary.

The predicted occupancy rate for Jetty 1 in the future scenario is 64.7%, and for Jetty 2 it is 62.5%. This is illustrated in **Tables 2.3 & 2.4** based on a typical year.

Table 2.1 Number of Vessels Berthed in 2017

Material	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Alumina	3	3	3	2	3	2	2	3	2	3	3	2	**31**
GPC	2	1	2	1	1	2	1	2	3	1	2	2	**20**
LP	1	0	2	1	1	1	2	0	1	1	1	1	**12**
CPC	2	0	1	1	0	0	0	1	0	0	0	1	**6**

Table 2.2 Summary of Future Shipping Movements

Material	No. of Ships 2017	No. of Additional Ships Required	Ship Capacity	Total Ships (following upgrade)
Alumina	31	19	60,000	**50**
GPC	20	10	30,000	**30**
Liquid Pitch	12	5	10,000	**14**
CPC Export	6	0	30,000	**1***
CPC Import	0	4	30,000	**4**
Notes: * the number of ships required for CPC export will go down in the future.				

Table 2.3 Jetty 1: GPC and Liquid Pitch Vessel Occupancy after Upgrade

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9	9	9
10	10	10	10	10	10	10	10	10	10	10	10
11	11	11	12	11	11	11	11	11	11	11	11
12	12	12	12	12	12	12	12	12	12	12	12
13	13	13	13	13	13	13	13	13	13	13	13
14	14	14	14	14	14	14	14	14	14	14	14
15	15	15	15	15	15	15	15	15	15	15	15
16	16	16	16	16	16	16	16	16	16	16	16
17	17	17	17	17	17	17	17	17	17	17	17
18	18	18	18	18	18	18	18	18	18	18	18
19	19	19	19	19	19	19	19	19	19	19	19
20	20	20	20	20	20	20	20	20	20	20	20
21	21	21	21	21	21	21	21	21	21	21	21
22	22	22	22	22	22	22	22	22	22	22	22
23	23	23	23	23	23	23	23	23	23	23	23
24	24	24	24	24	24	24	24	24	24	24	24
25	25	25	25	25	25	25	25	25	25	25	25
26	26	26	26	26	26	26	26	26	26	26	26
27	27	27	27	27	27	27	27	27	27	27	27
28	28	28	28	28	28	28	28	28	28	28	28
29		29	29	29	29	29	29	29	29	29	29
30		30	30	30	30	30	30	30	30	30	30
31		31		31		31	31		31		31

Table 2.4 Jetty 2: Alumina and CPC Vessel Occupancy After Upgrade

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9	9	9
10	10	10	10	10	10	10	10	10	10	10	10
11	11	11	12	11	11	11	11	11	11	11	11

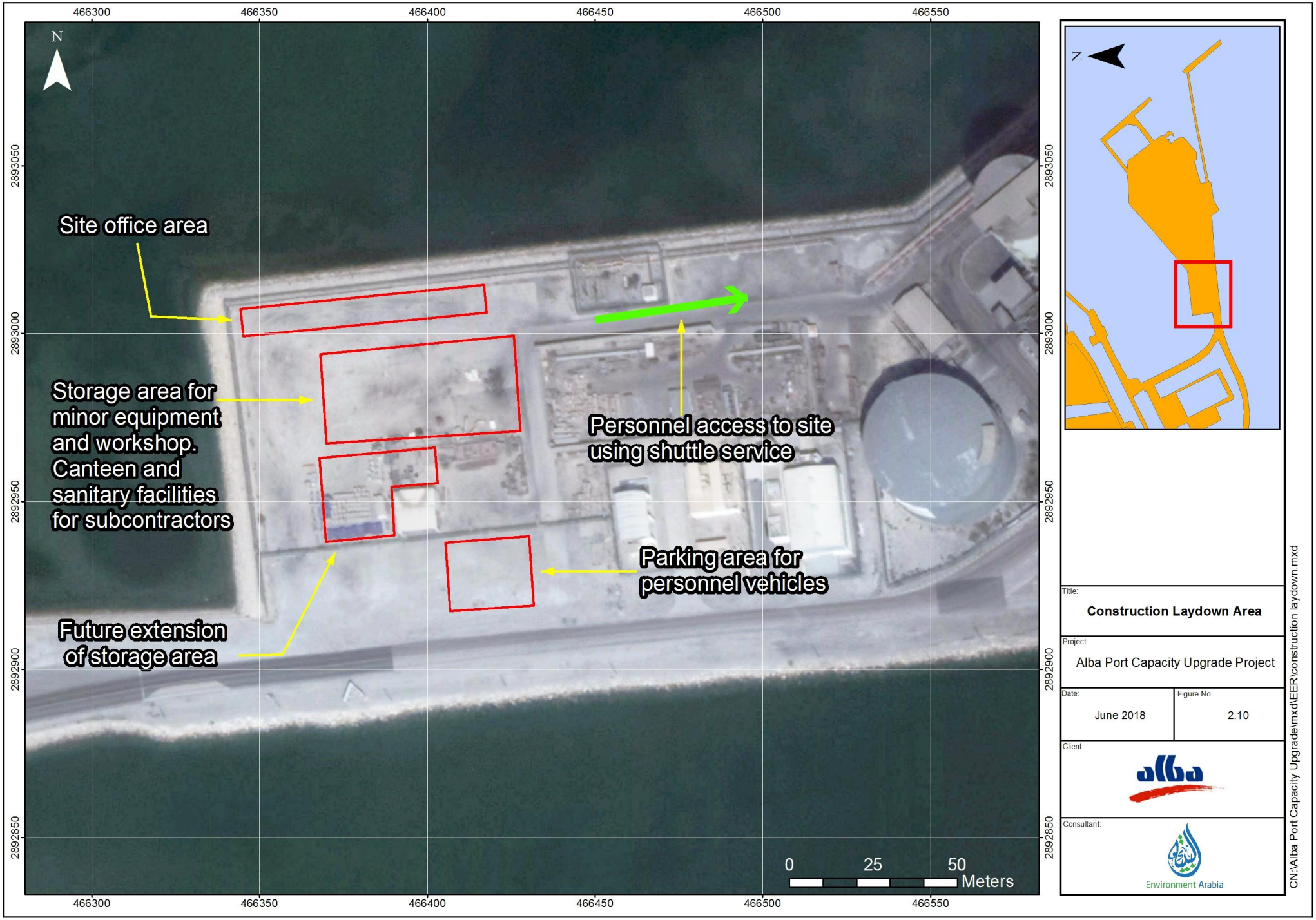
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
12	12	12	12	12	12	12	12	12	12	12	12
13	13	13	13	13	13	13	13	13	13	13	13
14	14	14	14	14	14	14	14	14	14	14	14
15	15	15	15	15	15	15	15	15	15	15	15
16	16	16	16	16	16	16	16	16	16	16	16
17	17	17	17	17	17	17	17	17	17	17	17
18	18	18	18	18	18	18	18	18	18	18	18
19	19	19	19	19	19	19	19	19	19	19	19
20	20	20	20	20	20	20	20	20	20	20	20
21	21	21	21	21	21	21	21	21	21	21	21
22	22	22	22	22	22	22	22	22	22	22	22
23	23	23	23	23	23	23	23	23	23	23	23
24	24	24	24	24	24	24	24	24	24	24	24
25	25	25	25	25	25	25	25	25	25	25	25
26	26	26	26	26	26	26	26	26	26	26	26
27	27	27	27	27	27	27	27	27	27	27	27
28	28	28	28	28	28	28	28	28	28	28	28
29		29	29	29	29	29	29	29	29	29	29
30		30	30	30	30	30	30	30	30	30	30
31		31		31		31	31		31		31

Key:

	GPC
	Liquid Pitch
	Alumina
	CPC Import

2.11 Construction Laydown Area

The Construction Laydown Area (CLA) will be located on vacant land within Alba's marine terminal (**Figure 2.9**), and there will be smaller storage sites located adjacent to the worksites. The CLA will be used for the storage of materials, some pre-assembly works and storage of waste.


466300
466350
466400
466450
466500
466550
N
2893050
2893000
2892950
2892900
2892850
Site office area
Storage area for minor equipment and workshop. Canteen and sanitary facilities for subcontractors
Future extension of storage area
Personnel access to site using shuttle service
Parking area for personnel vehicles
0
25
50
Meters
N
Title:
Construction Laydown Area
Project:
Alba Port Capacity Upgrade Project
Date:
June 2018
Figure No.
2.10
Client:
Consultant:
Environment Arabia
CN:\Alba Port Capacity Upgrade\mxd\EER\construction laydown.mxd

2.12 Staff Requirements for Construction

In relation to the Line 6 Expansion Project, labour requirements for the Port Upgrade are small. Staffing requirements have been calculated on the basis of a six day working week at 8 hours a day and are shown in **Figure 2.11** and **Table 2.5**. Staff numbers have been provided for EPC management and EPC site staff, and the workforce. The maximum number of personnel expected on site is 254 which is predicted to occur in month 12 of the construction programme.

Figure 2.11 Staffing Requirements

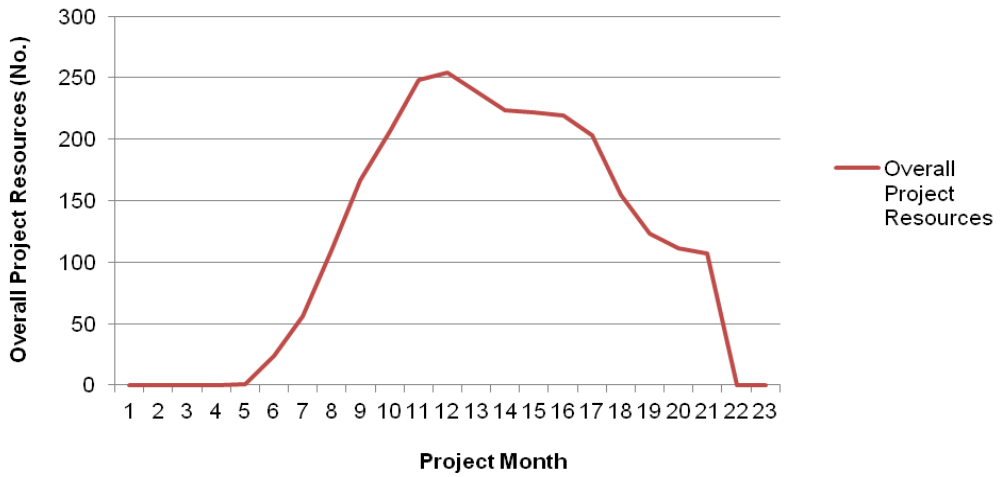


Table 2.5 Development of Project Resources Over Time

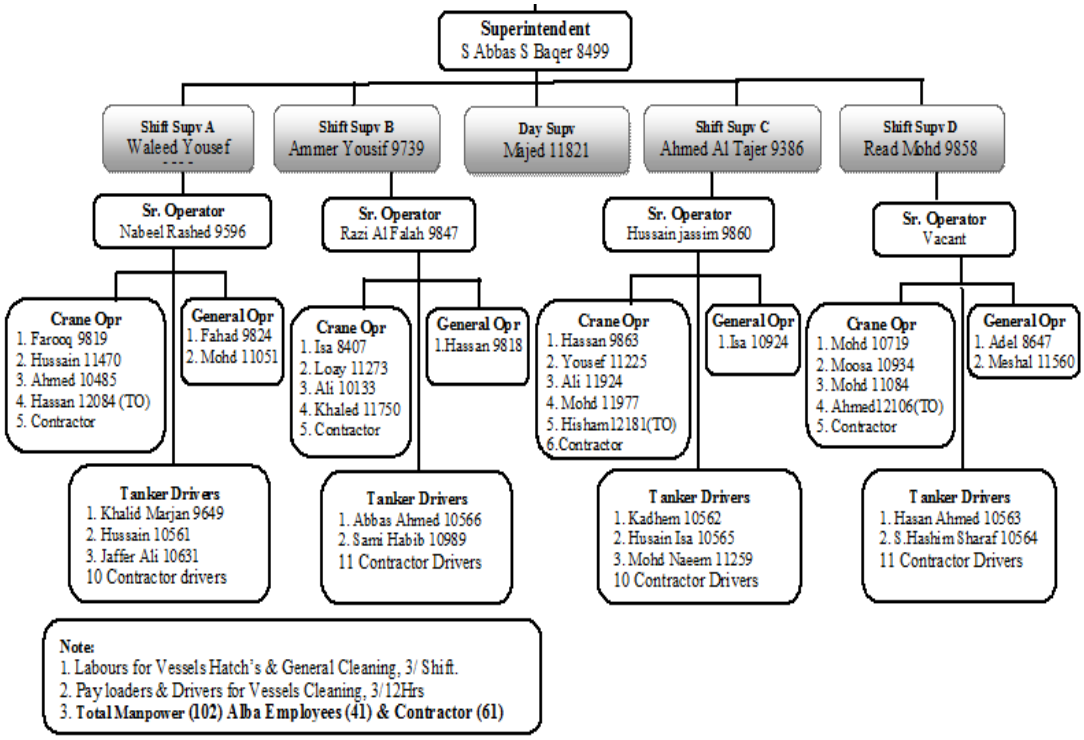
Month	1	2	3	4	5	6	7	8	9	10	11	12	13
Subcontractor Supervision Total	0	0	0	0	0	0	0	0	1	2	3	3	2
EPC Site Resources	0	0	0	0	1	5	8	8	8	11	15	17	17
Subcontractor Labour Total	0	0	0	0	0	19	48	102	158	194	230	234	220
Total	0	0	0	0	1	24	56	110	167	207	248	254	239

Month	14	15	16	17	18	19	20	21	22	23
Subcontractor Supervision Total	2	4	3	3	4	5	4	4	0	0
EPC Site Resources	18	18	19	19	19	19	18	18	0	0
Subcontractor Labour Total	204	200	197	181	132	99	89	85	0	0
Total	224	222	219	203	155	123	111	107	0	0

2.13 Operation Manpower

The current organisation chart for marine operations is provided in **Figure 2.12**. The current manpower consists of 41 Alba employees and 61 contractors, giving a total of 102 personnel. The port is operational 24 hours a day and this manpower total is derived from 3 no. 8-hour shifts. With the Port Upgrade, up to 20 further workers would be required. These additional people would be employed as truck and payload drivers, and in the housekeeping team.

Figure 2.12 Marine Organisation Chart 2018



3 ESIA METHODOLOGY

3.1 Terminology

National legislation in Bahrain refers to “Environmental Effects Evaluation” and “Environmental Impact Assessment” (EIA). For this report, this is identified as synonymous with the process of “Environmental and Social Impact Assessment” referred to in the international guidance referenced.

3.2 Legal Requirement for ESIA in Bahrain

The ESIA is to be undertaken in accordance with ‘*Ministerial Order No. 1 of 1998 with Respect to the Environmental Evaluation of Projects*’. In Bahrain, the ESIA process results in the preparation of a report which provides a review and assessment of all activities and potential significant impacts related to the project.

In accordance with Article 7 of ‘*Ministerial Order No.1 of 1998'* the report should provide:

- The complete and precise description of the project.
- The justification for establishing the project from an economic and social perspective.
- The objectives of the project.
- Project establishment.
- Results arising from its execution in general and on the natural resources and safety in particular.
- Procedures to be adopted to protect the environment.
- The programme for detecting emissions resulting from the project.
- A comprehensive description of the environmental situation which may be affected by the project and details of the reactions in all stages with this situation and analysis of the environment reactions resulting from it in these stages.

Typically, the ESIA process in Bahrain follows a systematic approach encompassing the entire development from construction to decommissioning within the following key phases (see **Figure 3.1**):

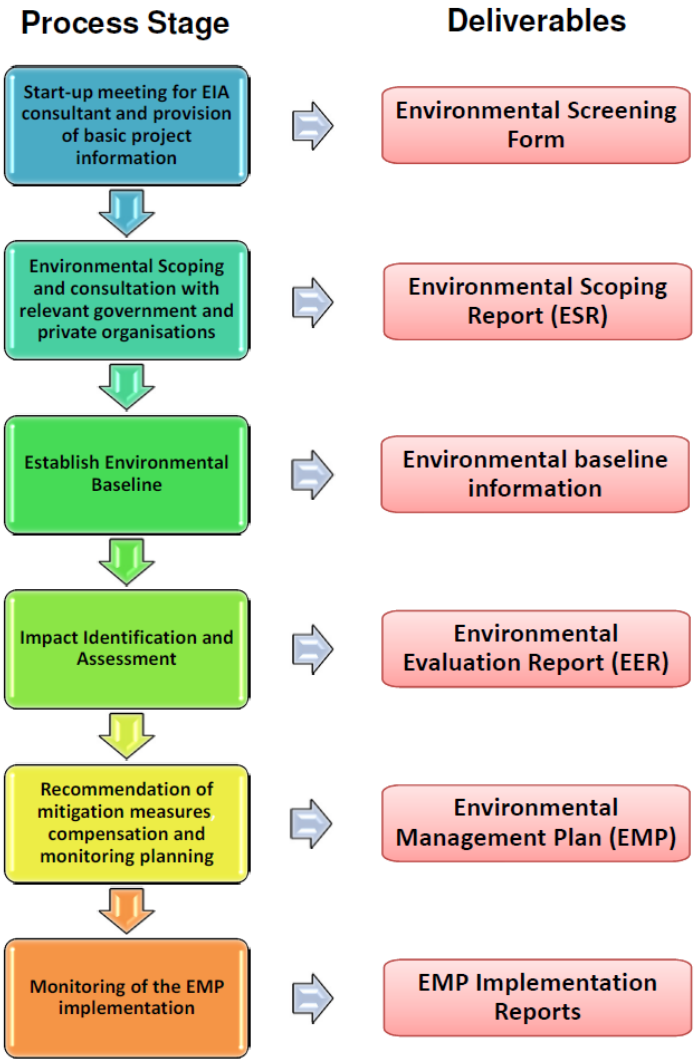
- Submission and review of environmental screening forms (e.g. EA-2).
- Production and review of an ESR.
- Production and submission of a draft evaluation report.
- Submission of final evaluation report.
- Production of Environmental Management Plan(s) (EMPs).

The objectives of the ESIA are:

- To aid in the decision-making process by providing a systematic assessment of the environmental implications of the proposed project, and possible alternatives (e.g. techniques, methods) before a decision is made.

- To identify adverse and beneficial impacts of the development during construction and operation.
- To recommend mitigation measures and formulate an action plan for any adverse impact that will arise as a result of the development.

Figure 3.1 Stages of EIA Methodology in Bahrain



3.3 International Guidance

The Port Capacity Upgrade Project is an international project. Materiel and finance will be obtained from global as well as local suppliers. To ensure that environmental and social risks are adequately addressed on major international projects, such as the Port Upgrade Project, the international trade and finance community has developed a set of guidance documents.

3.3.1 International Finance Corporation (IFC) Guidelines

The main set of benchmark documents are the World Bank Group's (WBG) International Finance Corporation (IFC) Environmental Health and Safety Guidelines. These

documents provide advice to developers of WBG funded projects on the standards of environmental, health (and social) performance expected of projects.

3.3.1.1 IFC Performance Standards on Environmental and Social Sustainability, January 2012

The Sustainability Framework of the International Finance Corporation (IFC, 2012) includes the Policy and Performance Standards on Environmental and Social Sustainability. The Policy describes the IFC's commitments, roles and responsibilities related to environmental and social sustainability. The Performance Standards are directed towards clients[2], providing guidance on how to identify risks and impacts, and are designed to help avoid, mitigate and manage risks and impacts 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 Performance Standards can also be applied by other financial institutions. There are eight Performance Standards as follows:

PS 1: Assessment and Management of Environmental and Social Risks and Impacts
PS 2: Labour and Working Conditions
PS 3: Resource Efficiency and Pollution Prevention
PS 4: Community Health, Safety and Security
PS 5: Land Acquisition and Involuntary Resettlement
PS 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources
PS 7: Indigenous Peoples
PS 8: Cultural Heritage

Performance Standard 1 applies to all projects that have environmental and social risks and impacts. Depending on project circumstances, the other Performance Standards may apply as well. The applicability of Performance Standards 2 to 8 is established during the environmental and social risks and impacts identification process.

In addition to meeting the requirements under the Performance Standards, clients must comply with applicable national law, including those laws implementing host country obligations under international law.

3.3.1.2 General EHS Guidelines – IFC, April 2007

The World Bank Environmental, Health and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of good international industry practice. The IFC uses the EHS Guidelines as a technical source of information during project appraisal. The 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. The environmental assessment process may recommend alternative (higher or lower) levels or measures, which, if acceptable to IFC, become project- or site-specific requirements.

[2] The term client is used throughout the Performance Standards broadly to the party responsible for implementing and operating the project that is being financed, or the recipient of the financing.

When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternative performance level is protective of human health and the environment.

The following guideline documents are relevant to this project:

- General EHS Guidelines (World Bank, 2007a);
- IFC EHS Guidelines for Shipping, April 2007; and
- IFC EHS Guidelines for Ports, Harbours and Terminals, February 2017.

3.3.1.3 World Bank Operational Policy 4.01 - Environmental Assessment, Revised April 2013 (World Bank, 2013)

For internal purposes the World Bank screens projects in respect of their environmental impact into 3 categories:

- Category A – the project is likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented. These impacts may affect an area broader than the sites or facilities subject to physical works. A full EIA is required.

- Category B – the potential adverse environmental impacts on human populations or environmentally important areas--including wetlands, forests, grasslands, and other natural habitats--are less adverse than those of Category A projects. The impacts are site-specific; few if any of them are irreversible; and in most cases mitigatory measures can be designed more readily than for Category A projects. A narrower scope, more limited EIA is required.

- Category C – the project is likely to have minimal or no adverse environmental impacts. Beyond screening, no further EA action is required for a Category C project.

For this project we have considered the Alba Port Upgrade is classed as a Category B project.

3.3.2 Equator Principles III, June 2013

The Equator Principles are a set of voluntary standards adopted by many banks that were originally developed in 2003 by IFC. The third iteration was published in 2013. They are used by the financial industry for assessing and managing environmental and social risk when providing loans to finance major industrial and infrastructure projects. The Equator Principles reference the IFC EHS guidelines as required project performance standards.

3.3.3 OECD Common Approaches

The OECD Common Approaches (OECD, 2012) are a set of requirements applied to projects that seek financial support from OECD Export Credit Agencies (ECAs). The requirements seek to harmonise procedures for environmental and social due diligence amongst ECAs and to provide a framework for taking decisions on the nature of environmental and social risks. They are underpinned by the IFC Performance Standards and other technical standards (e.g. European Union requirements and standards).

3.4 Stages of ESIA Methodology

3.4.1 Environmental Screening

Screening forms EA2, EA4 and EA6 were submitted to the SCE on 7th January 2018. A meeting was held with them on 12th March 2018 to discuss the project. An Environmental and Social Scoping Report was submitted on 21st March 2018. A scoping response was received from the SCE on 29th May 2018 which stated that the following must be addressed within the ESIA Report:

- Handling, transportation and storage of materials and especially during the loading, unloading process at the port. A relevant mitigation measure must be proposed to prevent any spillage.
- An Oil Contingency Plan must be submitted as a separate document.
- A Waste Management Plan must be submitted as a separate document.

3.4.2 Environmental Scoping

The process of scoping is determining, from all a project's possible impacts and from all the alternatives that could be addressed, those that are the key significant ones. This section identifies potential environmental impacts of the project and any subsequent work required during the EIA. The environmental parameters listed in **Table 3.1** have been given consideration in this ESSR.

The nature of each potential impact will be considered in more detail in the ESIA, for example, whether it is direct, indirect or secondary. Mitigation measures will also be described in greater detail within the hierarchy of prevention/avoidance, reduction/control of the magnitude of the impact, restoration and rehabilitation measures to remedy the impact and finally, if necessary, compensation measures.

Table 3.1 Parameters Investigated For Scoping

Parameters	Section
Air Quality	6
Community Health, Safety and Security	7
Geology and Hydrogeology	8
Labour and Working Conditions	9
Marine Ecology	10
Marine Sediment and Water Quality	11
Occupational Health and Safety	12
Traffic and Access	13
Waste Management	14

Table 3.2 presents the list of parameters that were excluded from the ESIA at the Scoping Stage, together with a summary of the reason for their exclusion.

Table 3.2 Parameters Excluded from Scoping

Parameter	Reason for Exclusion
Cultural Heritage and Archaeology	The project will involve construction in the marine environment and initial screening surveys in the study area have revealed limited potential for interaction with any cultural heritage or archaeological assets. The Bahrain Authority for Culture and Antiquities (BACA) is the institution in charge of archaeology and cultural heritage (it was formerly the Ministry of Culture). It is composed of two directorates: culture & arts, and archaeology & museums. Consultations were held with the BACA in January 2018 and they confirmed that there are no known heritage assets in the study area and there are no heritage sites protected by law.
Environmental Noise	The initial screening survey did not identify any noise sensitive receptors in the study area. The impact of noise emissions on site workers will be considered in the health and safety section of the ESIA, and marine noise within the marine and coastal ecology section.
Landscape and Visual Aspects	The Alba Port is already in existence and is surrounded by other marine ports and facilities, collectively known as the Sitra Marine Terminal. The project is in the marine environment in industrial waters and so there are no landscapes of conservation interest. The initial screening survey did not identify any related interests with respect to visual impacts in the project area. There are no sensitive visual receptors due to the industrial nature of the area. The addition of new jetties will not significantly change the nature and visual appearance of the existing port.
Terrestrial Ecology	The project is being constructed wholly within the marine environment.
Vibration	Vibration impacts are not considered as part of this assessment as no

Parameter	Reason for Exclusion
	potential environmental receptors have been identified that could be impacted by vibration from construction, operation or decommissioning.

3.4.3 Assessment

3.4.3.1 Introduction

The significance of the potential impacts of the Port Upgrade Project have been evaluated by compiling relevant information on the existing characteristics of the environment (i.e. the 'baseline'). Through data collation from the current Alba operations, consultation, desk study (i.e. literature review and comparison to Gulf/Bahrain/international/industry standards) and select specialist studies, an evaluation of the severity of each impact will be made by assessing the likely effects and implications with reference to the baseline situation.

3.4.3.2 Area of Influence

The project Area of Influence (AOI), in respect of its environmental and social impacts, is defined on a subject by subject basis within this ESIA. In some cases such as assessment of impacts, the AOI is relatively small and is constrained to the immediate vicinity of the project site. For other subjects such as the traffic and access is much larger. In each subject chapter, the relevant AOIs are defined.

3.4.3.3 Impact Criteria

The potential impacts will be defined as beneficial or adverse, short-/medium-/long-term or permanent, local/national/regional or strategic. During the assessment, the following base criteria will be used to determine the significance of potential impacts and where possible these will be quantified.

- **Type of impact**:
  - *Direct* – impacts that result from direct interaction between a project activity and the receiving environment;
  - *Indirect* – impacts that result from other activities as a consequence of the project;
  - *Secondary* – impacts that result from the direct interaction between the project activity and the environment as a result of subsequent interactions with the environment.
- **Extent:** whether the impact would occur onsite, in a limited area (within 1 km of the site); locally (within, say, 5 km of the site or within the relevant Municipality); nationally or internationally.
- **Duration:** whether the impact would be temporary (less than one year), short-term (one to five years), medium term (five to ten 10 years), long-term (over ten years), or permanent.
- **Likelihood:** based on the best available information (primary and secondary data), the likelihood of an impact is assigned a classification based upon the probability of an event occurring (i.e. unlikely, likely and definite).

- **Magnitude:** the quantifiable effects of impacts, measured where appropriate against an appropriate environmental standard (national, regional or international) or based on expert judgement.
- **Legal Requirements:** the specific legislation and permit requirements pertaining to the proposed project and the procedure for complying with legislation and obtaining permits.

3.4.3.4 Sensitivity Criteria

Sensitivity criteria for each environmental parameter are presented in the specialist sections of this Report. The sensitivity of the receiving parameter is a measure of the importance of an environmental receptor, as well as its sensitivity to any impact, e.g.:

- High – the receptor is of international, regional and/or national importance and as such is highly sensitive to any adverse effects;
- Medium – the receptor is important at national level, and therefore has a medium sensitivity to any adverse effects; or
- Low – the receptor is important at a local level or site-specific level only and therefore has a low sensitivity to any adverse effects.

3.4.4 Impact Significance Levels

Using a combination of the above, a consistent set of significance levels will be applied to impacts throughout the ESIA as presented in **Table 3.3**.

Table 3.3 Impact Significance Levels

Impact significance	Impact characteristic
Major Beneficial	The impact is large scale, giving rise to a significant gain to the environment.
Moderate Beneficial	The impact would provide a positive gain to the environment.
Minor Beneficial	The impact is small and would have a slight benefit to the environment.
Negligible	Either no impact or the impact is neutral (neither adverse nor beneficial).
Minor Adverse	The impact is small and of little concern; it is undesirable but acceptable.
Moderate Adverse	The impact gives rise to some concern but is likely to be tolerable in the short-term (e.g. during the construction phase) or would require a value judgement as to its acceptability.
Major Adverse	The impact is large-scale, giving rise to great concern; it should be considered unacceptable and requires mitigating, compensating or a significant change to the development if no alternative is available. If no mitigation is possible, then the impact would require a value judgement as to its acceptability.

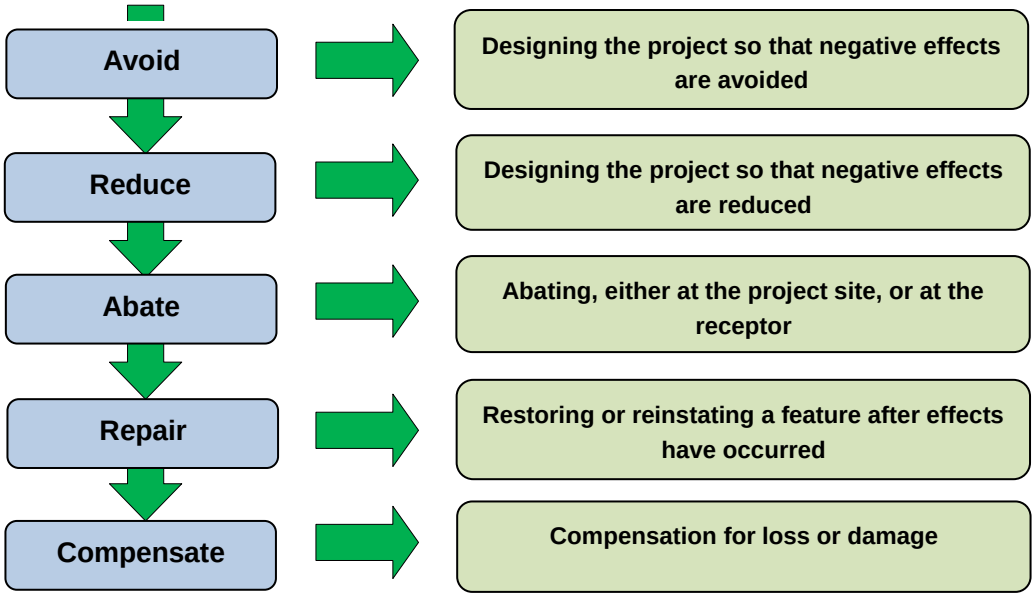
The methodology described is a general approach. For each parameter the criteria will be applied using a specifically adapted form of the methodology which is suited to the

type of impacts being considered. For example, some impacts may be assessed using quantitative impact criteria, whereas others may use qualitative methodologies.

3.4.5 Approach to Mitigation

The EIA process requires the assessment report to include a description of the measures envisaged in order to avoid, reduce and, if possible, remedy significant adverse effects. Such measures will be described in sections on mitigation within the specialist sections of the ESIA Report. The approach to mitigation has a hierarchy whereby priority will be given to avoiding or preventing effects and then, if this is not possible, to reducing or abating them, and then, if necessary, to offsetting them through repair (restoration or reinstatement) or compensation. The hierarchy is illustrated in **Figure 3.2**.

Figure 3.2 Mitigation Hierarchy



The types of mitigation measures presented will either be design mitigation or mitigation requiring additional features to be added to the project, or mitigation thorough monitoring and compensation programs.

4 PLANNING AND LANDUSE

4.1 Introduction

The consideration of existing land use and planning policies within environmental assessment is important to facilitate the assessment of impacts. This section presents details of the surrounding land uses and future development in the area as set out in the Bahrain National Plan 2030.

4.2 Area of Influence

The project's Area of Influence (AOI) has been described based on a land use survey undertaken within a 7 km radius of the project site. The project is largely marine-based, with limited topside construction. The selected 7km radius, takes into account both marine and terrestrial-based receptors and is considered to be the maximum AOI for significant impacts. However, the Bahrain Approach Channel, which extends for many kilometers outside the AOI, has been included for completeness because more shipping vessels will be entering Bahrain waters as part of the project.

Within the 7 km radius AOI, a range of land use types have been mapped and sensitive receptors highlighted. The land use has been derived based on information gathered from field surveys conducted by EACS and a review of Google Earth, local cadastral maps, and the Geographic Information System (GIS) database held by EACS.

4.3 Description of Land Use

Figure 4.1 presents the land use mapping. The Sitra Marine Terminal is shared between Alba, Bapco, GPIC and Banagas. There are pipelines along the Terminal which transfer products from Bapco's Sitra Tank Farm to the Terminal for export. The Tank Farm is located approximately 4.5 km west of the Terminal. As part of their Central Gas Plant-III project, Banagas plans is currently expanding its storage facilities on the Terminal.

To the north of Sitra Marine Terminal a new terminal is planned to be constructed on recently reclaimed land. This project is being led by NOGA. Adjacent to the new terminal, there is a large reclamation plot for a new town known as the East Sitra Housing Development. This project is being led by the Ministry of Housing. Beyond the new town lies the residential area of Sitra which is a mixture of residential, commercial and industrial land uses.

It is understood that it is Bapco's intention to locate a temporary construction labour camp on the NOGA plot specifically for the Bapco Modernization Programme. This site will house up to 15,000 workers and could be occupied by the start of 2019, with numbers gradually increasing over a period of two years. Bapco also plan to construct some new tanks and sealines in the vicinity of the Port.

To the south west of the Sitra Marine Terminal there is a reclamation plot which belongs to Edahma which is understood to be for industrial purposes. Adjacent to this to the east is the popular tourist resort of Al Dar Island. To the south west is the resort of Al Bandar and the Bahrain Yacht Club. There are many recreational vessels in this area. Also along this stretch of coast is Sitra Fisherman's Port. Commercial fishing dhows and

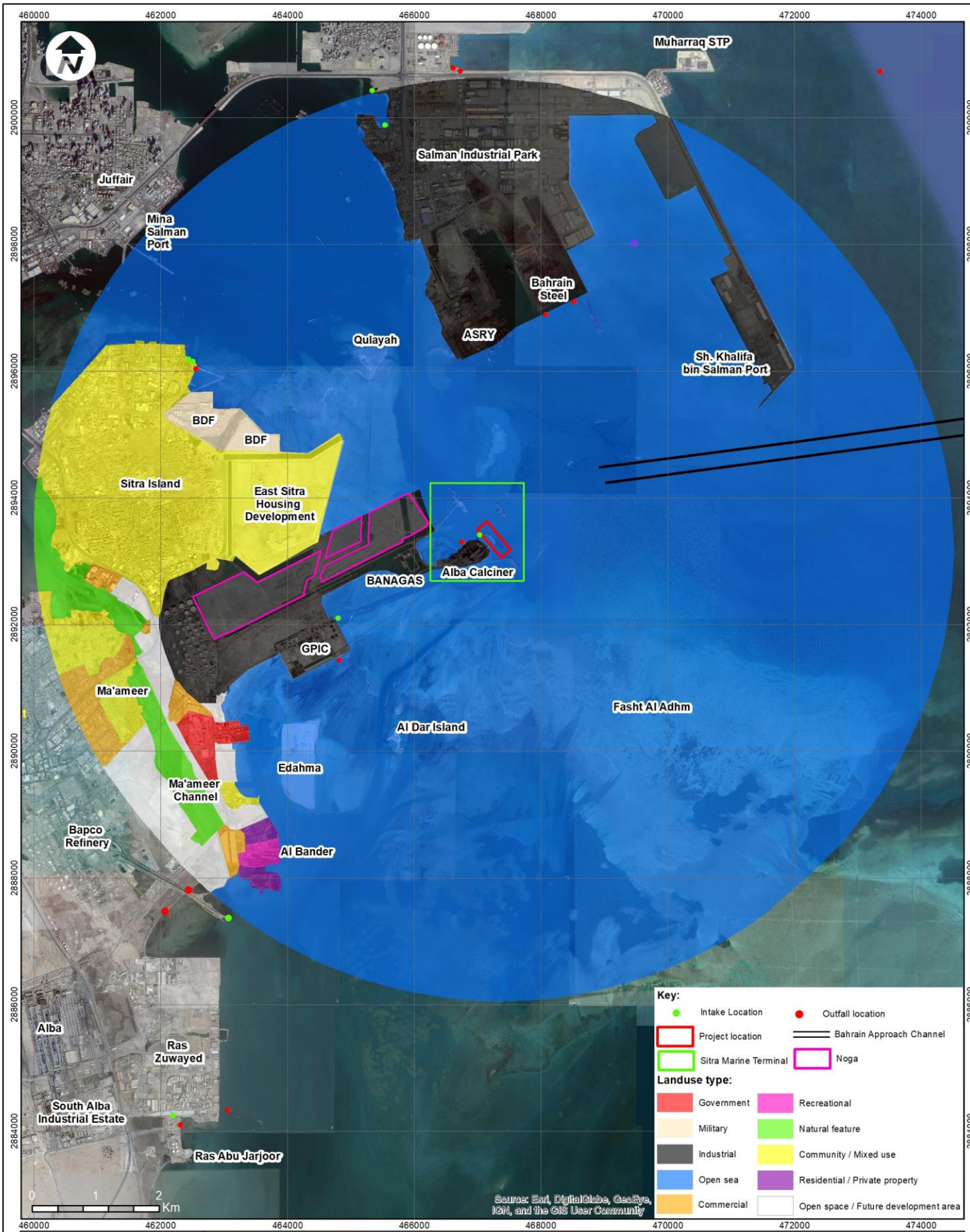
smaller fishing boats operate from this Port, together with boats taking passengers to Al Dar Island.

Between Sitra Port and the Al Bandar Resort is the Sitra Coastguard Headquarters. They have a fleet of boats which are moored in a purpose-built harbour and jetty.

Approximately 3.5 km to 4 km to the north lies the Arab Shipbuilding and Repair Yard (ASRY) and the Bahrain Steel plants.

Several outfalls can be found at a number of industrial plant in the study area, e.g. discharges from Bapco, GPIC, Bahrain Steel, Ras Abu Jarjoor Desalination Plant and the Mariculture Centre. Bapco, GPIC and the Calciner plant have marine intakes.

EACS has been advised by the Electricity and Water Authority (EWA) that the Ras Abu Jarjoor desalination plant is planning on having a seawater intake in the future (correspondence received from EWA – see **Appendix 5A**). Considering the relatively small scale marine works that will be undertaken and the fact that the desalination plant is approximately 10.7 km away from the Port and therefore outside the AOI, this facility has not been identified as a potential sensitive receptor. No impacts are predicted on this facility.



Title: **Current Land Use**		Client: alba
Project: Alba Port Capacity Upgrade Project		
Date: January 2018	Figure No.: 4.1	Consultant: Environment Arabia
Datum: WGS 84 - UTM 39N	Scale: 1:45,000 (A4)	

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4.4 Bahrain 2030: The National Plan

In line with the Bahrain 2030 National Planning and Development Strategy (NPDS), the Urban Planning and Development Authority (UPDA) (formerly the General Directorate of Urban Planning) has produced the National Detailed Land Use map (NDLU) (5th February 2016). The NDLU map aims to have a coordinated and effective use of available land resources in the country. Comprehensive land use planning has also been included as one of the priority objectives in the shorter-term (4-year) National Development Strategy (2015-2018).

Figure 4.2 presents the 2030 National Plan land use designations in the vicinity of the Port. The Alba Port is located at the eastern end of the Sitra Marine Terminal adjacent to the calciner plant. It is designated as 'heavy industry' in the Bahrain 2030 National Plan. This designation extends to its immediate neighbours of GPIC and Bapco (Sitra Storage Tank Farm). There is limited existing land use surrounding the Port, but the National Plan shows that significant future reclamation is proposed to the south for industrial purposes.

To the immediate north west there is land designated as 'light industrial' in the Plan. This land consists of land reserved for storage tanks for NOGA and for an expansion of GPIC. Approximately 2.5 km to the west of the end of Jetty 2, is the residential area of East Sitra, a recently reclaimed island belonging to the Ministry of Housing.

Approximately 3 km to the north are the Arab Shipbuilding and Repair Yard (ASRY) and Bahrain Steel. These are both designated as heavy industry in the National Plan. 5 km to the northeast is the Khalifa bin Salman Port.

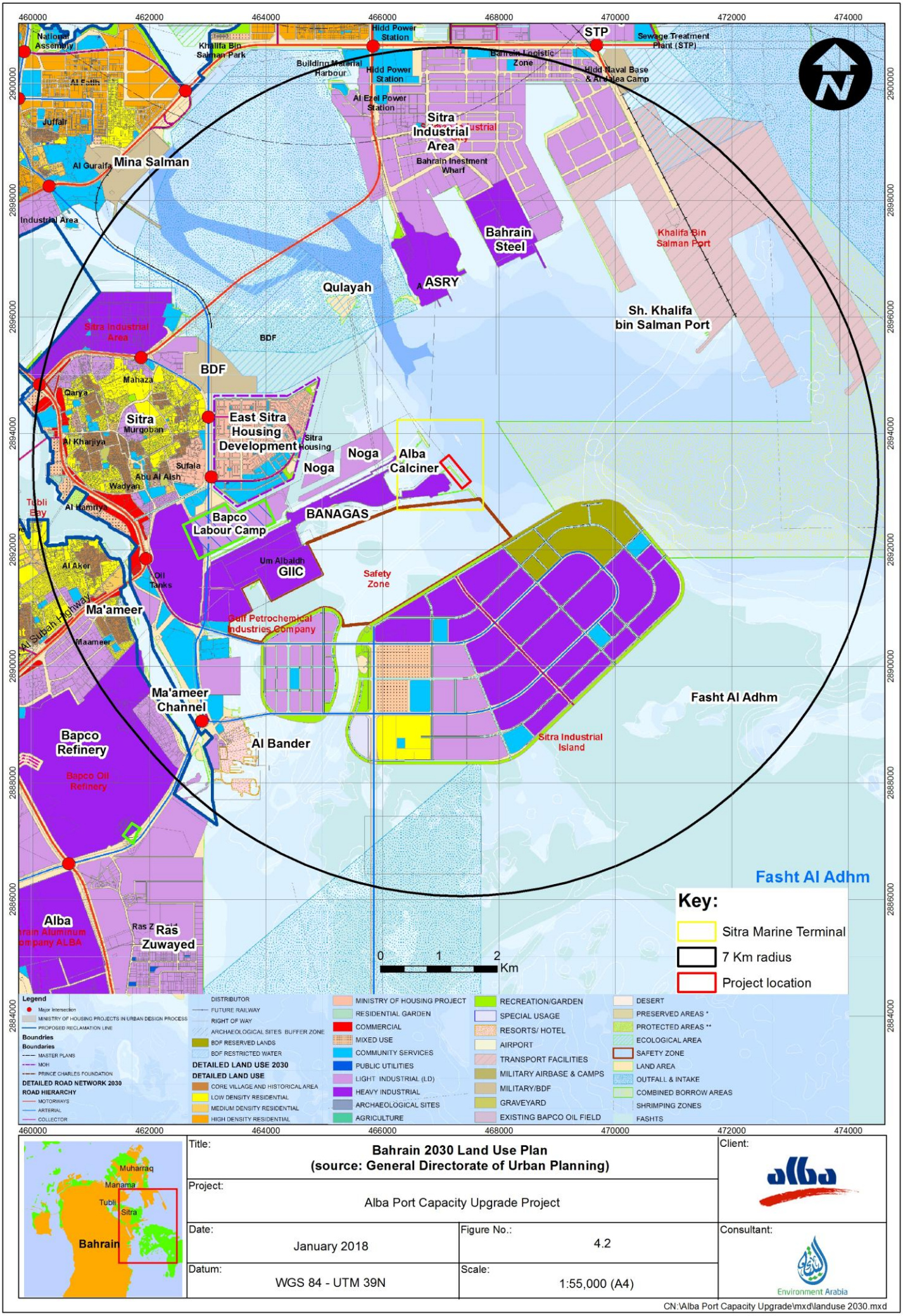
1.5 km to the east of the Port, are the western limits of an approved Government borrow area.

4.5 Identification of Potential Sensitive Receptors

Eighteen potential sensitive receptors have been identified within the 7 km study area for the Upgrade Project. These include nearest residential areas, recreational facilities, and the industrial neighbours to the Alba Port (**Table 4.1**). **Table 4.2** provides a matrix showing which of the sensitive receptors have the potential to be influenced by the project. The horizontal axis shows the environmental parameters and the vertical axis lists the sensitive receptors. Where ESIA parameters do not have a defined spatial impact, or spatial impact outside of the project site areas they have not been included in **Table 4.2**.

Table 4.1 Potential Sensitive Receptors

No.	Potential Sensitive Receptor	Type	Approx. Distance (km) (from centre of existing Alba jetties)
1	Sitra Residential Area	Residential	4.5
2	East Sitra Housing Development	Residential	2.8
3	Bapco Sitra Tank Farm	Industrial	4.7
4	Bapco Jetty	Industrial	0.2
5	GPIC Jetty	Industrial	0.3
6	GPIC Plant	Industrial	2.8
7	Alba Calciner Plant Water Intake	Industrial	0.2
8	Bapco Labour Accommodation (Future)	Residential	3.6
9	Ma'ameer Village	Residential	6.5
10	Sitra Port	Commercial	5.0
11	Al Bandar Resort	Recreational	6.0
12	Bahrain Yacht Club	Recreational	6.1
13	Bapco Intake	Industrial	7.3
14	Al Dar Island	Recreational	3.4
15	Fasht Al Adhm	Ecological	1.4
16	Bahrain Approach Channel	Commercial	1.5
17	Shaikh Khalifa bin Salman Port	Commercial	5.0
18	Marine Environment	Ecological	-



Title:	**Bahrain 2030 Land Use Plan (source: General Directorate of Urban Planning)**		Client: alba
Project:	Alba Port Capacity Upgrade Project		
Date:	January 2018	Figure No.: 4.2	Consultant: Environment Arabia
Datum:	WGS 84 - UTM 39N	Scale: 1:55,000 (A4)	

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Table 4.2 Matrix of AOI Against ESIA Parameters

No.	Name	ESIA Parameter						
		Air	Community, Health, Safety and Security	Marine and Coastal Ecology	Marine Sediment and Water Quality	Occupational Health and Safety	Soil and Groundwater	Traffic and Access
1	Sitra Residential Area	√	√					√
2	East Sitra Housing Development	√	√					√
3	Bapco Sitra Tank Farm					√		√
4	Bapco Jetty	√				√		
5	GPIC Jetty	√				√		
6	GPIC Plant					√		√
7	Alba Calciner Plant Water Intake				√			
8	Bapco Labour Acc.	√	√					√
9	Ma'ameer Village	√	√					√
10	Sitra Port		√			√		√
11	Al Bandar Resort		√		√	√		√
12	Bahrain Yacht Club		√		√	√		√
13	Bapco Intake				√			
14	Al Dar Island		√		√			
15	Fasht Al Adhm			√	√			
16	Bahrain Approach Channel					√		
17	Shaikh Khalifa bin Salman Port					√		
18	Marine Environment			√	√			
19	Ras Abu Jarjoor Intake (future scenario)				√		√	

5 STAKEHOLDER ENGAGEMENT

5.1 Introduction

The objectives of stakeholder engagement are to ensure that the impacts of developments are understood by all those who could be affected (the stakeholders). This allows for improved planning of developments and affords the opportunity to anticipate and avoid or manage unacceptable environmental and social impacts.

The process of ESIA in Bahrain requires consultation with key stakeholders at the scoping stage and through the preparation of the ESIA. This consultation includes a combination of correspondence, presentations and meetings. In addition, stakeholders are expected to be invited to attend the ESIA presentation to the SCE.

5.2 Legislation and Guidance

5.2.1 International Finance Corporation Performance Standards (IFC PS) on Environmental and Social Sustainability

IFC PS1 sets out requirements for on-going stakeholder engagement as part of an effective project Environmental and Social Management System (ESMS). The standard requires that local communities directly affected by the project (Affected Communities) are informed regarding:

i. The purpose, nature, and scale of the project;
ii. The duration of proposed project activities;
iii. Any risks to and potential impacts on such communities and relevant mitigation measures;
iv. The envisaged stakeholder engagement process; and
v. The grievance mechanism.

PS1 requires that a Stakeholder Engagement Plan (SEP) is developed for the project and that the extent of stakeholder engagement is proportional to the expected impact on local communities directly affected by the project (Affected Communities) and other stakeholder groups. PS1 also identifies that information should be disclosed to Affected Communities in a way that is accessible and includes information on emergency planning as it impacts Affected Communities. Periodic reports should be provided to Affected Communities at least one per year.

PS1 also requires that a grievance mechanism is established to receive and facilitate resolution of Affected Communities' concerns and grievances about the project environmental and social performance. PS4 identifies that the grievance mechanism should allow Affected Communities to express concerns about community health, safety and security.

5.2.2 Equator Principles III

Principle 5 requires project sponsors to undertake stakeholder engagement for all significant development projects. Principle 6 requires the establishment of a grievance mechanism for Affected Communities and other stakeholders. The specific requirements are equivalent to those set out in IFC PS1 in both cases.

Principle 10 requires information regarding the environmental and social impact of the project to be disclosed to stakeholders. As a minimum, a summary of the ESIA should be made accessible and available online. Principle 10 also states that where projects have greenhouse gas emissions in excess of 100,000 tonnes per year, these should be reported publically.

5.3 Identification of Stakeholders

There are five key constituents of stakeholders that have been identified for the Port Upgrade Project:

1) Supreme Council for Environment (SCE) – the national environmental authority who will be responsible for permitting the project.

2) National government officials– Alba is a nationally important industry that will require the co-ordinated input from multiple government ministries and their agencies. A key part of the stakeholder engagement process has been to introduce these ministries and agencies to the project and seek feedback in respect of their concerns and knowledge of planned developments.

3) National Government and leadership advisory bodies – the National Assembly comprises: The Council of Representative (the lower house); and the Consultative Council or Shura Council (the upper house).

4) Local government – consists of the Southern Governorate, the Southern Municipality and Southern Municipal Council, which is an elected body.

5) Non-Governmental Organizations – Organizations of Bahrain civil society with an environmental or social remit.

The following section outlines the consultations that have been undertaken as part of the ESIA. Alba has formed a committee consisting of Alba, the PMA, GPIC and Bapco. This committee has regular discussions regarding the project to ensure transparency and cooperation.

5.4 Consultation's to Date

The project stakeholder engagement process commenced during production of the Environmental and Social Scoping Report. The purpose of these consultations was to identify possible interactions and constraints in respect of other planned development programs and projects and to identify possible environmental constraints of the Port Upgrade Project. Furthermore, early engagement with key stakeholders allows any concerns to be identified at an early stage in the project planning.

A list of the organisations that have been consulted with is provided in **Table 5.1**, including the contact name and a summary of any responses received to date. **Appendix 5A** contains the correspondence and **Appendix 5B** the minutes of meetings.

Table 5.1 Stakeholder Engagement to Date

Organisation	Main Contacts	Notes
Agricultural Affairs and Marine Resources (AAMR)	Sheikh Khalifa bin Isa Al Khalifa Undersecretary Agricultural Affairs and Marine Resources	• Screening Form submitted to the AAMR for dredging. • Follow-up email on 8.1.18 to Bassam Al Showaikh (Fisheries Officer) explaining the four options under consideration. • Meeting held 1.4.18 to present options to fisheries directorate. • No dredging or reclamation now proposed, so update letter sent on 30.5.18 explaining preferred scheme.
Agriculture, Engineering and Water Resources Directorate (AEWRD)	Sheikh Khalifa bin Isa Al Khalifa (Undersecretary) Ali Hameed Al-Shabaani (Acting Director) Marcial A. Mojica (Senior Hydrogeologist)	• Screening form for reclamation and dredging submitted on 4.1.18. • Meeting held on 22.1.18. • The AEWRD stated that the aquifer is approximately 30m deep in the area and so they don't anticipate any problems concerning protection of the aquifer. • All applications for permits must be related to chart datum. • They requested a copy of the geotechnical survey. • Letter sent explaining the preferred option on 28.5.18.
Bahrain Authority for Culture and Antiquities	Sheikh Khalifa bin Ahmed Al Khalifa (Director, Directorate of Archaeology & Museums)	• Consultation letter sent on 4.1.18. • There are no heritage assets in study area. • Letter from BACA provided in **Appendix 5A**. • Letter sent explaining the preferred option on 28.5.18. • Email received on 3.6.18 stating that the BACA has no comments on the project.
Bahrain Environment Society	Dr. Shubar Al Wedaie	• Consultation letter sent on 30.5.18.
Bahrain Fisherman's Society	General Manager	• Consultation letter sent on 30.5.18.

Bahrain Gas Company (Banagas)	Prasad Kondaramvalappil (Acting Superintendent – HSE)	• Consultation letter sent on 4.1.18.
		• Meeting held on 7.2.18. Items discussed:
		  ○ Alba will have no impact on Banagas facilities.
		  ○ Banagas interested in obtaining information on emergency scenarios.
		  ○ Banagas interested in knowing whether there is any heavy equipment on haul road and where the laydown area will be.
		  ○ Banagas want to know expected vehicle movements.
		• Letter sent explaining the preferred option on 28.5.18.
		• Request for information from Banagas received on 5.6.18. Alba liaising directly with Banagas through stakeholder engagement programme.

Bahrain Petroleum Company (Bapco)	Ijaz Ashraf (Advisor Environmental Affairs)	• Consultation letter sent to Bapco by Noga Holding. • Alba is holding regular discussions with Bapco in the Project Co-ordination meetings, but for the ESIA a meeting was held on 15.2.18. • Bapco wanted information regarding black dust coming from the jetty during unloading. • Bapco requested a plan showing the locations for the geotech survey. • Bapco requested a copy of the RA and MS for the jetty construction. • Bapco want to be involved in the ship simulation. Further information is provided in the Minutes in **Appendix 5B**. • Letter sent explaining the preferred option on 28.5.18.

Organisation	Main Contacts	Notes
Bahrain Women Society	Mona Al Alawi Head of Bahrain Women Council	• Consultation letter sent on 29.5.18.
Central Planning Office (CPO), Ministry of Works	Dominic McPolin (Chief Executive Officer)	• Consultation letter sent on 4.1.18. • Meeting held on 30.1.18. • EACS should take into account the results from the EIA undertaken for the calciner plant. • Alba's smelter is at high risk from other projects in the area. • The proposed East Sitra Link Road will affect Alba's haul road. The CPO requested data regarding the need for a conveyor to convey raw materials to the smelter from the Port. They will open discussions with concerned stakeholders. • There area increased traffic demands in the area which are placing a strain on the existing network including Avenue 96 and King Hamad Highway. • The road works at Alba and Nuwaidrat roundabouts are running 2 years behind schedule. • EWA are planning a seawater intake at Ras Abu Jarjoor – this needs to be included in the study. • The BDF want to dredge two areas in the vicinity of the Port. Alba should contact Brigadier General Abdulaziz for a meeting. • Letter sent explaining the preferred option on 28.5.18.
Council of Representatives	Abbas Al Madhi Head of Services Committee	• Consultation letter sent on 30.5.18.
Electricity and Water Authority (EWA)	Shaikh Nawaf Bin Ebrahim Bin Hamad Al Khalifa (Chief Executive Officer)	• Consultation letter sent on 4.1.18. • Meeting held on 14th February 2018. • EWA welcomed the consultation and asked to be further consulted with regard to selection of monitoring locations during any required reclamation and dredging. • Letter sent explaining the preferred option on 28.5.18. • Meeting held on 11.6.18.
Environment Friends Society	Khawla Al Muhanadi	• Consultation letter sent on 30.5.18.
General Directorate of Civil Defence	Bassam Khalaf (Head of Protection and Safety)	• Consultation letter sent on 4.1.18. • Consultations will continue with this Directorate by Alba when necessary. • Letter sent explaining the preferred option on 28.5.18.
Gulf Petrochemical Industries Company	Yasser A.Rahim Alabbasi (Plant Operation Manager)	• GPIC are part of the Project Co-ordination meetings which are regularly held. • Specific introduction meeting held on 16.1.18. • The meeting notes are extensive and contained in **Appendix 5B**. • Letter sent explaining the preferred option on 28.5.18.
Migrant Workers Protection Society	Marietta Dias Chairperson	• Consultation letter sent on 29.5.18.
Ministry of Housing	Dr Fattah Abbas (Senior Project Manager, Special Projects)	• Consultation letter sent on 4.1.18. • Meeting held 21.1.18. • MoH welcomed early engagement and were interested in the option selection process. They provided a map showing the recently reclaimed areas close to Alba. • Dialogue is to be maintained to allow sharing of

Organisation	Main Contacts	Notes
		information on the construction of both the East Sitra Housing Plot and the jetties. • Letter sent explaining the preferred option on 28.5.18. • East Sitra Masterplan sent to EACS on 12.6.18. • Email received on 31.5.18 stating the project is not anticipated to have an impact on the East Sitra Housing Plot.
Ministry of Industry and Commerce (MICT)	Yasser Alawi AlMahfoodh (Chief Engineering Services)	• Consultation letter sent on 4.1.18. • Meeting held on 15.1.18. • The MICT understand the importance of the Alba Expansion Project and the need to upgrade the Port and has no objection in principle to this project. There are no industrial areas belonging to the Ministry close to the Project; North Sitra Industrial Area is located to the north of Sitra Island. • The MICT requested a copy of the ESIA when complete. • Letter sent explaining the preferred option on 28.5.18.
Ministry of Municipalities Affairs and Urban Planning (Urban Planning and Development Authority)	Rashid Al Saad (Deputy CEO)	• Consultation letter sent on 4.1.18. • Meeting held on 8th February 2018. • UPDA stated that the coordinates for the project should be sent to them and recommended that Alba applies for the project to be designated as a Strategic Project. • The UPDA are interested in Alba building a conveyor to transport alumina and CPC to the smelter and wish to open a dialogue with the relevant parties. • Letter sent explaining the preferred option on 28.5.18.
Ministry of Transport and Telecommunications (MTT)	Didar Dalkic (Advisor to the Minister)	• Consultation letter sent on 4.1.18. • Meeting held 24.1.18. • The MTT stated that the project does not affect them in any way and they have no concerns or objections. • The MTT are developing proposals for the Bahrain link of the GCC railway. They would be keen to talk to Alba regarding any potential use of this rail link by Alba. • Letter sent explaining the preferred option on 28.5.18.
NOGA	Nasser Al Bin Ali	• NOGA are a part of the Project Co-ordination Meetings that are regularly held.
Nogaholding	Dr Dafer Al Jalahma (Chief Executive)	• Consultation letter sent on 4.1.18. • As the holding company for oil and gas assets owned by the Government of Bahrain, Nogaholding distributed the consultation letter to concerned stakeholders and assisted with setting up meetings.
Ports and Maritime Affairs (PMA)		• Consultation letter sent on 4.1.18. • Meeting held 25.1.18. • Alba is required to have a licence to operate its jetties from the PMA. • The PMA needs to know that all other stakeholders are happy with the project proposals before they can approve the project. • The PMA should be thought of as part of the project team and wish to be closely involved in future discussions with stakeholders. • Regular meetings are held as part of the Project Co-ordination meetings.
Roads, Planning & Design Directorate (RPDD), Ministry of	Huda Fakhroo (Assistant Undersecretary)	• Consultation letter sent on 4.1.18. • Response received on 22.1.18 outlining the RPDD's plans for the East Sitra Link Road. • Route provided for ESLR on 13.5.18.

Organisation	Main Contacts	Notes
Works		• Letter sent explaining the preferred option on 28.5.18.
Sanitary Engineering Planning and Projects Directorate (SEPPD), Ministry of Works	Asma Murad (Acting Assistant Undersecretary)	• Consultation letter sent on 4.1.18. • Response received on 22.1.18. The SEPPD stated that there are no conflicts between the Alba Port Project and their projects in the area. • Letter sent explaining the preferred option on 28.5.18.
Shura Council	Ali Saleh Al Salah Head of the Shura Council	• Consultation letter sent on 30.5.18.
Southern Governorate	Shaikh Khalifa bin Ali Al Khalifa (Governor)	• Consultation letter sent on 12.1.18. • Letter sent explaining the preferred option on 28.5.18.
Southern Municipal Council	Ahmed Yusif Al Ansari Head of the Municipal Council	• Consultation letter sent on 29.5.18.
Southern Municipality	Asim Bin Abdul-Latif General Director	• Consultation letter sent on 29.5.18.
Supreme Council for Environment (SCE)	Luma Abbas Al Mahroos (Head of Environmental Assessment)	• Meeting held on 11.12.12. • Screening forms EA-2, EA-4 and EA-6 submitted on 7.1.18. • WMP and Emergency Plan sent on 11.2.18. • Meeting held on 12.3.18. • Scoping Report submitted on 21.3.18. • Response to Scoping Report received from the SCE on 29.5.18 which stated that the consultant should proceed with the EIA – see **Appendix 5A**. EIA should include information on materials handling, an Oil Spill Response Plan and a Waste Management Plan.
Supreme Council for Women	Shaikha Deena Bin Rashid Al Khalifa Head of International and National Relations	• Consultation letter sent on 29.5.18.

5.5 Stakeholder Engagement Plan

Alba has a SEP for the Line 6 Project, and will also prepare a SEP for the Port Project following completion of the ESIA process and publication of this ESIA Report.

Alba plan to hold a meeting regarding the environmental and social impacts of the project and to explain how it intends to mitigate and manage these. Invitees to the meeting will have the opportunity to provide direct feedback to Alba personnel, the EPC Contractor and its environmental consultant.

The meeting will present simplified summaries of key aspects of the ESIA that can be understood by a layman. These will be presented in graphics form as far as possible and will be presented in English and Arabic. Full copies of all ESIA documentation will be available to refer to.

Project personnel will be on hand to talk to participants and to answer questions. All visitors will be given an opportunity to provide written and verbal feedback which they will be able to be give anonymously if required.

Meetings would be arranged for the following stakeholder groups:

1) Government and civil society;
2) Press and media;
3) Site neighbours; and
4) General public.

The meeting(s) will be advertised in the press. Invitees within the project stakeholder database will be sent invitation letters and a frequently asked question sheet. The event is scheduled for the autumn of 2018. The feedback will be captured in the SEP.

5.6 External Grievance Mechanism

Alba have developed an external grievance mechanism to provide a structured means of receiving and resolving concerns and complaints made by individuals or groups affected by Alba's activities. Issues can be raised using the dedicated Alba Integrity Line phone number (800-000-00) or via the company website. All issues raised will be investigated by relevant staff and the outcome will be reported to the complainant.

5.7 Publication of the ESIA

This ESIA Report will be published on the Alba website together with the ESIA for the Line 6 Project.

5.8 Follow up Engagement

The type and focus of follow up engagement will depend upon the outcome of the meeting and other consultations. The feedback from these will be analysed to identify if there are any concerns that have been raised that are not adequately addressed by the ESIA process. If this is the case, additional mitigation and management measures will be considered to address these concerns. The feedback will also be used to identify what aspects of the stakeholder engagement programme should continue and what form it will take.

5.9 Summary

A summary of management actions for stakeholder engagement are shown in **Table 5.2**.

Table 5.2 Summary of Required Actions for Stakeholder Engagement

Issue / Impact	Mitigation / Monitoring / Enhancement Measures
Stakeholder Engagement Plan	• Development of a project SEP.
Stakeholder Meeting(s)	• Undertake meeting(s) inviting feedback on the environmental and social impact of the project from identified stakeholder groups.
Follow up Engagement	• Analyse the feedback from the exhibition and other consultations. • Revise mitigation and management plans where appropriate. Identify what aspects of stakeholder engagement it is appropriate to continue. • Update SEP to include feedback and outcomes of exhibition and other consultations.

6 AIR QUALITY

6.1 Introduction

This section of the ESIA describes the existing environment in relation to air quality and assesses the potential impacts of the construction and operational phases of the proposed Port Capacity Upgrade Project.

Air quality around the Sitra Marine Terminal is affected by a number of existing air emission sources, which include shipping, cargo handling and transportation activities, on-site processes such as the calciner plant, and more distant industrial operations including the Bapco Refinery, the main Alba site, Riffa power station and the steel plants within the Sitra industrial area to the north. The key long-term pollutant emission sources associated with the project are those arising from additional shipping vessel movements and road transport operations to and from the main Alba site.

These activities are all contributors to local air pollution, which include emissions of sulphur dioxide (SO_2), nitrogen oxides (NO_X), carbon monoxide (CO) and fine particulates (usually expressed as the PM_{10} or $PM_{2.5}$ airborne fraction). The approach in this ESIA is therefore to evaluate available data to characterise a representative air quality baseline, and to quantify the impact of the implementation of the Port Upgrade Project on sensitive receptors.

6.2 Legislation and Guidance

Air quality standards are established to protect human health and the environment. This assessment was conducted in consideration of the guidelines set out by the International Finance Corporation (IFC)[3,4]. The General Guidance states that '*when host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent'.* The Air Quality Guidance and IFC Performance Standard 3 (2012)[5] indicate that nationally adopted standards should be used, but in their absence, air quality guidelines recommended by the World Health Organisation (WHO)[6], or other internationally recognised sources, should be adopted.

In Bahrain, national air quality standards are laid down by the SCE. The current Bahrain national Standards[7] are summarised in **Table 6.1**. For comparison, the current WHO Guidelines and interim targets for SO_2, NO_2, CO and PM_{10} are also presented.

[3] International Finance Corporation (2007). General EHS Guidelines: Introduction. Environmental, Health and Safety General Guidelines, 30 April 2007

[4] International Finance Corporation (2007). General EHS Guidelines: Environmental. Air Emissions and Ambient Air Quality, 30 April 2007

[5] International Finance Corporation (2012) Performance Standard 3, Resource Efficiency and Pollution Prevention, 1 January 2012.

[6] WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulphur dioxide, Global Update 2005.

[7] Ministerial Order No. 10 of 1999 with respect to Environmental Standards (air and water), as amended.

Table 6.1 Ambient Air Quality Standards and Guidelines

Pollutant	Averaging Period	Bahrain ($\mu g.m^{-3}$)	WHO Guidelines ($\mu g.m^{-3}$)	WHO Interim Targets (IT) ($\mu g.m^{-3}$)
SO_2	10 minutes	-	500	
	Hourly	350(1)	-	
	Daily	125	20(2)	125 (IT 1) 50 (IT 2)
	annual	50	-	
NO_2	Hourly	200	200	
	Daily	150	-	
	Annual	40	40	
CO	8-hourly	10,000	-	
PM_{10}	Daily	340(3)	50	150 (IT 1) 100 (IT 2) 75 (IT 3)
	Annual	-	20	70 (IT 1) 50 (IT 2) 30 (IT 3)

Notes:

(1) Not to be exceeded more than twice in any 30-day period at a given location.

(2) WHO also propose interim targets of 125$\mu g.m^{-3}$, which is equal to the former WHO guideline (WHO, 2000), and 50$\mu g.m^{-3}$, which is viewed as a 'feasible and achievable goal that would lead to significant health improvements'.

(3) Article 12 of Ministerial Order 10 (1999, as amended) states that 'Exceeding the measurements of particles in the surrounding air subject to be inhaled within twenty-four hours, shall not be considered as a breach of this measurement if this is due to extraordinary concentrations with natural origins such as sandstorms'.

In accordance with the IFC Guidelines[3] this assessment was based on the Bahrain national standards, where applicable, and WHO air quality guidelines where standards are not available, or are more stringent. In respect of ambient PM_{10} concentrations, the national daily standard is tailored to specific conditions in Bahrain, where achievement of stringent particulate levels is unlikely due to naturally elevated background concentrations. Therefore, whilst the WHO annual standard for PM_{10} is used as a reference in accordance with the IFC Guidelines, it is not currently achieved across Bahrain, irrespective of the proposed Port Capacity Upgrade Project.

The WHO air quality guideline values are also presented alongside a set of interim targets, in recognition of the need for a staged approach to achieving the recommended guidelines, but also so as to encourage continual improvement in areas where interim targets are routinely achievable. In the case of daily SO_2 concentrations, the Bahrain national standard is equivalent to the WHO interim target concentration, and this level has been adopted in this assessment.

Prediction of the 10-minute average SO_2 concentrations for comparison with the short-term guideline is not possible using predictive dispersion modelling which uses 1-hour average meteorological dispersion values. The WHO Air Quality Guidelines[6] state that, '*Because short-term SO_2 exposure depends very much on the nature of local sources*

and the prevailing meteorological conditions, it is not possible to apply a simple factor to this value in order to estimate corresponding guideline values over longer time periods, such as one hour'. The assessment of short term SO_2 concentrations is therefore based on the consideration of the Bahrain national 1-hour standard, which is a suitable benchmark for short-term population health effects.

6.3 Assessment Methodology

6.3.1 Environmental Baseline

There is no current Government funded air pollution monitoring in the vicinity of the Sitra Marine Terminal. Historically the SCE operated a monitoring network which included an air quality monitoring station in the Central Governorate. This network was discontinued in late 2012. The original ESIA (2014) for the Alba Line 6 and PS5 project (which the port expansion is designed to serve), provided an overview of baseline air quality from this dataset, and the supplementary ESIA (2017) included updated site-based monitoring of airborne particulate matter. No new ambient air quality monitoring has been undertaken at the Port in support of this Port Capacity Upgrade aspect of the associated project.

6.3.2 Construction Phase Assessment

An assessment of potential impacts associated with the construction phase was undertaken using a risk-based approach, based on screening criteria and consideration of the scale of likely activities and the proximity to sensitive receptors. In the absence of Bahraini national technical guidance on the assessment of construction effects on air quality, the principles and main procedures laid down in guidance provided by the UK Institute for Air Quality Management[8] (IAQM) were applied. A summary of the assessment process is provided below:

Construction phase assessment steps:

1) Screen the need for a more detailed assessment;
2) Separately for demolition, earthworks, construction and trackout:
   A. determine potential dust emission magnitude;
   B. determine sensitivity of the area; and
   C. establish the risk of dust impacts.
3) Determine site specific mitigation; and
4) Examine the residual effects to determine whether or not additional mitigation is required.

6.3.3 Air Quality Modelling and Operational Phase Assessment

Pollutant emissions from the shipping and road transport activities associated with the Port Upgrade were assessed using a combination of the AERMOD and ADMS-5 atmospheric dispersion models. Both are new generation steady-state Gaussian dispersion models that are able to predict ground level concentrations arising from emissions to atmosphere, from both elevated point sources (e.g. vessel stacks) and ground level releases such as line (road) and area (fugitive emission) sources.

[8] Institute of Air Quality Management (2014) Guidance on the Assessment of Dust from Demolition and Construction

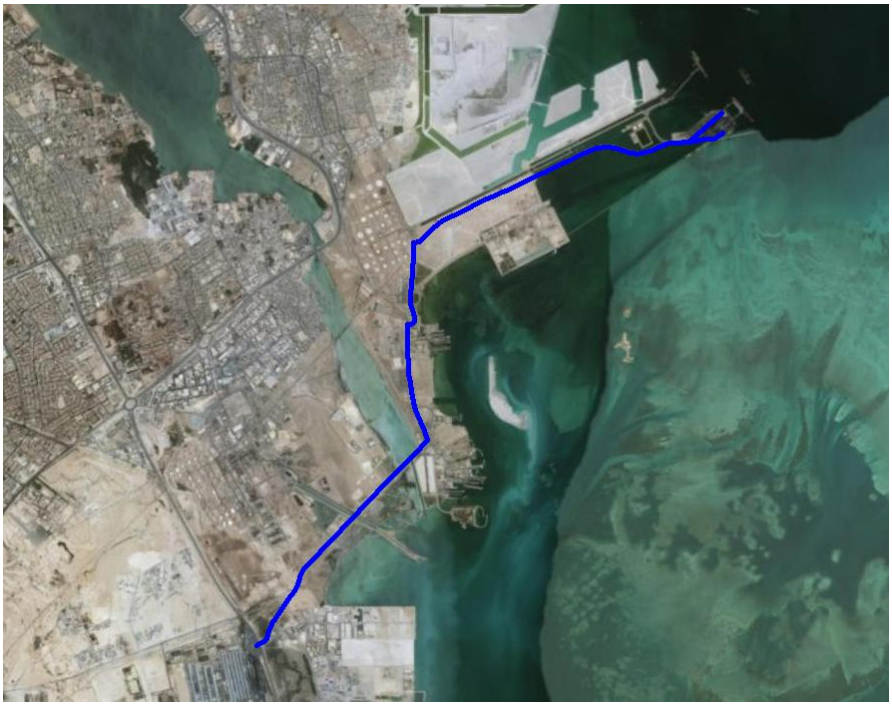
The American Meteorological Society and Environmental Protection Agency Regulatory Model Improvement Committee developed the new generation dispersion model AERMOD, which incorporates the latest understanding of the atmospheric boundary layer. The Atmospheric Dispersion Modelling System (ADMS) was developed at Cambridge by the UK consultancy CERC. The model allows for the skewed nature of turbulence within the atmospheric boundary layer. Both are widely used across the world for regulatory and assessment purposes.

The models utilise the same meteorological dispersion data, and generate similar predictions of ground level concentrations. Two inter-comparison studies commissioned by the UK Environment Agency found that differences in calculated concentrations between the models were due to modelling uncertainties, and concluded that neither model was more accurate in its predicted pollutant concentrations.

In both models, atmospheric dispersion is determined by input data (emission source and pollutant release parameters, the terrain, hourly sequential meteorological data and building dimensions) to calculate ground level pollutant concentrations across a selected receptor grid and discrete receptor points.

ADMS-Roads is a fully validated modelling system frequently used in traffic-based air quality impact assessments, and was used to model emissions as a line source, along the haul route between the port and the main Alba site. Using this model, concentrations of NO_2 and PM_{10} were predicted at relevant receptor locations, using current traffic flows and those predicted post-implementation of the Port Capacity Upgrade project. At relevant receptors, the modelled predictions were added to the shipping emissions impact assessment to provide total pollutant loading estimations. The operational traffic haul route assessed in the model is shown in **Figure 6.1**.

Figure 6.1 Modelled Road Transportation Route



As detailed in **Section 14**, existing daily HGV trips are 243/day (or 20 2-way movements per hour), and the Port Upgrade Project would give rise to an additional 162 daily trips (14 2-way movements per hour).

Emissions from shipping vessels were derived from the additional activities which are set out in **Section 2 Project Description** (see **2.8 Shipping Schedules**). The modelling accounted for main and auxiliary engine line source emissions for movements at cruise speed, in the Reduced Speed Zone (RSZ), and manoeuvring, and as point sources for hotelling at berth. Emission factors were derived from USEPA (2009)[9].

The shipping vessel emission rates are given in **Table 6.2**.

Table 6.2 Shipping Vessel Emission Rates

Alumina	Emission Rate				Units
	NO_x	SO_2	PM_{10}	CO	
Cruise	0.0070	0.0041	0.0006	0.0005	g/m/s
RSZ	0.0036	0.0022	0.0003	0.0003	g/m/s
Manoeuvring	0.0051	0.0037	0.0005	0.0004	g/m/s
Hotelling	0.7252	0.5910	0.0710	0.0543	g/s
CPC	**Emission Rate**				**Units**
	NO_x	SO_2	PM_{10}	CO	
Cruise	0.0053	0.0031	0.0004	0.0004	g/m/s
RSZ	0.0028	0.0018	0.0002	0.0002	g/m/s
Manoeuvring	0.0046	0.0034	0.0004	0.0004	g/m/s
Hotelling	0.7252	0.5910	0.0710	0.0543	g/s
GPC Import	**Emission Rate**				**Units**
	NO_x	SO_2	PM_{10}	CO	
Cruise	0.0053	0.0031	0.0004	0.0004	g/m/s
RSZ	0.0028	0.0050	0.0007	0.0007	g/m/s
Manoeuvring	0.0046	0.0185	0.0025	0.0024	g/m/s
Hotelling	0.7252	0.5910	0.0710	0.0543	g/s
Liquid Pitch	**Emission Rate**				**Units**
	NO_x	SO_2	PM_{10}	CO	
Cruise	0.0025	0.0015	0.0002	0.0002	g/m/s
RSZ	0.0015	0.0010	0.0001	0.0001	g/m/s
Manoeuvring	0.0029	0.0023	0.0003	0.0002	g/m/s
Hotelling	1.8855	1.5366	0.1847	0.1411	g/s

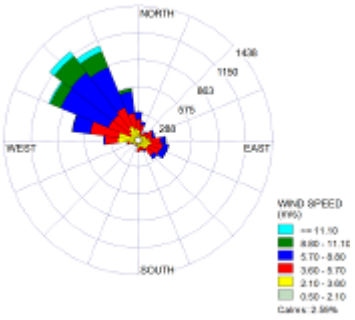
Vessels were assumed to be in berth (hotelling) during those periods set out in **Section 2.8**, and periods of cruising, RSZ and manoeuvring were included for the hour before and after each vessel is berthed.

[9] U.S. Environmental Protection Agency (2009). Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories. Final Report, April 2009.

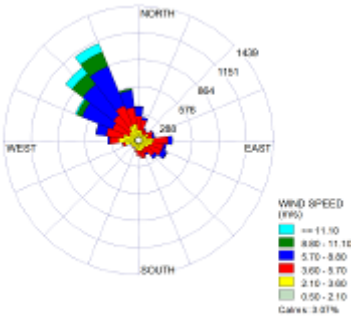
Five years (2011–2015) of hourly sequential meteorological data from the Bahrain International Airport meteorological recording station were used in the model runs. This meteorological recording station was the closest (approximately 13km to the north-west) and most representative recording station for the study area. Wind roses for 2011 - 2015 are provided in **Figure 6.2**. Evaluation of the wind roses indicate a consistent, predominant north westerly wind direction across the five-year period.

Figure 6.2 Annual Wind Roses – Bahrain 2011 - 2015

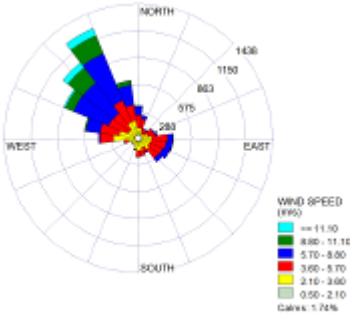
2011



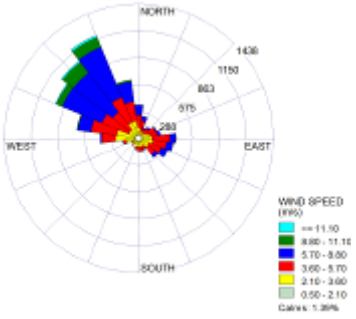
2012



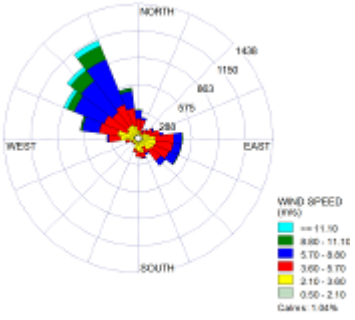
2013



2014



2015



As set out in **Section 4 Planning and Land Use**, the selected representative sensitive receptor locations in the air quality assessment were:

- the existing Sitra residential area;
- the proposed East Sitra Housing Development;

- Ma'ameer Village;
- the Bapco Labour accommodation for the Bapco Modernisation Programme and its Aromatics project;
- the Bapco and GPIC jetties; and
- Fasht Al Adhm.

These locations were represented by thirteen discrete receptor points used in the model set up, as detailed in **Table 6.3**, and shown in **Figure 6.3**.

Table 6.3 Model Receptor Locations

Receptor name	X(m)	Y(m)	Location	Z(m)
R1	464780.4	2894476	East Sitra	1.5
R2	464085.7	2893266	East Sitra	1.5
R3	462952.8	2893964	Sitra	1.5
R4	462782.6	2893279	Sitra	1.5
R5	466803.1	2893772	Bapco jetty	1.5
R6	467479.9	2893057	GPIC jetty	1.5
R7	462323.2	2887737	Bapco workers accommodation	1.5
R8	461682.7	2890582	Ma'ameer	1.5
R9	461266.4	2891826	Ma'ameer	1.5
R10	466475.4	2891558	Fasht al Adhm	0
R11	467643.8	2891951	Fasht al Adhm	0
R12	469415.5	2892034	Fasht al Adhm	0
R13	471664.9	2895744	Sh. Khalifa bin Salman Port	1.5

For the assessment of the operational traffic haul route as it passes the proposed Bapco Workers Accommodation building, an additional receptor was added (R14) at the boundary of the accommodation area, at 20m from the road, to represent the worst case likely future exposure location.

Figure 6.3 Receptor Locations R1 – R13

Key

	Vessel emission point locations at the jetty
	Discrete model receptor point locations
	Fasht al Adhm boundary

6.3.4 ESIA Significance Criteria

In addition to the general ESIA impact criteria set out in **Section 3.4**, the air quality assessment applied the screening criteria provided by the IFC[4] which are as follows:

- *Emissions do not result in pollutant concentrations that reach or exceed relevant ambient quality guidelines and standards by applying national legislated standards, or in their absence, the current WHO Air Quality Guidelines or other internationally recognized sources; and*

- *Emissions do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards. As a general rule, this Guideline suggests 25 percent of the applicable air quality standards to allow additional, future sustainable development in the same airshed.*

Where relevant air quality standards are predicted to be met, the assessment has considered that the IFC requirements are complied with and air quality impacts in EIA terms are not significant.

In describing air quality at receptor locations, the assessment has used the terms Process Contribution (PC), the modelled value as a result of project emissions, and the Predicted Environmental Concentration (PEC), which is the PC added to the local

background pollutant concentration[10]. A further consideration in the assessment was therefore whether the predicted pollutant PC values would be less than 25% of the relevant standard.

Where the additional effect on local air quality due to the Port Capacity Upgrade project would be likely to be significant, that is, to give rise to an exceedance of a relevant standard as a result of the changes, additional mitigation measures would be required.

This approach was based on the assessment criteria set out in **Table 6.4** for the construction and operational phases.

Table 6.4 Air Quality Assessment Criteria

Impact Significance	Impact Characteristic	
	Construction Phase	**Operational Phase**
Major Adverse	Risk based assessment concludes significant off-site effects, with revisions required to the project CEMP.	The Port Upgrade project gives rise to a significant breach of relevant air quality standards or guidelines, and/or a substantial change in primary pollutant emissions in the context of IFC guidelines.
Moderate Adverse	Risk based assessment concludes some off-site effects, with revisions required to the project CEMP.	The Port Upgrade project gives rise to a minor breach of relevant air quality standards or guidelines, and/or a significant change in primary pollutant emissions in the context of IFC guidelines.
Minor Adverse	Risk based assessment concludes minor off-site effects, with minor revisions required to the project CEMP.	The Port Upgrade project gives rise to minor changes in primary pollutant emissions, but relevant air quality standards would be met and there would be a minor change in effects at receptor locations.
Negligible	Risk based assessment concludes no significant off-site effects, and that the project CEMP will provide adequate controls.	The Port Upgrade project gives rise to no material changes in primary pollutant emissions, relevant air quality standards would be met and there would be no material change in effects at receptor locations.

[10] *In accordance with UK Environment Agency H1 Environmental Permitting Guidance (Annex F), the short term background concentration was taken to be twice the long term background concentration: PECshort term = PCshort term + (2 x Background long term)*

6.3.5 Mitigation and Management

Where the assessment identifies adverse impacts, where appropriate, management and mitigation measures are proposed to reduce the impact. These approaches are based on the air emissions management strategies as set out in IFC Guidelines for Ports, Harbours and Terminals[11], which cross-refer to those for Shipping[12]. Management and mitigation measures include as a matter of course recommendations for good practice in construction and environmental management.

6.4 Air Quality Baseline

The original ESIA undertaken for the Alba Line 6 development (Bilfinger Tebodin BV, 2014) provided an overview of existing air quality, based on historical data from the previous SCE automatic monitoring network, which included an air quality monitoring station in the Central Governorate. This network was discontinued in late 2012; in summary, the 2012 data indicated that:

- Most measurements of SO_2, NO_2 and PM_{10} were within the relevant national standards;
- SO_2 levels exceeded the 1 hour standard on 2 occasions in March 2012;
- Nitrogen dioxide (NO_2) levels were elevated in July and August 2012 with reported exceedences of the 1-hour standard; this may have been associated with atmospheric ozone interactions, although analyser drift at the end of the monitoring network support may have been a contributory cause;
- Particulate matter (PM_{10}) levels were raised occasionally throughout the monitoring period with the PM_{10} 24-hour standard being exceeded on some days in nearly all months. This reflects ambient conditions across Bahrain which are influenced by seasonal meteorology and natural sources of airborne particulates.

Based on these data, **Table 6.3** provides the background concentrations of sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO) and particulate matter (PM_{10}) used in the assessment

Table 6.5 Background Air Pollutant Concentrations

Pollutant	Long Term Background Concentration, µg.m^{-3}
SO_2	6
NO_2	17
CO	630
PM_{10}	91

Table 6.5 shows that the average urban background pollutant concentrations are below the respective Bahrain national air quality standards. The continuous, long-term monitoring data are considered to be robust, and representative of background air

[11] International Finance Corporation (2017). Environmental, Health and Safety Guidelines for Ports, Harbours and Terminals. 2 February 2017

[12] International Finance Corporation (2007). Environmental, Health and Safety Guidelines for Shipping. 30 April 2007

quality in the region, and were taken to represent baseline conditions for this assessment.

6.5 Impact Assessment

6.5.1 Construction Phase

6.5.1.1 On-site Construction Dust Emissions

An assessment of potential air quality impacts associated with the construction project was carried out in accordance with IAQM guidance[8]. The first stage is to screen for the requirement for a detailed assessment, based on the distance of potentially sensitive receptors from the works.

A detailed construction dust assessment is required where there are human receptors within 350m of the site boundary and/or within 50m of the route(s) used by construction vehicles on the public highway, up to 500m from the site entrance(s). Designated or sensitive ecological sites, those within 50m of the site boundary or within 50m of the route(s) used by construction vehicles on the public highway, up to 500m from the site entrance(s), are also identified at this screening stage.

The jetty construction and GPC shed demolition activities are well beyond these distance criteria for potential construction dust effects on residential settlements and the ecologically sensitive Fasht. Therefore, the IAQM guidance indicates that no significant effects are likely, and in accordance with **Table 6.4**, construction dust impacts will be **negligible**.

6.5.1.2 Off-site Construction Traffic Emissions

The project EPC contractor has not yet been able to provide details of the off-site demolition and construction vehicle movements. Assuming that the haul route will follow the principal project network along Sitra Wharf access road, along Um Al Saad Avenue, to the main King Hamad Highway (see **Figure 14.2**), then no permanent receptors will be affected.

6.5.2 Operational Phase

6.5.2.1 Shipping Emissions Modelling Results

The results of the shipping emissions modelling study are presented in **Tables 6.6 to 6.14**, showing the maximum short-term and long-term pollutant concentrations at each receptor location, applying 5 years of meteorological data. The tables also show the percentage contribution of the project emissions (the Process Contribution, PC) to the relevant air quality standard, together with the overall Predicted Environmental Concentration (PEC), accounting for the existing background levels.

The predicted maximum short-term concentrations are the same for the upgraded port and the existing operations, given that emissions occur from existing shipping movements and may coincide with worst-case peak hour dispersion conditions.

Table 6.6 Modelled Annual Mean Nitrogen Dioxide Concentrations - Shipping

Ref	Receptor	Without Scheme PC, $\mu g.m^{-3}$	With Scheme PC, $\mu g.m^{-3}$	Change PC, $\mu g.m^{-3}$	Change/ AQS %	With Scheme PEC, $\mu g.m^{-3}$	PEC/AQS %
R1	East Sitra	0.0115	0.0141	0.0026	0.01%	17.01	42.5%
R2	East Sitra	0.0144	0.0194	0.0049	0.01%	17.02	42.5%
R3	Sitra	0.0087	0.0120	0.0033	0.01%	17.01	42.5%
R4	Sitra	0.0098	0.0129	0.0032	0.01%	17.01	42.5%
R5	Bapco jetty	0.0187	0.0242	0.0055	0.01%	17.02	42.6%
R6	GPIC jetty	0.0256	0.0303	0.0047	0.01%	17.03	42.6%
R7	Bapco WA	0.0019	0.0024	0.0006	0.00%	17.00	42.5%
R8	Ma'ameer	0.0031	0.0043	0.0011	0.00%	17.00	42.5%
R9	Ma'ameer	0.0040	0.0048	0.0008	0.00%	17.00	42.5%
R10	Fasht al Adhm	0.0118	0.0146	0.0027	0.01%	17.01	42.5%
R11	Fasht al Adhm	0.0503	0.0679	0.0176	0.04%	17.07	42.7%
R12	Fasht al Adhm	0.0464	0.0613	0.0149	0.04%	17.06	42.7%
R13	Sh. Khalifa bin Salman Port	0.0016	0.0020	0.0004	0.00%	17.00	42.5%

Table 6.7 Modelled 1-hour Mean Nitrogen Dioxide Concentrations - Shipping

Ref	Receptor	With Scheme PC, $\mu g.m^{-3}$	Change/AQS %	With Scheme PEC, $\mu g.m^{-3}$	PEC/AQS %
R1	East Sitra	3.25	2%	37.25	19%
R2	East Sitra	3.60	2%	37.60	19%
R3	Sitra	3.36	2%	37.36	19%
R4	Sitra	3.65	2%	37.65	19%
R5	Bapco jetty	11.02	6%	45.02	23%
R6	GPIC jetty	32.72	16%	66.72	33%
R7	Bapco WA	1.81	1%	35.81	18%
R8	Ma'ameer	1.55	1%	35.55	18%
R9	Ma'ameer	2.53	1%	36.53	18%
R10	Fasht al Adhm	5.06	3%	39.06	20%
R11	Fasht al Adhm	8.42	4%	42.42	21%
R12	Fasht al Adhm	5.31	3%	39.31	20%
R13	Sh. Khalifa bin Salman Port	2.27	1%	36.27	18%

Table 6.8 Modelled 24-hour Mean Nitrogen Dioxide Concentrations - Shipping

Ref	Receptor	With Scheme PC, $\mu g.m^{-3}$	Change/AQS %	With Scheme PEC, $\mu g.m^{-3}$	PEC/AQS %
R1	East Sitra	0.88	1%	34.88	23%
R2	East Sitra	0.44	0%	34.44	23%
R3	Sitra	0.45	0%	34.45	23%
R4	Sitra	0.39	0%	34.39	23%
R5	Bapco jetty	1.89	1%	35.89	24%
R6	GPIC jetty	2.85	2%	36.85	25%
R7	Bapco WA	0.14	0%	34.14	23%
R8	Ma'ameer	0.20	0%	34.20	23%
R9	Ma'ameer	0.15	0%	34.15	23%
R10	Fasht al Adhm	0.62	0%	34.62	23%
R11	Fasht al Adhm	1.76	1%	35.76	24%
R12	Fasht al Adhm	1.13	1%	35.13	23%
R13	Sh. Khalifa bin Salman Port	0.13	0%	34.13	23%

Table 6.9 Modelled Annual Mean Sulphur Dioxide Concentrations - Shipping

Ref	Receptor	Without Scheme PC, µg.m^{-3}	With Scheme PC, µg.m^{-3}	Change PC, µg.m^{-3}	Change/AQS %	With Scheme PEC, µg.m^{-3}	PEC/AQS %
R1	East Sitra	0.0161	0.0213	0.0052	0.01%	6.02	12.0%
R2	East Sitra	0.0208	0.0293	0.0085	0.02%	6.03	12.1%
R3	Sitra	0.0126	0.0172	0.0046	0.01%	6.02	12.0%
R4	Sitra	0.0138	0.0193	0.0055	0.01%	6.02	12.0%
R5	Bapco jetty	0.0358	0.0506	0.0148	0.03%	6.05	12.1%
R6	GPIC jetty	0.0211	0.0245	0.0035	0.01%	6.02	12.0%
R7	Bapco WA	0.0025	0.0033	0.0008	0.00%	6.00	12.0%
R8	Ma'ameer	0.0049	0.0064	0.0015	0.00%	6.01	12.0%
R9	Ma'ameer	0.0052	0.0064	0.0012	0.00%	6.01	12.0%
R10	Fasht al Adhm	0.0146	0.0186	0.0040	0.01%	6.02	12.0%
R11	Fasht al Adhm	0.0743	0.0932	0.0190	0.04%	6.09	12.2%
R12	Fasht al Adhm	0.0608	0.0844	0.0236	0.05%	6.08	12.2%
R13	Sh. Khalifa bin Salman Port	0.0018	0.0021	0.0003	0.00%	6.00	12.0%

Table 6.10 Modelled 1-hour Mean Sulphur Dioxide Concentrations - Shipping

Ref	Receptor	With Scheme PC, µg.m^{-3}	Change/AQS %	With Scheme PEC, µg.m^{-3}	PEC/AQS %
R1	East Sitra	23.47	7%	35.47	10%
R2	East Sitra	27.48	8%	39.48	11%
R3	Sitra	19.90	6%	31.90	9%
R4	Sitra	19.45	6%	31.45	9%
R5	Bapco jetty	56.84	16%	68.84	20%
R6	GPIC jetty	26.65	8%	38.65	11%
R7	Bapco WA	6.22	2%	18.22	5%
R8	Ma'ameer	9.00	3%	21.00	6%
R9	Ma'ameer	4.50	1%	16.50	5%
R10	Fasht al Adhm	24.95	7%	36.95	11%
R11	Fasht al Adhm	47.29	14%	59.29	17%
R12	Fasht al Adhm	24.99	7%	36.99	11%
R13	Sh. Khalifa bin Salman Port	3.99	1%	15.99	5%

Table 6.11 Modelled 24-hour Mean Sulphur Dioxide Concentrations - Shipping

Ref	Receptor	With Scheme PC, $\mu g.m^{-3}$	Change/AQS %	With Scheme PEC, $\mu g.m^{-3}$	PEC/AQS %
R1	East Sitra	2.62	2%	14.62	12%
R2	East Sitra	4.60	4%	16.60	13%
R3	Sitra	1.51	1%	13.51	11%
R4	Sitra	3.03	2%	15.03	12%
R5	Bapco jetty	4.41	4%	16.41	13%
R6	GPIC jetty	2.32	2%	14.32	11%
R7	Bapco WA	0.40	0%	12.40	10%
R8	Ma'ameer	0.79	1%	12.79	10%
R9	Ma'ameer	0.62	0%	12.62	10%
R10	Fasht al Adhm	1.30	1%	13.30	11%
R11	Fasht al Adhm	7.61	6%	19.61	16%
R12	Fasht al Adhm	4.54	4%	16.54	13%
R13	Sh. Khalifa bin Salman Port	0.18	0%	12.18	10%

Table 6.12 Modelled Annual Mean PM_{10} Concentrations - Shipping

Ref	Receptor	Without Scheme PC, $\mu g.m^{-3}$	With Scheme PC, $\mu g.m^{-3}$	Change PC, $\mu g.m^{-3}$	Change/AQS %	With Scheme PEC, $\mu g.m^{-3}$	PEC/AQS %
R1	East Sitra	0.0020	0.0027	0.0007	0.00%	91.00	455%
R2	East Sitra	0.0026	0.0037	0.0011	0.01%	91.00	455%
R3	Sitra	0.0016	0.0022	0.0006	0.00%	91.00	455%
R4	Sitra	0.0017	0.0025	0.0007	0.00%	91.00	455%
R5	Bapco jetty	0.0046	0.0066	0.0019	0.01%	91.01	455%
R6	GPIC jetty	0.0025	0.0029	0.0004	0.00%	91.00	455%
R7	Bapco WA	0.0003	0.0004	0.0001	0.00%	91.00	455%
R8	Ma'ameer	0.0006	0.0008	0.0002	0.00%	91.00	455%
R9	Ma'ameer	0.0007	0.0008	0.0002	0.00%	91.00	455%
R10	Fasht al Adhm	0.0018	0.0024	0.0005	0.00%	91.00	455%
R11	Fasht al Adhm	0.0095	0.0118	0.0023	0.01%	91.01	455%
R12	Fasht al Adhm	0.0076	0.0107	0.0030	0.02%	91.01	455%
R13	Sh. Khalifa bin Salman Port	0.0002	0.0003	0.0000	0.00%	91.00	455%

Table 6.13 Modelled 24-hour Mean PM_{10} Concentrations - Shipping

Ref	Receptor	With Scheme PC, $\mu g.m^{-3}$	Change/AQS %	With Scheme PEC, $\mu g.m^{-3}$	PEC/AQS %
R1	East Sitra	0.36	1%	182.36	365%
R2	East Sitra	0.63	1%	182.63	365%
R3	Sitra	0.20	0%	182.20	364%
R4	Sitra	0.41	1%	182.41	365%
R5	Bapco jetty	0.60	1%	182.60	365%
R6	GPIC jetty	0.27	1%	182.27	365%
R7	Bapco WA	0.05	0%	182.05	364%
R8	Ma'ameer	0.11	0%	182.11	364%
R9	Ma'ameer	0.08	0%	182.08	364%
R10	Fasht al Adhm	0.18	0%	182.18	364%
R11	Fasht al Adhm	1.04	2%	183.04	366%
R12	Fasht al Adhm	0.62	1%	182.62	365%
R13	Sh. Khalifa bin Salman Port	0.02	0%	182.02	364%

Table 6.14 Modelled 8-hour Mean Carbon Monoxide Concentrations - Shipping

Ref	Receptor	With Scheme PC, $\mu g.m^{-3}$	Change/AQS %	With Scheme PEC, $\mu g.m^{-3}$	PEC/AQS %
R1	East Sitra	0.88	0%	1260.88	13%
R2	East Sitra	1.26	0%	1261.26	13%
R3	Sitra	0.57	0%	1260.57	13%
R4	Sitra	0.84	0%	1260.84	13%
R5	Bapco jetty	1.76	0%	1261.76	13%
R6	GPIC jetty	0.60	0%	1260.60	13%
R7	Bapco WA	0.16	0%	1260.16	13%
R8	Ma'ameer	0.27	0%	1260.27	13%
R9	Ma'ameer	0.21	0%	1260.21	13%
R10	Fasht al Adhm	0.52	0%	1260.52	13%
R11	Fasht al Adhm	2.91	0%	1262.91	13%
R12	Fasht al Adhm	1.72	0%	1261.72	13%
R13	Sh. Khalifa bin Salman Port	0.07	0%	1260.07	13%

6.5.2.2 Shipping Emissions Results Discussion

Tables 6.6 to 6.11 and **Table 6.14** show that the maximum modelled long-term and short-term PC values for nitrogen dioxide, sulphur dioxide and carbon monoxide are all below 25% of the relevant air quality standard, and that total PEC values, including the existing background concentration, do not give rise to a breach of any relevant standard. **Tables 6.12 and 6.13** show that the maximum predicted long and short-term PC values for PM_{10} are also well below 25% of the relevant standards, although due to elevated background PM_{10} concentrations, the PEC values are greater than the standards.

A summary of the individual pollutant receptor concentration results is as follows:

Nitrogen dioxide: **Table 6.6** shows that annual mean PC values at all receptors are all less than 0.1% of the standard, and add a negligible contribution to the existing background levels, with the total remaining around a third of the standard. **Tables 6.7 and 6.8** show a similar impact for short term (1-hour and 24-hour) PC values, the largest hourly maxima being predicted on the Bapco and GPIC jetties, as would be expected. The short-term PEC vales, including the background contribution, are around 25% of the relevant standards for most receptor locations, and up to 33% on the jetty.

Sulphur dioxide: **Table 6.9** shows that annual mean PC values at all receptors are all less than 0.1% of the standard, and add a negligible contribution to the existing background levels, with the total remaining below 40% of the standard at all receptors. **Tables 6.10 and 6.11** show that the predicted short term (1-hour and 24-hour) PC values are generally below 10% of the relevant standards, with again the largest hourly maxima being at the most proximate receptors on the Bapco and GPIC jetties, and at the boundary of the Fasht. The short-term PEC values, including the background contribution, are at or below 20% of the hourly and the daily standard at all receptors.

Carbon monoxide: **Table 6.14** shows that 8-hour average PC values at all receptors are negligible, and so add a negligible contribution to the existing background levels, with the total remaining around 13% of the standard at all receptors.

PM_{10}: **Tables 6.12 and 6.13** show that the predicted annual mean PC values at all receptors are less than 0.1% of the WHO Guideline, and therefore add a negligible contribution to the existing background levels, which monitoring data indicate are significantly above this benchmark value at urban background locations. These existing concentrations are also above the WHO Interim Target value. Daily average PM_{10} PC values are below 2% of the WHO Guideline (and less than 0.3% of the Bahrain national standard). The existing background concentrations are greater than the short-term WHO Guideline.

The results show that the additional shipping emissions give rise to insignificant air quality impacts at all receptors, and are all well below a 25% contribution to the relevant standard, in accordance with the IFC Guideline criterion. Total pollutant concentrations, including the existing background component, remain below the relevant annual and short-term average standards except for PM_{10}, for which existing levels are greater than the WHO Guideline values. The overall impact of shipping emissions associated with the port upgrade project is **negligible**.

6.5.2.3 Road Traffic Emissions

As described in **Section 6.3.3**, the additional 14 HGV movements per hour associated with the Port Upgrade Project were modelled using the ADMS-Roads system, assuming an average speed along the route of 32kph (20mph). The results at all receptors (including R14, representative of the worst case likely future exposure location within the future Bapco worker accommodation unit), are given in **Tables 6.15 to 6.20**.

Table 6.15 Modelled Annual Mean Nitrogen Dioxide Concentrations - Traffic

Ref	Receptor	Without Scheme PC, $\mu g.m^{-3}$	With Scheme PC, $\mu g.m^{-3}$	Change PC, $\mu g.m^{-3}$	Change/AQS %	With Scheme PEC, $\mu g.m^{-3}$	PEC/AQS %
R1	East Sitra	0.01	0.01	0.00	0%	17.01	43%
R2	East Sitra	0.02	0.03	0.01	0%	17.03	43%
R3	Sitra	0.01	0.01	0.00	0%	17.01	43%
R4	Sitra	0.01	0.02	0.01	0%	17.02	43%
R5	Bapco jetty	0.01	0.02	0.01	0%	17.02	43%
R6	GPIC jetty	0.02	0.04	0.02	0%	17.04	43%
R7	Bapco WA	0.06	0.10	0.04	0%	17.10	43%
R8	Ma'ameer	0.01	0.02	0.01	0%	17.02	43%
R9	Ma'ameer	0.01	0.02	0.01	0%	17.02	43%
R10	Fasht al Adhm	0.01	0.02	0.01	0%	17.02	43%
R11	Fasht al Adhm	0.01	0.02	0.01	0%	17.02	43%
R12	Fasht al Adhm	0.00	0.01	0.00	0%	17.01	43%
R13	Sh. Khalifa bin Salman Port	0.00	0.00	0.00	0%	17.00	43%
R14	Bapco WA roadside	0.64	1.09	0.45	1%	18.09	45%

Table 6.16 Modelled 1-hour Mean Nitrogen Dioxide Concentrations – Traffic

Ref	Receptor	Without Scheme PC, $\mu g.m^{-3}$	With Scheme PC, $\mu g.m^{-3}$	Change PC, $\mu g.m^{-3}$	Change/AQS %	With Scheme PEC, $\mu g.m^{-3}$	PEC/AQS %
R1	East Sitra	0.37	0.63	0.26	0%	34.63	17%
R2	East Sitra	0.42	0.72	0.30	0%	34.72	17%
R3	Sitra	0.16	0.27	0.11	0%	34.27	17%
R4	Sitra	0.18	0.31	0.13	0%	34.31	17%
R5	Bapco jetty	0.28	0.47	0.20	0%	34.47	17%
R6	GPIC jetty	0.55	0.93	0.38	0%	34.93	17%
R7	Bapco WA	0.49	0.83	0.34	0%	34.83	17%
R8	Ma'ameer	0.22	0.37	0.15	0%	34.37	17%
R9	Ma'ameer	0.23	0.40	0.16	0%	34.40	17%
R10	Fasht al Adhm	0.14	0.24	0.10	0%	34.24	17%
R11	Fasht al Adhm	0.17	0.29	0.12	0%	34.29	17%
R12	Fasht al Adhm	0.19	0.32	0.13	0%	34.32	17%
R13	Sh. Khalifa bin Salman Port	0.19	0.32	0.13	0%	34.32	17%
R14	Bapco WA roadside	2.69	4.53	1.84	1%	38.53	19%

Table 6.17 Modelled 24-hour Mean Nitrogen Dioxide Concentrations – Traffic

Ref	Receptor	Without Scheme PC, $\mu g.m^{-3}$	With Scheme PC, $\mu g.m^{-3}$	Change PC, $\mu g.m^{-3}$	Change/AQS %	With Scheme PEC, $\mu g.m^{-3}$	PEC/AQS %
R1	East Sitra	0.05	0.09	0.04	0%	34.09	23%
R2	East Sitra	0.09	0.15	0.06	0%	34.15	23%
R3	Sitra	0.07	0.12	0.05	0%	34.12	23%
R4	Sitra	0.10	0.18	0.07	0%	34.18	23%
R5	Bapco jetty	0.13	0.22	0.09	0%	34.22	23%
R6	GPIC jetty	0.17	0.30	0.12	0%	34.30	23%
R7	Bapco WA	0.21	0.36	0.15	0%	34.36	23%
R8	Ma'ameer	0.07	0.12	0.05	0%	34.12	23%
R9	Ma'ameer	0.08	0.14	0.06	0%	34.14	23%
R10	Fasht al Adhm	0.06	0.10	0.04	0%	34.10	23%
R11	Fasht al Adhm	0.06	0.11	0.04	0%	34.11	23%
R12	Fasht al Adhm	0.03	0.06	0.02	0%	34.06	23%
R13	Sh. Khalifa bin Salman Port	0.02	0.03	0.01	0%	34.03	23%
R14	Bapco WA roadside	1.99	3.36	1.38	1%	37.36	25%

Table 6.18 Modelled Annual Mean PM_{10} Concentrations – Traffic

Ref	Receptor	Without Scheme PC, $\mu g.m^{-3}$	With Scheme PC, $\mu g.m^{-3}$	Change PC, $\mu g.m^{-3}$	Change/AQS %	With Scheme PEC, $\mu g.m^{-3}$	PEC/AQS %
R1	East Sitra	0.0004	0.0006	0.0003	0%	91.00	455%
R2	East Sitra	0.0009	0.0015	0.0006	0%	91.00	455%
R3	Sitra	0.0004	0.0007	0.0003	0%	91.00	455%
R4	Sitra	0.0006	0.0010	0.0004	0%	91.00	455%
R5	Bapco jetty	0.0007	0.0012	0.0005	0%	91.00	455%
R6	GPIC jetty	0.0013	0.0022	0.0009	0%	91.00	455%
R7	Bapco WA	0.0036	0.0061	0.0025	0%	91.01	455%
R8	Ma'ameer	0.0007	0.0013	0.0005	0%	91.00	455%
R9	Ma'ameer	0.0005	0.0009	0.0004	0%	91.00	455%
R10	Fasht al Adhm	0.0008	0.0014	0.0006	0%	91.00	455%
R11	Fasht al Adhm	0.0007	0.0013	0.0005	0%	91.00	455%
R12	Fasht al Adhm	0.0003	0.0004	0.0002	0%	91.00	455%
R13	Sh. Khalifa bin Salman Port	0.0001	0.0001	0.0000	0%	91.00	455%
R14	Bapco WA roadside	0.0379	0.0645	0.0265	0%	91.06	455%

Table 6.19 Modelled 24-Hour Mean PM_{10} Concentrations - Traffic

Ref	Receptor	Without Scheme PC, $\mu g.m^{-3}$	With Scheme PC, $\mu g.m^{-3}$	Change PC, $\mu g.m^{-3}$	Change/AQS %	With Scheme PEC, $\mu g.m^{-3}$	PEC/AQS %
R1	East Sitra	0.0032	0.0054	0.0022	0%	182.01	364%
R2	East Sitra	0.0051	0.0086	0.0036	0%	182.01	364%
R3	Sitra	0.0041	0.0069	0.0029	0%	182.01	364%
R4	Sitra	0.0062	0.0105	0.0043	0%	182.01	364%
R5	Bapco jetty	0.0077	0.0130	0.0053	0%	182.01	364%
R6	GPIC jetty	0.0103	0.0175	0.0072	0%	182.02	364%
R7	Bapco WA	0.0126	0.0214	0.0088	0%	182.02	364%
R8	Ma'ameer	0.0043	0.0072	0.0030	0%	182.01	364%
R9	Ma'ameer	0.0050	0.0084	0.0035	0%	182.01	364%
R10	Fasht al Adhm	0.0036	0.0061	0.0025	0%	182.01	364%
R11	Fasht al Adhm	0.0038	0.0064	0.0026	0%	182.01	364%
R12	Fasht al Adhm	0.0020	0.0033	0.0014	0%	182.00	364%
R13	Sh. Khalifa bin Salman Port	0.0010	0.0016	0.0007	0%	182.00	364%
R14	Bapco WA roadside	0.1176	0.1991	0.0815	0%	182.20	364%

Table 6.20 Modelled 8-Hour Mean CO Concentrations – Traffic

Ref	Receptor	Without Scheme PC, $\mu g.m^{-3}$	With Scheme PC, $\mu g.m^{-3}$	Change PC, $\mu g.m^{-3}$	Change/AQS %	With Scheme PEC, $\mu g.m^{-3}$	PEC/AQS %
R1	East Sitra	0.07	0.12	0.05	0%	1260.12	13%
R2	East Sitra	0.10	0.17	0.07	0%	1260.17	13%
R3	Sitra	0.06	0.11	0.04	0%	1260.11	13%
R4	Sitra	0.07	0.13	0.05	0%	1260.13	13%
R5	Bapco jetty	0.13	0.22	0.09	0%	1260.22	13%
R6	GPIC jetty	0.27	0.46	0.19	0%	1260.46	13%
R7	Bapco WA	0.21	0.35	0.14	0%	1260.35	13%
R8	Ma'ameer	0.10	0.16	0.07	0%	1260.16	13%
R9	Ma'ameer	0.06	0.11	0.04	0%	1260.11	13%
R10	Fasht al Adhm	0.05	0.08	0.03	0%	1260.08	13%
R11	Fasht al Adhm	0.07	0.11	0.05	0%	1260.11	13%
R12	Fasht al Adhm	0.04	0.08	0.03	0%	1260.08	13%
R13	Sh. Khalifa bin Salman Port	0.03	0.05	0.02	0%	1260.05	13%
R14	Bapco WA roadside	1.45	2.44	0.99	0%	1262.44	13%

6.5.2.4 Road Traffic Emission Results Discussion

Tables 6.15 to 6.17 and **Table 6.20** show that the maximum modelled long-term and short-term PC values for nitrogen dioxide and carbon monoxide from traffic emissions are all below 1% of the relevant air quality standard, and that total PEC values, including the existing background concentration, do not give rise to a breach of any relevant

standard. **Tables 6.18 and 6.19** show that the maximum predicted long and short-term PC values for PM_{10} are negligible, although due to elevated background PM_{10} concentrations, the PEC values are greater than the respective standards.

The results show that the additional road transport emissions give rise to insignificant air quality impacts at all receptors, and are all well below a 25% contribution to the relevant standard, in accordance with the IFC Guideline criterion. Total pollutant concentrations, including the existing background component, remain below the relevant annual and short-term average standards except for PM_{10}, for which existing levels are greater than the WHO Guideline values. The overall impact of HGV emissions associated with the port upgrade project is **negligible**.

6.5.3 Nuisance Dust Assessment

As part of stakeholder engagement for the ESIA consultations were held with GPIC. GPIC reported that they had a specific on-going concern with respect to the deposition of fugitive pet coke dust at the GPIC Urea Jetty. It is reported that during unloading of pet coke (particularly a fine grained pet coke sourced from Kuwait) that fugitive emissions occur and impact the GPIC Urea Jetty. As the urea product, which GPIC export from the jetty, is white there is a concern that the black pet coke particles may visibly impact the quality of the product and lead to customer complaints. GPIC also receive customer audits of their facilities and have expressed concern that customer representatives may raise this as a quality issue. This is an issue that the SCE are aware of and also raised during the ESIA commencement meeting with them. As part of the Port Capacity Upgrade works there will be improvements made to the pet coke handling and conveying systems designed to reduce fugitive emissions (see **Section 2**).

As part of the assessment it is proposed to measure dust levels at the GPIC Urea Jetty to determine the impact of fugitive emissions of pet coke dust. It is proposed to use depositional and directional dust gauges to measure dust deposition rates during unloading of ships delivering pet coke at Alba jetty. The monitoring works have been discussed with GPIC and will be undertaken with their agreement and cooperation. The work will comprise:

i. Measurement of average dust deposition rates at GPIC Urea Jetty and GPIC jetty site entrance during periods of pet coke ship unloading and when pet coke ship unloading is not occurring.

ii. Simultaneously measurement of the compass direction that dust is coming from using a directional dust deposition gauge will be carried out.

iii. Analysis of deposited dust composition using optical microscopy to attempt to determine whether deposited dust at the GPCI Urea Jetty contains pet coke.

iv. Recording of weather conditions during monitoring periods using data for Bahrain International Airport.

It is expected that work may take up to 6 months to complete as it will be necessary to monitor dust emissions under specific conditions including when pet coke is being unloaded and the GPIC Urea Jetty is downwind. Once the monitoring work is complete it will be reported in a supplementary ESIA dust monitoring report.

6.5.4 Operational Phase Impact Conclusions

The impact of shipping and HGV haul route emissions at the selected range of receptor locations will be negligible, and in combination would not therefore give rise to significant effects at any one location. The greatest impacts, as would be expected, are at locations in closest proximity to the emission source, and for shipping emissions this would be on the existing jetties, and for road transport would be at the receptor representative of the future Bapco workers' accommodation, at an assumed worst-case position close to the roadside. The terrestrial residential receptor locations are all upwind of these emission sources and at a sufficient distant for the pollutant releases to be sufficiently diluted and dispersed, such that impacts will be **negligible**.

6.6 Mitigation

6.6.1 Demolition and Construction Phases

The assessment has shown that construction dust and vehicle emissions impacts during the demolition and construction phases of the Port Upgrade development will be negligible, due to the distance separation between activities and sensitive receptors, and so no specific mitigation measures are required. The EPC Contractor will prepare a CEMP for the works, and good international industry practice would be expected to be applied.

6.6.2 Operational Phase

The impact assessment has concluded that, due to a large distance separation and the upwind location of sensitive receptors, emissions associated with the Port Capacity Upgrade project will not be significant, and in EIA terms, mitigation of significant air quality effects is not required. Nevertheless, where appropriate and cost-effective, the general management and controls set out in the EHS Guidelines for Ports, Harbours and Terminals[11] should be considered, and the relevant, key measures are provided below:

Recommended air emissions management strategies relevant to port and terminal operations include:

- Application of air quality management procedures to avoid, minimize, and control combustion emissions, including GHG emissions, related to land-based port activities, including:
    - Where practicable, design port layouts and facilities to minimize travel distances and transfer points, for example from ships' off-loading and on-loading facilities to storage areas, and to avoid/minimize re-storage and re-shuffling of cargo.
    - Where practicable, upgrade land vehicle and equipment fleets with low emission vehicles, including use of alternative energy sources, and fuels/fuel mixtures (e.g., vehicle and equipment fleets powered by electricity or compressed natural gas, hybrid locomotives, etc.).
    - Maintain cargo transfer equipment (e.g., cranes, forklifts, and trucks) in good working condition to reduce air emissions.
    - Encourage reduced engine idling during on- and off-loading activities.

Fugitive dust emissions are generated during port and terminal construction activities, such as excavation and bulldozing; movement of fill and materials by front end loaders, excavators and trucks; and the re-suspension of dust from equipment and vehicle movement on port roadways. Dust prevention and control recommendations applicable to construction and operational phase activities are provided in the General EHS Guidelines.

Recommended equipment and techniques to manage fugitive dust associated with dry bulk materials storage and handling facilities in ports and terminals include:

- Cover storage and handling areas, where practicable (e.g., store pulverized coal and pet-coke in silos);
- Install dust suppression mechanisms (e.g., water spray);
- Use telescoping arms and chutes to minimize free fall of materials and eliminate the need for slingers;
- Regularly sweep docks and handling areas, truck and rail storage areas, and paved roadway surfaces, and use vacuum collectors at dust-generating activities;
- Use slurry transport, pneumatic or continuous screw conveyors, and covering other types of conveyors;
- Minimize dry cargo pile heights and contain piles with perimeter walls and/or wind break fencing;
- Remove materials from the bottom of piles to minimize dust re-suspension;
- Ensure that hatches are covered when material handling is not being conducted; and
- Cover transport vehicles.

A fugitive dust assessment is being carried out and a supplementary ESIA dust monitoring report will be produced on completion of the dust monitoring work. As the dust monitoring may take up to six months to complete this will be submitted after the main ESIA report.

The Port Upgrade works include engineering measures to improve the pet coke unloading and conveying equipment specifically to reduce the potential for fugitive dust emission.

6.7 Summary

Table 6.21 presents a summary of the impacts in relation to air quality.

Table 6.21 Summary of Air Quality Impacts and Mitigation Measures

Impact	Impact Significance	Mitigation	Residual Impacts
Demolition and Construction Phase			
Demolition and Construction Dust	Negligible	Best practice dust management and control measures in CEMP.	Negligible

Construction Vehicle Emissions	Negligible	Contractor to provide a Construction Traffic Management Plan.	Negligible
Operational Phase			
Additional Shipping Emissions	Negligible	Implement Ports, Harbours and Terminals general EHS Guidelines, as relevant and appropriate.	Negligible
Additional Road Transport Emissions	Negligible	Not required.	Negligible
Nuisance Dust Emissions	Not yet determined.	A fugitive dust assessment is being carried out.	Supplementary dust monitoring report will be prepared.

7 COMMUNITY HEALTH, SAFETY AND SECURITY

7.1 Introduction

The section identifies potential impacts of the Alba Port Capacity Upgrade Project construction and operation on site neighbours and the wider community. As the Port is located within the Sitra Marine Terminal, there are limited communities that could be affected, although there will be interactions with the general public through transportation during construction and operation. The following potential issues have been identified:

- Transportation of equipment and materials to site during construction;
- Impacts on fishermen during construction;
- Impacts on fishermen during decommissioning;
- Transportation of alumina, liquid pitch and CPC to the smelter during operation;
- Spillages of materials into the marine environment including oil; and
- Management of security personnel.

Management of transportation is discussed in **Section 13** and the marine environment is discussed in **Sections 11** and **12** of this ESIA Report.

7.2 Legislation and Guidance

7.2.1 International Guidance

7.2.1.1 International Finance Corporation, International Performance Standards on Environmental and Social Sustainability, 2012. Performance Standard 4, Community Health, Safety and Security (IFC PS4)

IFC PS4 provides guidance on the potential risks and impacts to Affected Communities from project activities and provides guidance on the assessment and management of potential adverse impacts. IFC PS4 is backed by technical guidance contained in the World Bank Guidelines described below.

7.2.1.2 World Bank General Environmental Health and Safety (EHS) Guidelines, 2007: 3 Community Health and Safety (World Bank, 2007a)

Provides guidance for the protection of the public in respect of impacts that may arise outside of the physical project boundaries. The guidance provides guidance on management of water quality, building safety, traffic safety, transportation of hazardous materials, disease prevention and emergency preparedness and response.

7.2.2 National Legislation

7.2.2.1 Law No. 24 of 2006 On Private Security and Guard Companies, Ministerial Order No. 36 of 2007 Authorising the General Directorate of Guards to Regulate the Security industry

These legal instruments set out the requirement for the regulation of private security companies and security guard qualification and training in Bahrain.

7.3 Assessment Methodology

The impact assessment provides a qualitative assessment of impacts based on expert judgment taking into account the magnitude and duration of any potential impacts. Impacts are classified using the impact significance descriptions in **Table 3.3**. Where needed, required management and mitigation measures to eliminate or reduce impacts to acceptable levels are described.

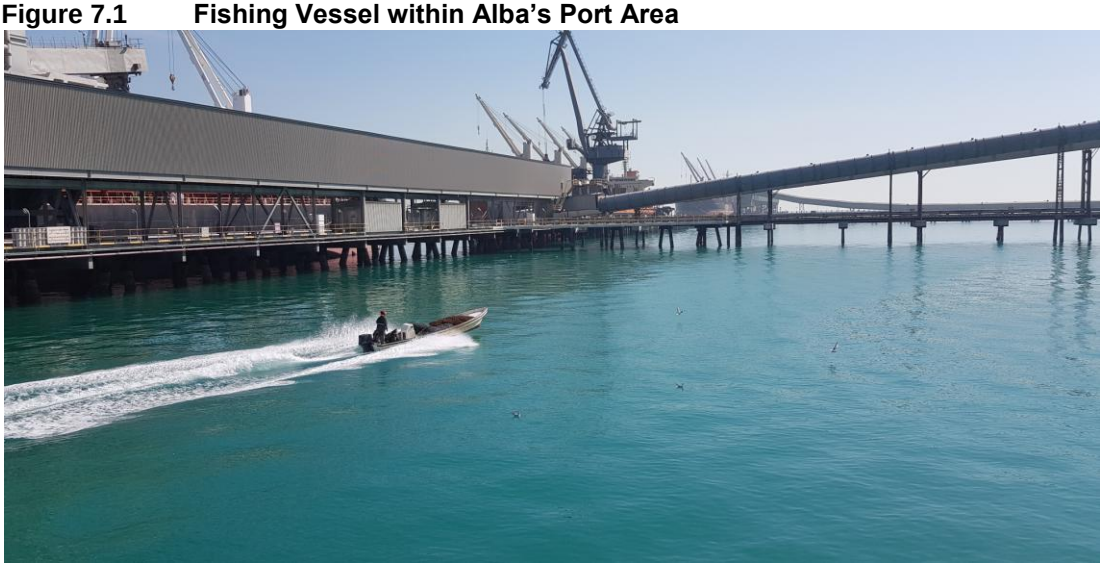
7.4 Baseline

7.4.1 Sitra Marine Terminal

The Sitra Marine Terminal is shared between Alba, Bapco, GPIC and Banagas. There are pipelines along the Terminal which transfer products from Bapco's Sitra Tank Farm to the Terminal for export. To the north of Alba's two jetties, there are two jetties belonging to Bapco, and to the south is the GPIC jetty. Alba's calciner plant is located adjacent to the jetties. To the west of the calciner, Banagas has a tank storage area.

Private craft (e.g. fishing vessels) are not allowed to enter the area around the Terminal and they are not permitted to drive their vessels underneath the roads and conveyors connecting the jetties to the land. During site visits undertaken to the Port, small fishing vessels have been observed driving within Alba's Port area (**Figure 7.1**).

Figure 7.1 Fishing Vessel within Alba's Port Area



7.4.2 Sitra Island

Sitra is one of Bahrain's largest islands with an area of approximately 22 km^2 and an estimated population of 81,000 in (2016). The island's western coast forms the boundary of Tubli Bay. Historically, the island's economy was based on agriculture and fishing; however, large sections of the island are now used for industry, specifically related to oil and gas. The southern portion of Sitra Island is dominated by GPIC and Bapco. To the north of GPIC, areas of land have been reclaimed for a project being led by NOGA.

A large plot of land has been reclaimed along the eastern coast of Sitra Island for a government housing project. The eastern edge of this development is approximately

3 km from Alba's Port. This community will be the closest once the houses have been built.

Shaikh Jaber Al Ahmed Al Subah Highway is the primary access route to Sitra Island. Many car dealerships and furniture showrooms are also present along this road. Access to the Port is available off this highway.

Sitra is the site of many school campuses including as Al Noor International School, Alia School and The Indian School, as well as many other government schools. The Applied Science University also is located in Sitra.

In the southern tip of Sitra Island there is Sitra Fishermen's Port, the Coastguard Headquarters, the Central Stores Directorate, the Bahrain Yacht Club and Al Bandar Resort.

7.4.3 Eker and Ma'ameer Villages

West of Sitra Island are the villages of Eker and Ma'ameer. With an area of 0.385 km², Al Eker is divided into 2 regions: East Eker (Block 623) and West Eker (Blocks 624, 625, 626). The village has a mix of Sunni and Shia residents. Newer homes are found in East Eker relative to West Eker. Light industry can be found in the village, including Eastern Ready Mix, wood work shop and aluminium kitchen manufacturing.

Public facilities include one health centre, two government schools and a Quran teaching centre. Commercial establishments are limited to a small market and several cold stores. Al Eker is home to the Gulf Petrochemical Industries Company (GPIC) Club and the Applied Science University.

South of the village of Eker is the village of Ma'ameer, an industrial area adjacent to the Bapco Refinery as well as a small number of factories and production units including Awal Ready-Mixed Concrete (ARMCON), Eastern Asphalt, GPIC, Aluminium Bahrain and Al Zamil Aluminium.

Ma'ameer spans four blocks: 633, 634, 635 and 636. Only two boys' schools are present in Ma'ameer in addition to one religious school (*Hawza*). As common in many Bahraini villages, there are several mosques in Ma'ameer; however, there is no health centre available for local residents. Recreational facilities are limited to one park and one cultural and sports club. Commercial establishments are also limited to small cold stores and shops. Residents of Ma'ameer are predominantly Shia Muslims.

7.4.4 Security

The general public are not allowed access to the Sitra Marine Terminal. Unauthorised people are prevented from entering by a security gate located just past the entrance to GPIC, along the Terminal access road. This security gate is controlled by Bapco. Alba has its own security team who control access into the Port/Calciner via a swing gate. Visitors have to present some form of ID and are accompanied into the Port.

7.5 Assessment of Impacts

7.5.1 Impacts on Fishermen During Construction

As discussed in **Section 7.4.1**, private craft (e.g. fishing vessels) are not allowed to enter the area around the Terminal, although they have been observed driving within Alba's Port area.

The piles for the jetty extensions will be drilled and built from a barge specifically equipped for such works. A detailed method statement is not available, but it is understood that one barge will be sufficient which will be berthed beside the jetty under construction. It will be supplied with materials (e.g. concrete, rebar, steel structures) by means of dedicated boats. As the works will be undertaken within a small area adjacent to the existing jetties, interference with other sea users will be negligible.

With regard to the fishermen, there is the potential for there to be a minor adverse to major adverse impact from a safety perspective depending on the nature of the incident, as the fishermen are entering an operational area without permission. Alba should take measures to prevent fishermen from entering the area during the construction phase.

The local fishing community should be advised in advance of the works through adverts in the local English and Arabic press, and by informing the Bahrain Fishermen's Society.

7.5.2 Impacts on Fishermen During Decommissioning

At the end of their material life, the jetties will require decommissioning. Decommissioning activities may require the movement of vessels in the Port area with heavy machinery for dismantling the jetty and piles. As with construction, there is the potential for there to be a minor adverse impact to major adverse impact form a safety perspective depending on the nature of the incident. During decommissioning activities, Alba should take measures to prevent fishermen from entering the area and be given advanced notice of any works.

7.5.3 Management of Security Personnel

7.5.3.1 Construction Phase

All elements of the Port Upgrade will be constructed within Alba's property. If the EPC contractor is required to have its own security personnel, they will be employed from the local marketplace. They will be required to comply with Alba's requirements which are set out in Alba's documents:

- Security Capping Document;
- Security Services Plan; and
- Security Incident Response Plan

This suite of documents has been approved by the Ministry of Interior. The documents address:

- Roles and responsibilities;
- Co-ordination with other entities, e.g. Alba HSE department;
- Security manpower;

- Security systems;
- Security alerts and response levels;
- Incident response plan.

The private security industry in Bahrain is regulated by the Ministry of Interior, Directorate of Guards who licence private security companies. They also require background checks and training for all guards.

Training of Security Personnel

For all security guards the following is required / undertaken:

i. Checking and clearance of personal records with Bahrain police, concerned competent authorities and police records in the persons country of origin;

ii. All guards must attend training at the Guard Training School, operated by the General Directorate of Guards, Ministry of Interior. The training comprises:

- Introduction to security;
- Role and responsibilities of security guards;
- Customer care;
- Equality and diversity;
- Security patrolling;
- Access control;
- Inspection;
- Security and emergency situations;
- Fire;
- First aid, H&S;
- Emergency situations;
- Communications and report writing; and
- Parade training.

Security guards do not carry firearms.

Overall the safety risks associated with security personnel is considered to be Negligible. If required by the contractor their security arrangements will be well planned using licenced businesses, background checked and trained personnel.

7.5.3.2 Operational Phase

For the operational phase of the Port Upgrade Project, the security arrangements at the site will not change. The same standards of security operational planning and training of personnel will apply. Alba security guards do not carry firearms.

Overall the safety risks associated with security personnel is considered to be Negligible. Security arrangements will be well planned using background checked and trained personnel. Furthermore, only authorised people will be permitted to gain access to the marine terminal.

7.6 Mitigation

7.6.1 Impacts on Fishermen During Construction

Although vessels are not permitted to drive within the Sitra Marine Terminal, fishermen have been observed driving in and around Alba's jetties. Alba should take measures to prevent this practice. In accordance with the Bahrain Coastguard's requirements, the commencement date for the construction works should be advertised two weeks in advance in the local English and Arabic press.

7.6.2 Management of Security Personnel

Use of licenced/background checked and trained security personnel.

7.7 Summary

Table 7.1 provides a summary of impacts.

Table 7.1 Community Health and Safety – Summary of Required Mitigation and Management Actions

Impact	Significant	Mitigation/ Enhancement Measures	Residual Impact
Construction Phase			
Impact on Local Fishermen	Minor to Major Adverse	• Alba should take measures to prevent the unauthorized access of fishing vessels in the jetty area. • Advance notice of construction works to be given via local press and the Bahrain Fishermen's Society.	Negligible
Management of Security Personnel	Minor Adverse	• Use of licenced, background checked and trained security personnel.	Negligible
Operational Phase			
Management of Security Personnel	Negligible	• Use of licenced, background checked and trained security personnel.	Negligible

8 GEOLOGY AND HYDROGEOLOGY

8.1 Introduction

This section addresses the geological and hydrogeological conditions that are expected to be present at the project site and considers the potential impact of the scheme on soil and groundwater resources. It takes into consideration the construction (including commissioning), operation and decommissioning phases of the project. The section includes consideration of geological and hydrogeological conditions across the whole project site but does not consider the impact of shallow marine sediments which are addressed in **Section 11**.

The potential impacts on soil and groundwater from use and storage of chemicals during the construction and operation are also addressed in this Section.

8.2 Legislation and Guidance

For legislation and guidance relating to geology and hydrogeology, please refer to the Project Standards in **Appendix 1A**.

8.3 Assessment Methodology

8.3.1 Environmental Baseline

The environmental baseline was established through the following:

1. Site inspection visit;
2. Review of historical maps / aerial photographs;
3. Review of relevant literature on the geology of the project location;
4. Consultation with the AEWRD; and
5. Review of the geotechnical site investigation report for Alba Port Capacity Upgrade Project.

8.3.2 Environmental Assessment – Soil and Groundwater

The methodology is based on IFC General EHS Guidelines; 1.8 Contaminated Land, April 2007. The assessment utilizes the Contaminants – Exposure Pathways – Receptors methodology where:

1. Contaminants – contamination that may be present based on the evidence for the previous use of the land or may be introduced by the proposed project or its construction.
2. Exposure Pathways – the means by which contamination may migrate.
3. Receptors – environmental receptors including occupants, workers, geological and hydrogeological receptors.

A Conceptual Site Model (CSM) has been developed which identifies all of the potential Contaminants, Exposure Pathways and Receptors for each stage of the project. Where a Contaminant, Exposure Pathway and Receptor all exist, or may exist, for a given situation then consideration has been given to mitigation of the potential environmental impact. Where one or more of these elements – Contaminants, Exposure Pathways

and Receptors are not present then the environmental impact is generally considered to be insignificant.

8.3.3 Environmental Assessment – Chemicals

The quantities of chemicals used in the construction phase will be relatively limited and are unknown at this stage. However, potential environmental impacts are likely to be minor in all cases and good practice management controls should reduce potential impacts to negligible. It is not possible to provide MSDSs at this stage. In this section we have included Good International Industry Practice (GIIP) that should be adopted for chemical management in subsequent phases of the project.

8.3.4 ESIA Significance Criteria

The findings of the contamination assessment have been classified using the following EIA Impact Significance Criteria: (i) Major Beneficial, (ii) Minor Beneficial (iii) Negligible, (iv) Minor Adverse, (v) Major Adverse. These classifications will apply both pre and post mitigation.

The Significance Criteria will be applied to the following scenarios:

1. Impact of pre-existing soil and groundwater contamination.
2. Impact of construction activities.
3. Impact of the project.

Table 8.1 shows descriptions of risk impact significance classifications for each scenario given above.

The table demonstrates that under certain circumstances remediation of contaminated land as part of a development should be considered a beneficial impact of a project. The table also sets out the criteria for a negligible impact and clearly shows the importance of designed mitigation, monitoring and management activities in minimising the potential impacts.

Table 8.1 also refers to the amenity value of a resource. The amenity value of a natural resource is its capability to be used for a certain purpose, e.g. groundwater being used for abstraction of a drinking water supply, use of land for agriculture. Should the project reduce the amenity value of a resource this will be considered a major adverse impact. For example, contamination of groundwater so that it is no longer suitable for use as drinking water. Where the project is expected to release pollution to a resource but it does not affect its amenity value the impact will be considered a minor adverse impact.

8.3.5 Mitigation and Management

Where the assessment identifies adverse impacts management and mitigation measures will be proposed to reduce the impact to negligible. Management and mitigation measures will include as a matter of course recommendations for good practice in construction and environmental management.

Table 8.1 Soil and Groundwater Impact Assessment Significance Criteria

Scenario	Major Adverse	Minor Adverse	Negligible	Minor Beneficial	Major Beneficial
Pre-existing contamination	The site is contaminated, and risk assessment indicates that significant environmental harm is occurring and is on-going.	The site is contaminated and will require remediation to make it suitable for the intended development but there is no evidence that significant environmental harm is on-going.	No appreciable contamination present.	A former contaminated industrial site is remediated as a result of development.	Contamination that is presently causing environmental harm is remediated as a result of development.
Demolition and Construction impacts	Workers will be exposed to unacceptably high concentrations of contamination. Work may introduce new pathways which would expose environmental targets to unacceptably high concentrations of contamination causing pollution (exceedance of environmental standards).	Workers may be exposed to elevated concentrations of contamination. Work may introduce new temporary pathways which could expose environmental targets to increased concentrations of contamination.	Adverse environmental impacts to workers mitigated through the use of appropriate personal protective equipment. Use of mitigation measures to eliminate potential introduction of contamination exposure pathways. Appropriate environmental management and monitoring to mitigate contamination impacts.	Remediation of contamination.	Remediation of significant contamination.
Impacts of new development	The new development is likely to impact the quality of soil and groundwater through the release of pollutants and this would reduce the amenity value of a natural resource (e.g. aquifer) and prevent it being used for its intended or suitable purpose.	The new development may impact the quality of soil and groundwater through minor pollution but would not reduce the amenity value of a natural resource.	The new development is not expected to reduce the amenity value of a natural resource through the release of pollutants to soil or groundwater.	n/a	n/a

8.4 Baseline

8.4.1 Site History

Jetty 1 was constructed at the same time as the smelter became operational in 1971. Jetty 2 was constructed in 1995, prior to land reclamation for the calciner and desalination plants in 2001.

8.4.2 Geology

The Kingdom of Bahrain is occupied by Tertiary sediments, which are gently folded on a regional scale into elongate domes or periclines of near north-south trend. Bahrain Island is dominated by one such dome, developed principally in carbonate sediments of Cretaceous-Tertiary age, which dip gently outwards. The Bahrain dome is elongate (about 30 km x 30 km) and with slight asymmetry. The geological sequence is composed of three main formations:

- Dammam Formation - which consists of fossiliferous dolomitised limestone, dolomitic marl and dolomitic limestone, has two forms, known as Alat limestone and Khobar dolomite, from the Middle Eocene.
- Rus Formation of the Lower Eocene consists of chalky dolomitic limestone, shale, gypsum, and anhydrite.
- Umm er-Radhuma - formation of the Palaeocene is composed of dolomitic limestone and calcarenite with some argillaceous and bituminous facies, which is underlain by shales, marls and argillaceous limestone of the upper Arma formation of the Cretaceous.

These tertiary sediments are generally overlain by sandy to sandy loam soils that are calcareous in nature and limestone and mudstone rocks. Across the land side project area, a layer of sand fill has been placed on top of the quaternary deposits in order to reclaim the land.

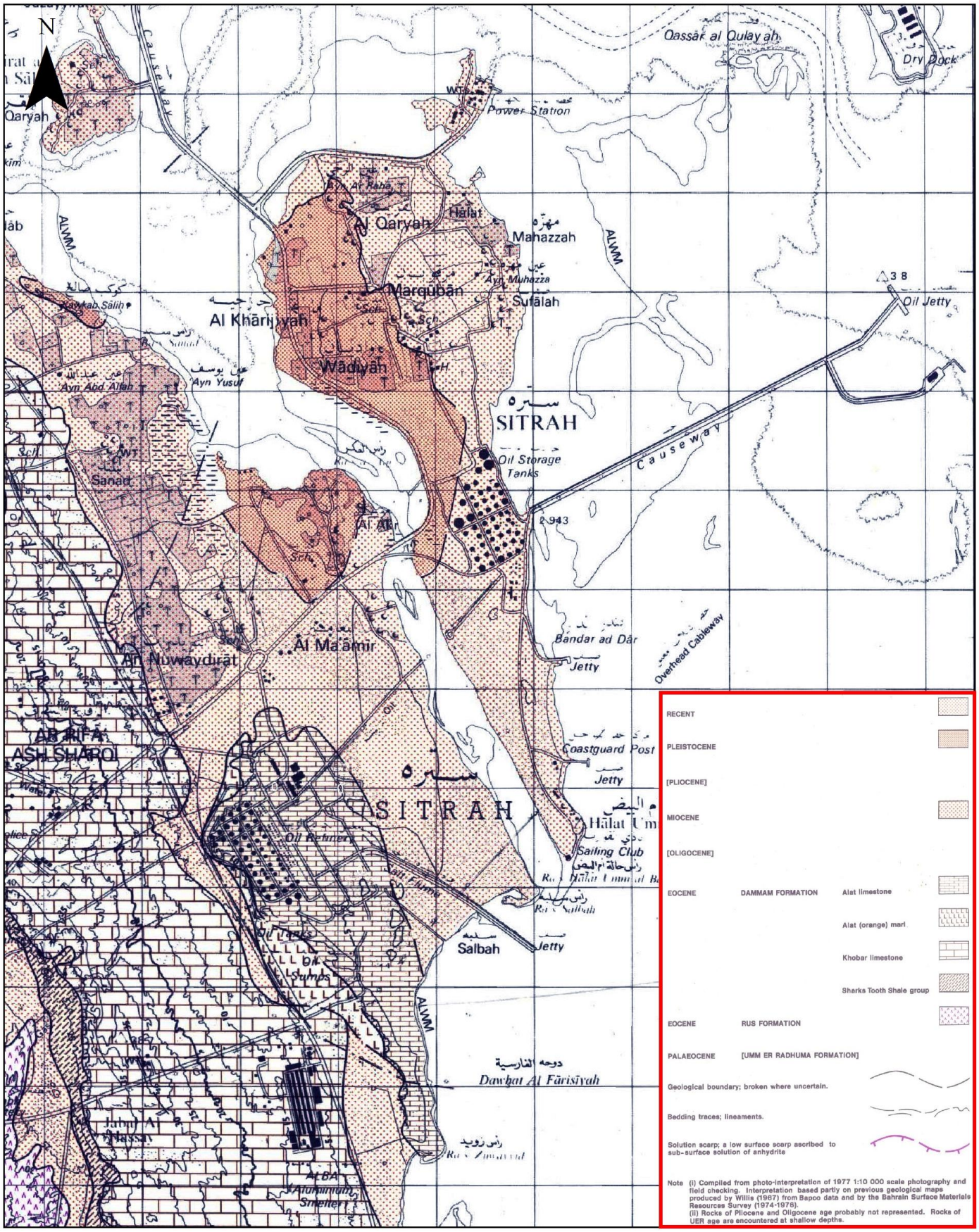
The general geological sequence present is summarised in **Table 8.2** and **Figure 8.1** shows a geological map of Bahrain.

Table 8.2 General Geological Sequence of Bahrain

Era	Period	Formation	Member	Approximate Thickness (m)	Lithology	Hydrogeological Significance
Quaternary	Recent	Superficial		-	Aeolianite, bioclastic limestone, beachrock	Unsaturated
	Pleistocene	Superficial		10	Sand, sabkha deposits	Unsaturated
Tertiary	Oligocene-Miocene	Jabal Cap		33	Dolomitic bioclastic limestone, algal coral breccia	Forms cap to Jabal ad Dukhan
	Eocene	Neogene		10-60	Marl with subordinate sandy limestone	Confines Dammam aquifers. Basal limestone forms part of the 'A' aquifer
		Dammam	Alat Limestone	15-25	Fossiliferous dolomitised limestone	Main 'A' aquifer. Formerly sustained small artesian flows. Low productivity. Used in NE and W coast
			Orange Marl	19-15	Orange-brown dolomitic marl	Confines Aquifer B when present
			Khobar Dolomite	30-39	Dolomitic limestone	Main 'B' aquifer usually confined. Highly permeable in top 5-10m. Main source of freshwater
			Khobar Marl	Discontinuous	Marl and shale	Forms part of the 'B' aquitard
			Alveolina Limestone	c. 10	Friable brown dolarenite	
			Sharks Tooth Shale	8-20	Shale with silty dolomitic limestone	Aquitard.
		Rus		60-150	Chalky dolomitic limestone, shale, gypsum and anhydrite	Part of 'C' aquifer. Aquitard if evaporites present. Brackish groundwater in a lens form
	Paleocene	Umm Er Radhuma (UER)		115-350	Dolomitic limestone and calcarenite, often argillaceous and bituminous	'C' aquifer in upper UER and Rus. Salinity stratified. Lower UER saline with low permeability.
Mesozoic	Cretaceous	Aruma		c. 400	Mainly shale in the upper part, limestone predominant below	Aruma shales form hydraulic base to Umm Er Radhuma.

Note: Green (Aquifer A); Orange (Aquifer B); Pink (Aquifer C); Grey (confining aquitards). Table based on GDC, 1980[13]

[13] Groundwater Development Consultants, 1980. Umm Er Radhuma Study, Bahrain Assignment. Ministry of Works and Agriculture.



Title: **Excerpt of Geological Map of Bahrain**			Client: alba
Project: Alba Port Capacity Upgrade Project			
Date: June 2018		Figure No.: 8.1	Consultant: Environment Arabia
Datum: WGS 84 - UTM 39N		Scale: 1:50,000 (A4)	

CN:\Alba Port Capacity Upgrade\mxd\EER\geology.mxd

The Alba Calciner Plant and Port are located at the 'Sitra Marine Terminal'. The geological mapping indicates that the full geological sequence in **Table 8.2** is present at the site. This comprises beach rock, sand and silt over bed rock deposits commencing with the Jabal Cap and neogene deposits overlying the Alat Limestone and other deposits of the Dammam Formation.

8.4.3 Geotechnical Investigation of the Alba Port Capacity Upgrade[14]

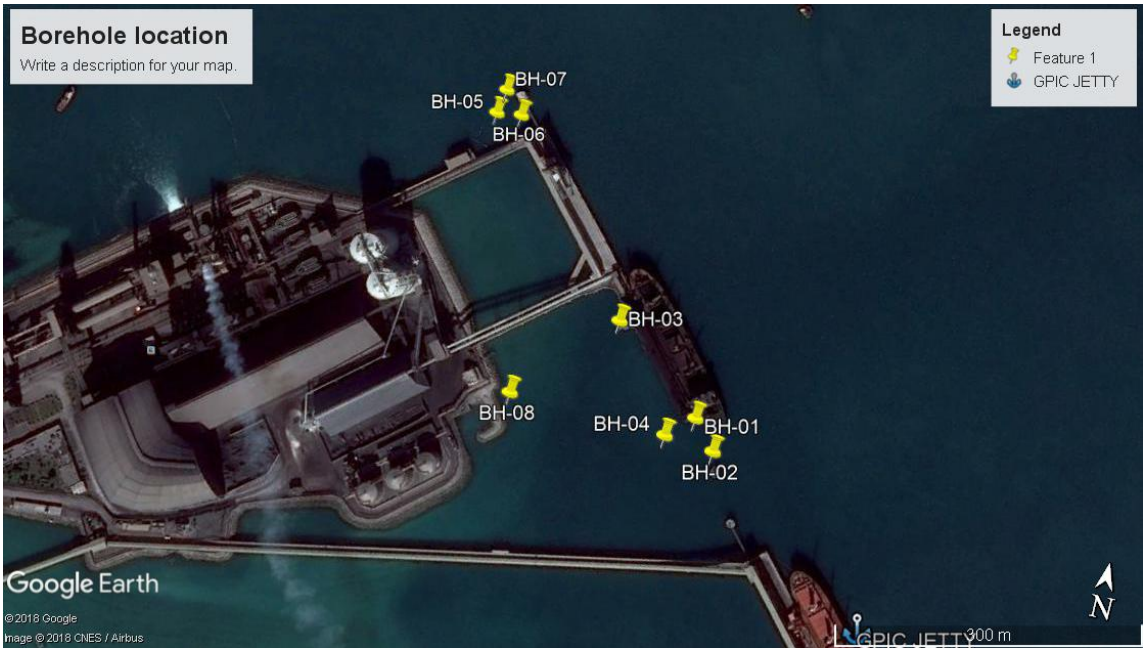
A geotechnical investigation of the project site was conducted and geological and geotechnical longitudinal profiles are available. The works comprised of eight marine boreholes and laboratory tests, together with an appraisal of ground conditions and recommendations for foundation design and construction. The borehole locations are shown in **Figure 8.2**.

The drilled boreholes show that there are general similarities and continuities of the subsurface materials, in spite of some local variations. The surface and subsurface ground materials in the study area can be divided into the following types:

- Sand from 0.00 m to 7.00 m
- Gravel from 1.00 to 8.45 m
- Calcarenite (carbonate sandstone) from 4.30 to 10.45 m
- Calcisiltite / Calcilutite (limestone) from 7.00 to 25.00 m

The description and depth of strata encountered in each borehole are summarised in **Table 8.3**. The findings of the geotechnical survey are consistent with the expected geological sequence and mapping.

Figure 8.2 Borehole Locations



[14] Report no. BQEL/ G-1482/MAR- 2018, Geotechnical Site Investigation. The Port Capacity Upgrade Project - Alba Line 6 Sitra, Kingdom of Bahrain, QEL March 2018.

Table 8.3 Soil and Rock Formation with its Approximate Boundaries

Borehole No.	Loose to very loose sand	Medium dense to dense sand or very sandy gravel	Calcarenite (carbonate sandstone)	Bedrock Calcisiltite/Calcilutite	
				Residually weathered to silt/clay	Very weak core runs
01	SBL-3.00	3.00-4.30	4.30-5.00		
		5.00-7.20		7.20-9.40	9.40-25.00
02	SBL-3.00	3.00-4.45	4.45-5.00		
		5.00-7.00		7.00-9.25	9.25-25.00
03		SBL-7.45	7.45-8.00		
		8.00-8.20		8.20-9.30	9.30-25.00
04	SBL-2.00	2.00-2.45			
	2.45-3.45	3.45-3.50	3.50-3.65		
		3.65-6.00		6.00-10.25	10.25-25.00
05		SBL-3.00			
	3.00-4.45	5.00-7.00	4.45-5.00	7.00-9.30	9.30-25.40
06	SBL-2.00	2.00-2.45			
	2.45-4.00	4.00-4.45	4.45-4.60		
		4.60-7.45		7.45-9.05	9.05-25.50
07	SBL-2.00	2.00-4.00			
	4.00-4.45	5.00-7.00	4.45-5.00	7.00-9.20	9.20-25.00
08	0.30-1.00	SBL-0.30			
	1.45-7.00	1.00-1.45			
		7.00-8.45	8.45-10.45	10.45-15.10	15.10-25.00

8.4.4 Hydrogeology

The geological units of Bahrain contain three distinct aquifers - A, B and C which approximately correspond to the Alat and Khobar member of the Dammam Formation and the Rus-Umm Er Radhuma carbonate, respectively. Also locally at Sitra Port, reclaimed land will be saturated with seawater from a depth of approximately 1m bgl.

The A, B and C units are at least partly separated and discontinuous due to the presence of low permeability strata (aquitards). Aquifers A and B are considered fresh water and aquifer C is considered a saline aquifer and requires treatment prior to use as potable water. The three aquifers are regional and are recharged by sub flow from Saudi Arabia. In general, the hydrologic gradient is from west to east across the island. Protection of existing groundwater resources is considered to be of the highest priority and groundwater aquifers are considered to be sensitive.

Consultations with the AEWRD were undertaken during the scoping phase of the project and have indicated that groundwater resources (Aquifer A – Alat Limestone) are present at approximately 30m below ground level in the vicinity of the port, therefore they don't anticipate any problems concerning protection of the aquifer. The Meeting Minutes are included in **Appendix 5B**.

8.4.5 Contamination

The Alba Marine Terminal is an industrial site and as such there is some potential for contamination of shallow soils and groundwater. However, this potential is limited as the

site is covered with hardstanding, there are limited chemicals used and this would limit the ingress of any spilled contaminants.

8.5 Impact Assessment

8.5.1 Demolition

The GPC storage shed has a fine layer of green coke dust over most of the walls and floor. During demolition activities, there is the potential for this coke dust to become airborne and settle on neighbouring properties such as GPIC, the NOGA plots and East Sitra Housing Plot, and also settle on the sea. As described in **Section 2.3.4**, before any demolition takes place, the shed will be completely emptied and washed down, and demolition works are planned to progress with sequences of partial dismantling so that dust generation is controlled. This will limit the potential for dust impacts.

GPC is composed primarily of carbon and may contain limited amounts of elemental forms of sulphur, metals and non-volatile inorganic compounds. It is chemically inert and is considered to pose few environmental risks as it does not vaporise into the atmosphere, does not react chemically in the presence of water, and does not react chemically in the presence of light[15]. The potential temporary dispersal of coke dust during demolition will not have an impact on neighbouring soils or marine sediments.

8.5.2 Construction Phase

Piles for the jetty will be driven in-situ and will be steel casing with an outside diameter of 900 mm, filled with concrete with reinforcing caging in the bottom section of the pile. They will be driven 10 – 15m into the seabed.

Piles for the storage silos will be 22-23 m deep.

Piling and borehole drilling has the potential to interact with groundwater resources. There is the potential to introduce contaminants to the aquifer (Aquifer A) and increase the salinity of the aquifer by opening up new pathways and have a minor adverse impact. Permission for piling should be sought from the AEWRD so that the design can include for any requirements in respect of the protection of groundwater resources. Inclusion of agreed mitigation measures in design and construction methodologies should reduce the potential impacts on groundwater resources to negligible.

Any dewater activities should be permitted by SCE and suitable arrangements should be made for the discharge or disposal of water.

Other construction work including excavation and topside development is not expected to have any significant impact on soil or groundwater as there is not expected to be pre-existing sources of contamination in the project location. Any contaminated soils identified may require special handling, storage and disposal arrangements, but there is no expectation of the presence of contamination due to the limited industrial use of the land.

Construction activities will require the use of fuels and chemicals that will represent a potential source of contamination. Chemicals that may be required include: bonding

[15] Petroleum Coke: Industry and Environmental Issues, Oct 2013

agents, mastics and sealers, paints and coatings, cleaning fluids, release agents, oils and drilling muds. These will need to be stored and used correctly to ensure there is no pathway by which they may cause contamination of soil or groundwater.

Spills or releases of fuels, oils or chemicals during the construction stage would most realistically result in local contamination of soil or groundwater that would constitute a minor adverse impact. Implementation of good practice environmental protection measures during construction should effectively control potential environmental impacts and render them negligible. Details of suggested mitigation measures are identified in the following section.

Foundation excavation for the construction of the storage silos will be carried out by excavators. Deep excavation will be required for the airlift pit adjacent to the silo and so dewatering will be required. Where possible, maximum use will be made of excavated material in back fill operations for the silo base and pit wall. If controlled following accepted SCE requirements, then there will be no impact on sea water quality.

8.5.3 Operation Phase

There are no significant potential impacts on groundwater resources during operation of the Alba Port. The potential for contamination of marine sediments during operation is considered in **Section 11**.

8.6 Mitigation

8.6.1 Demolition and Construction Phases

The following management actions are suggested for the demolition of the storage shed and the construction of the Port:

- Permission should be obtained for piling from the AEWRD to verify that the proposed method and depth of piling will not adversely impact groundwater resources.
- Use of low environment impact, water-based muds for piling (if required).
- Apply for a permit for any dewatering operations from the SCE.
- If any contaminated soils are encountered (visual contamination or odour) construction work in its vicinity should be suspended. A procedure should be developed to assess the risk significance of the contamination and to establish suitable handling, storage and disposal/remediation requirements.
- Good environmental practice and correct storage and use of chemicals:
  - Storage and use of fuels, oil and chemicals during construction should be in accordance with the MSDS.
  - MSDSs should be displayed at the point of storage for all chemicals.
  - All small quantities or containers of fuels and chemicals should be stored in drip trays.
  - No fuels or chemicals should be stored within 10 m of the sea.
  - Where fuel or chemical containers are in excess of 200 litres they should be stored in bunds capable of storing 110% of the volume of any single containers or 25% of the total volume where multiple containers are stored.
  - Bulk fuel containers should be double-skinned or should be stored within a bund with a capacity of 110% of the volume of the tank.

- A spill kit should be available at each bulk fuel storage point.
- A spill procedure should be prepared and displayed at all fuel storage points. The procedure should be drilled within 6 weeks of commencing construction.
- Storage areas for fuels and other volatile chemicals should have a sun shelter.
- All generators, power packs, compressors, etc. should be underlain by a drip tray.

8.6.2 Operation Phase

No measures required, other than following GIIP for storage of any fuels and/or chemicals.

8.7 Monitoring

The implementation of the recommended mitigation measures should be audited during the demolition and construction phases of the project.

8.8 Summary

Table 8.4 presents a summary of the impacts in relation to soils and groundwater.

Table 8.4 Summary of Soil and Groundwater Impacts

Impact	Impact Significance	Mitigation Measures	Residual Impacts
Demolition Phase			
Impact on soil and groundwater from pet coke during demolition	Negligible	• Adoption of good practice measures for demolition that reduce dust arisings.	Negligible
Construction Phase			
Impact on soil and groundwater during piling	Minor Adverse	• Permission for piling should be sought from the AEWRD to verify that the proposed method and depth of piling will not adversely impact groundwater resources. • Any site investigation boreholes or piles should be sealed immediately following drilling. • Use of low environment impact, water-based muds for piling. • Residual mud will require to be disposed of responsibly to landfill.	Negligible
Impact on human health from pre-existing contamination during construction	Negligible	A procedure should be developed in the unlikely event that unexpected soil contamination be encountered including risk assessment handling, storage and disposal/ remediation arrangements of contaminated soils identified.	Negligible
Dewatering	Negligible	Ensure a permit is obtained for all dewatering operations from the SCE.	Negligible

Impact	Impact Significance	Mitigation Measures	Residual Impacts
Spills of fuels, oils or chemicals causing soil and groundwater contamination during construction	Minor Adverse	Good environmental practice and correct storage and use of chemicals: • Storage and use of fuels, oil and chemicals should be in accordance with the MSDS. • MSDSs should be displayed at the point of storage for all chemicals. • All small quantities or containers of fuels and chemicals should be stored in drip trays. • No fuels or chemicals should be stored within 10 m of the sea. • Where fuel or chemical containers are in excess of 200 litres they should be stored in bunds capable of storing 110% of the volume of any single containers or 25% of the total volume where multiple containers are stored. • Bulk fuel containers should be double-skinned or should be stored within a bund with a capacity of 110% of the volume of the tank. • A spill kit should be available at each bulk fuel storage point. • A spill procedure should be prepared and displayed. The procedure should be drilled within 6 weeks of commencing construction. • Storage areas for fuels and other volatile chemicals should have a sun shelter. • All generators, power packs, compressors, etc. Should be underlain by a drip tray.	Negligible
Operation Phase			
Impact on groundwater resources	None	None required.	None

9 LABOUR AND WORKING CONDITIONS

9.1 Introduction

For any business, the workforce is a valuable asset, and a sound worker-management relationship is a key ingredient to the successful implementation of a project. Failure to establish and foster a sound relationship can undermine worker commitment and retention and can jeopardise the delivery of a project. Conversely, through a constructive worker-management relationship, and by treating workers fairly and providing them with safe and healthy working conditions, project proponents can create tangible benefits, such as enhancement of the efficiency and productivity of their operations.

The construction and operation of the Port will require a skilled labour force. The construction phase will require the employment of a workforce of approximately 250 workers. There will be a large proportion of expatriate male workers from the Indian sub-continent who will be employed on relatively low wages with accommodation provided in labour camps by their employer. The operation workforce will be mostly sourced from the local population.

There have been numerous reports from the Middle East region concerning poor treatment of such migrant workers including: poor health and safety standards, poor accommodation standards and non payment of wages[16,17]. As the workers will be housed, paid and looked after by third-party contractors during the construction phase, there is a risk that the workers will be treated unfairly and given sub-standard accommodation.

This section addresses the requirements for the management of directly employed workers, main contractors, sub-contractors and the employees of suppliers to meet reasonable, fair and equitable employment conditions in line with IFC Performance Standard No. 2 Labour and Working Conditions, 2012.

Community Impacts and Occupational Health and Safety have been addressed in **Sections 7** and **12** respectively.

9.2 Assessment Methodology

This chapter of the ESIA firstly sets out the manpower requirements for the Port Upgrade for the demolition, construction and operation phases. It then presents a comparison of existing Bahrain labour law with Performance Standard No. 2 to see where the insufficiencies lie.

Following this comparison, the chapter then sets out the mitigation and management measures that need to be adopted during the construction and operational phases to ensure the Port Upgrade complies with relevant national and international laws and guidance.

[16] For A Better Life: Migrant Worker Abuse in Bahrain and the Government Reform Agenda. Human Rights Watch, 2012

[17] India: Exploited dreams: Dispatches from Indian migrant workers in Saudi Arabia, Amnesty International, 2014

The classification of impact significance used in this assessment is qualitative. The impact assessment significance descriptions set out in **Table 3.3** have been used. Where there is a requirement to adopt a measure to meet legal obligations then a minor, moderate or major adverse impact has been selected, depending on the likelihood and consequences of any non-compliance in the absence of mitigation. Where suitable mitigation and management measures are identified that would lead to routine compliance, then the residual impact has been assessed as negligible.

9.3 Workforce Numbers

9.3.1 Demolition Workforce

Demolition of the GPC shed will take place prior to construction of the storage silos and, as a separate package of work, will only require a small workforce of approximately 20 people.

9.3.2 Construction Workforce

The estimated number of workers is provided in **Section 2**, but the data has been repeated here for ease of reference. **Figure 9.1** and **Table 9.1** show the estimated numbers of workforce required for the Port Upgrade Project during the construction phase. These numbers consist of staff from the main contractors and all anticipated sub-contractors. The maximum number of personnel expected on site is 254 which is predicted to occur in month 12 of the construction programme.

Figure 9.1 Staffing Requirements

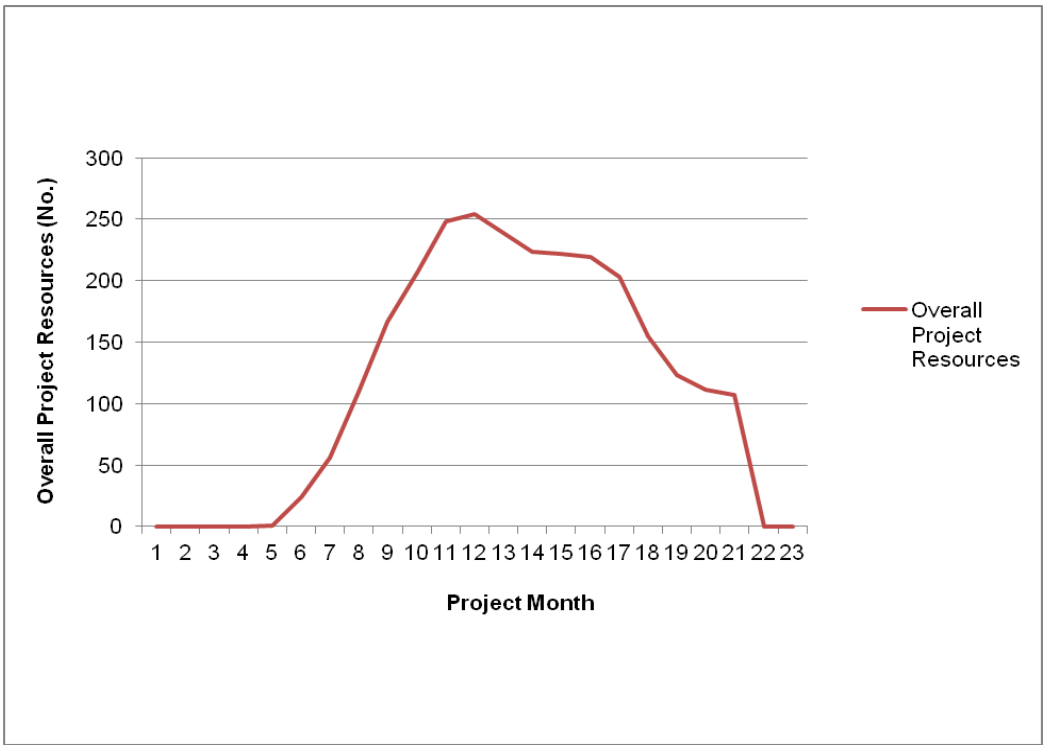


Table 9.1 Development of Project Resources Over Time

Month	1	2	3	4	5	6	7	8	9	10	11	12	13
Subcontractor Supervision Total	0	0	0	0	0	0	0	0	1	2	3	3	2
EPC Site Resources	0	0	0	0	1	5	8	8	8	11	15	17	17
Subcontractor Labour Total	0	0	0	0	0	19	48	102	158	194	230	234	220
Total	0	0	0	0	1	24	56	110	167	207	248	254	239

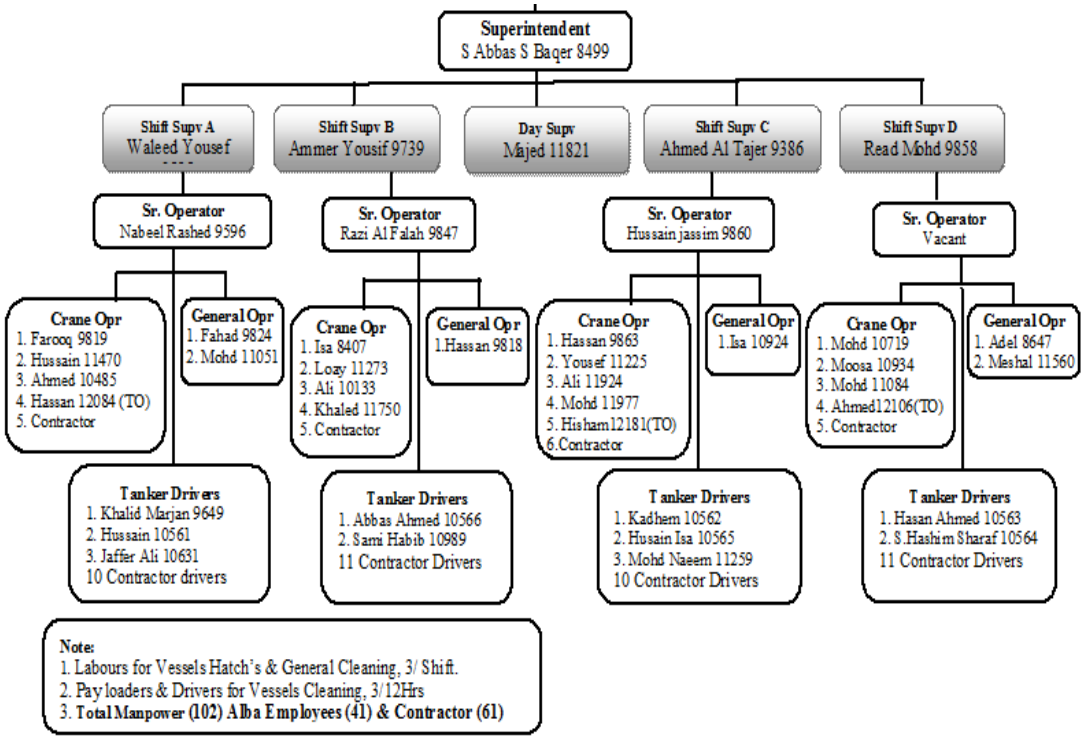
Month	14	15	16	17	18	19	20	21	22	23
Subcontractor Supervision Total	2	4	3	3	4	5	4	4	0	0
EPC Site Resources	18	18	19	19	19	19	18	18	0	0
Subcontractor Labour Total	204	200	197	181	132	99	89	85	0	0
Total	224	222	219	203	155	123	111	107	0	0

9.3.3 Operation Workforce

The risks for impacts on the workforce during operation are low for directly employed workers because Alba has a suite of Human Resources policies and procedures which ensure its operations are undertaken in line with Bahraini labour law. However, there is the potential for impacts to occur within the supply chain, e.g. forced labour and child labour.

Alba employs approximately 2650 staff, about 100 are employed in the Port. The Marine Operation Organization Chart is presented in **Figure 9.2**. There will be a requirement for approximately 20 additional staff for the expansion of the Port.

Figure 9.2 Marine Operation Organization Chart



9.4 Comparison of Bahrain Labour Law and International Guidance

Table 9.2 presents a comparison of Bahrain law and international guidance with respect to labour law. The information presented is an overview of the main legal points and is not intended to be a legal interpretation of the law. The comparison presented indicates that there are some gaps between Bahrain law and IFC Performance Standard No. 2. These gaps are in the areas of:

- Human resources policy and procedures;
- Grievance mechanism;
- Workers engaged by third parties; and
- Management of supply chain.

In all other respects, existing Bahrain law appears to be sufficient to implement IFC requirements on labour and working conditions.

Table 9.2 Comparison of Bahrain Labour Law and IFC PS2

Summary of PS2 Provision	Key Points of Bahrain Law
Human Resources Policy and Procedures The client will adopt and implement human resources policies and procedures appropriate to its size and workforce that set out its approach to managing workers consistent with the requirements of this Performance Standard and national law. The client will provide workers with documented information that is clear and understandable, regarding their rights under national labour and employment law and any applicable collective agreements, including their rights related to hours of work, wages, overtime, compensation and benefits upon beginning the working relationship and when any material changes occur.	No provisions in Bahrain Law.
Working Conditions and Terms of Employment Where the client is a party to a collective bargaining agreement with a workers' organisation, such agreement will be respected. Where such agreements do not exist, or do not address working conditions and terms of employment, the client will provide reasonable working conditions and terms of employment. The client will identify migrant workers and ensure that they are engaged on substantially equivalent terms and conditions to non-migrant workers carrying out similar work. Where accommodation services are provided to workers covered by the scope of this PS, the client will put in place and implement policies on the quality and management of the accommodation and provision of basic services. The accommodation services will be provided in a manner consistent with the principles of non-discrimination and equal opportunity. Workers' accommodation arrangements should not restrict workers' freedom of movement or of association.	*Labour Law 2012, Article 19* States that the employment contract should include the terms of employment agreed by the parties, and may be entered into for a fixed term, or for an indefinite duration, which can be terminated on notice, or for execution of a specific project. The contract should be in writing in both English and Arabic and both parties should be given a copy. *Labour Law 2012, Article 39* Discrimination in wages based on sex, origin, language, religion or ideology shall be prohibited. *Ministerial Order No.40 of 2014 with respect to the requirements and specifications of workers' accommodation* Sets out minimum physical requirements for accommodation.
Workers' Organisation In countries where national law recognises workers' rights to form and to join workers'	*Workers Trade Union Law, 2002* This recognises the right of workers to organise collectively without discrimination in

Summary of PS2 Provision	Key Points of Bahrain Law
organisations of their choosing without interference and to bargain collectively, the client will comply with national law. Where national law substantially restricts workers' organisations, the client will not restrict workers from developing alternative mechanisms to express their grievances and protect their rights regarding working conditions and terms of employment. The client should not seek to influence or control these mechanisms. In either case described above, and where national law is silent, the client will not discourage workers from electing worker representatives, forming or joining workers' organisations of their choosing, or from bargaining collectively, and will not discriminate or retaliate against workers who participate, or seek to participate, in such organisations and collective bargaining. The client will engage with such workers' representatives and workers' organisations, and provide them with information needed for meaningful negotiation in a timely manner. Workers' organisations are expected to fairly represent the workers in the workforce.	employment. Article 10 states that: 'the workers of any establishment, of any particular sector, of any particular activity or of similar or associate industries or professions may establish their own trade union subject to the provision of this law'. Article 11 concerns the procedure for the formation of a trade union and states: 'The procedure for the formation of a trade union shall be by submitting to the Ministry its Constitution and the names of the founding members, provided that the Constitution shall not conflict with the provisions of the applicable laws and regulations in the Kingdom'.
Non-Discrimination and Equal Opportunity The client will not make employment decisions on the basis of personal characteristics[18] unrelated to inherent job requirements. The client will base the employment relationship on the principle of equal opportunity and fair treatment, and will not discriminate with respect to any aspects of the employment relationship, such as recruitment and hiring, compensation (including wages and benefits), working conditions and terms of employment, access to training, job assignment, promotion, termination of employment or retirement, and disciplinary practices. The client will take measures to prevent and address harassment, intimidation, and/or exploitation, especially in regard to women. The principles of non-discrimination apply to migrant workers. In countries where national law provides for non-discrimination in employment, the	*Labour Law 2012, Wages - Article 39* Discrimination in wages based on sex, origin, language, religion or ideology shall be prohibited.

[18] Such as gender, race, nationality, ethnic, social and indigenous origin, religion or belief, disability, age or sexual orientation.

Summary of PS2 Provision	Key Points of Bahrain Law
client will comply with national law. When national laws are silent on non-discrimination in employment, the client will meet this Performance Standard. In circumstances where national law is inconsistent with this Performance Standard, the client is encouraged to carry out its operations consistent with the intent of the above without contravening applicable laws. Special measures of protection or assistance to remedy past discrimination or selection for a particular job based on the inherent requirements of the job will not be deemed as discrimination, provided they are consistent with national law.	
Retrenchment Prior to implementing any collective dismissals, the client will carry out an analysis of alternatives to retrenchment. If the analysis does not identify viable alternatives to retrenchment, a retrenchment plan will be developed and implemented to reduce the adverse impacts of retrenchment on workers. The retrenchment plan will be based on the principle of non-discrimination and will reflect the client's consultation with workers, their organisations, and, where appropriate, the government, and comply with collective bargaining agreements if they exist. The client will comply will all legal and contractual requirements related to notification of public authorities, and provision of information to, and consultation with workers and their organisations. The client should ensure that all workers receive notice of dismissal and severance payments mandated by law and collective agreements in a timely manner. All outstanding back pay and social security benefits and pension contributions and benefits will be paid (i) on or before termination of the working relationship to the workers, (ii) where appropriate, for the benefit of the workers, or (iii) payment will be made in accordance with a timeline agreed through a collective agreement. Where payments are made for the benefit of workers, workers will be provided with evidence of such payments.	*Labour Law 2012, Article 101* States that the worker shall be entitled to compensation for termination by the employer unless the termination of the contract is for a legitimate reason. The burden of proof of the legitimacy of termination of the contract shall be borne by the employer. *Labour Law 2012, Article 111* Determines what compensation employees are entitled to under different circumstances of dismissal by the employer.
Grievance Mechanism The client will provide a grievance mechanism for workers (and their organisations,	No specific provisions in Bahrain law.

Summary of PS2 Provision	Key Points of Bahrain Law
where they exist) to raise workplace concerns. The client will inform the workers of the grievance mechanism at the time of recruitment and make it easily accessible to them. The mechanism should involve an appropriate level of management and address concerns promptly, using an understandable and transparent process that provides timely feedback to those concerned, without any retribution. The mechanism should also allow for anonymous complaints to be raised and address. The mechanism should not impede access to other judicial or administrative remedies that might be available under the law or through existing arbitration procedures, or substitute for grievance mechanisms provided through collective agreements.	
Child Labour The client will not employ children in any manner that is economically exploitative, or is likely to be hazardous to or interfere with the child's education, or to be harmful to the child's health or physical, mental, spiritual, moral or social development. The client will identify the presence of all persons under the age of 18. Where national laws have provisions for the employment of minors, the client will follow those laws applicable to the client. Children under the age of 18 will not be employed in hazardous work. All work of persons under the age of 18 will be subject to an appropriate risk assessment and regular monitoring of health, working conditions and hours of work.	*Labour Law 2012, Employment of Minors, Articles 23 - 28* It is prohibited to employ any minor who is not yet 15. Minors should not be employed for more than 6 hours a day. They should be given one or more breaks, the total of which should not be less than 1 hour for a rest and a meal. They should not work more than 4 consecutive hours. They should not be employed at night or on weekly rest days or official holidays. Prior to appointment, the employer must verify: • the custodian or guardian approve the minor's employment; • the minor has undergone a medical examination to determine his physical fitness; • the minor is not engaged in hazardous work; • the Ministry is notified of al data related to the minor. Following the employment of the minor, an employer shall: • post in an apparent location the provisions on the employment of minors; • draft a statement clarifying the names of minors working, their age, the works entrusted to them and the date of their employment; • subject the minor to a periodic medical examination to verify his physical fitness.
Forced Labour The client will not employ forced labour, which consists of any work or service not voluntarily performed that is exacted form an individual under threat of force or penalty. This covers any kind of involuntary or compulsory labour, bonded labour, or similar labour-contracting arrangements. The client will not employ trafficked persons.	*Order No. 79 of 2009 Respecting the Procedures of Foreign Worker Transfer to Another Employer, Article 2* This states that a foreign worker has the right to transfer to work with another employer without obtaining consent of the existing employer, without prejudice to the rights of the worker. A worker can leave employment if he/she is not paid.

Summary of PS2 Provision	Key Points of Bahrain Law
Occupational Health and Safety The client will provide a safe and healthy work environment, taking into account inherent risks in its particular sector and specific classes of hazards in the client's work areas, including physical, chemical, biological, and radiological hazards, and specific threats to women. The client will take steps to prevent accidents, injury, and disease arising from, associated with, or occurring in the course of work by minimising, as far as reasonably practicable, the causes of hazards. In a manner consistent with good international best practice, as reflected in various internationally recognised sources including the World Bank Group EHS Guidelines, the client will address areas that include the (i) identification of potential hazards to workers, particularly those that may be life-threatening, (ii) provision of preventative and protective measures, including modification, substitution, or elimination of hazardous conditions or substances, (iii) training or workers, (iv) documentation and reporting of occupational accidents, diseases, and incidents, and (v) emergency prevention, preparedness, and response arrangements. For additional information related to emergency preparedness and response to Performance Standard 1.	*Labour Law 2012, Title VX Occupational Safety and Health and Working Environment, Article 166* The employer must provide a safe and healthy work environment and take measures to protect workers from the following hazards: • mechanical hazards arising as a result of a collision or contact between the worker's body and a solid object; • hazards arising from handling solid, liquid or gas chemical substances or arising from the leakage of such substances to the working environment; • Natural hazards affecting the worker's safety and health as a result of a natural hazard or damage such as heat, humidity, cold, noise, dangerous and harmful radiations, quakes or the high or low atmospheric pressure in the workplace; • Hazards arising from the unavailability of means of safety, rescue, first aid and hygiene or the like and hazards arising from nutrition in cases where the employer is bound by virtue of the law to provide nutrition; • Fire hazards and hazards arising from electricity and lighting. Employers should prepare emergency plans which are tested to ascertain the adequacy and workers are trained in executing them. Employers should also inform workers' of potential hazards, provide them with free protective equipment and train them in its use.
Workers Engaged by Third Parties With respect to contracted workers the client will take commercially reasonable efforts to ascertain that the third parties who engage these workers are reputable and legitimate enterprises and have an appropriate ESMS that will allow them to operate in a manner consistent with the requirements of this Performance Standard (apartment from retrenchment & supply chain requirements). The client will establish policies and procedures for managing and monitoring the performance of such third party employers in relation to the requirements of this Performance Standard. In addition, the client will use commercially reasonable efforts to incorporate these requirements in contractual agreements with such third party	No specific provisions in Bahrain Law.

Summary of PS2 Provision	Key Points of Bahrain Law
employers. The client will ensure that contracted workers have access to a grievance mechanism. In cases where the third party is not able to provide a grievance mechanism, the client will extend its own grievance mechanism to serve workers engaged by the third party.	
Supply Chain Where there is a high risk of child labour or forced labour in the primary supply chain, the client will identify those risks consistent with the above requirements. If child labour or forced labour cases are identified, the client will take appropriate steps to remedy them. The client will monitor its primary supply chain on an ongoing basis in order to identify any significant changes in its supply chain and if new risks or incidents of child and/or forced labour are identified, the client will take appropriate steps to remedy them. Additionally, where there is a high risk of significant safety issues related to supply chain workers, the client will introduce procedures and mitigation measures to ensure that primary suppliers within the supply chain are taking steps to prevent or to correct life-threatening situations. The ability of the client to fully address these risks will depend upon the client's level of management control or influence over its primary suppliers. Where remedy is not possible, the client will shift the project's primary supply chain over time to suppliers that can demonstrate that they are complying with this Performance Standard.	No specific provisions in Bahrain law.

9.5 Impact Assessment

9.5.1 Forced Labour

There are potential risks of forced labour within the supply chain within Bahrain particularly as the construction workforce will comprise migrant workers. Whilst forced labour is banned under law in Bahrain, working under poor conditions of health and safety or living in sub-standard accommodation facilities or working without regular pay can comprise forced labour to one extent or another. Whilst there are legal safe guards these may rely on the courts to implement them which may be slow to respond and be beyond the financial reach and knowledge of migrant workers. Overall the potential for forced labour is classified as a potentially Major Adverse impact, as if it is not actively managed and mitigated, failure to respect migrant workers rights is likely to occur in some cases.

The responsibility falls to the project owner, Alba, to ensure that the supply chain acts responsibly and meet its duties to protect workers' rights including implementation of labour contracts, provision of information regarding workers' rights, provision of suitable labour accommodation, payment of wages and implementation of a grievance mechanism.

9.5.2 Payment of Wages

This is related to the issue of forced labour, but is also discussed separately to highlight the issue.

The non-payment of wages can come about through poor financial management by contractors. So even if a contractor is paid by the client, the workers may not get paid. This can lead to non performance by the contractor, industrial action by workers and social unrest. As such this is identified as a potential Major Adverse impact and must be actively managed to mitigate its potential impacts.

9.5.3 Labour Accommodation

The provision of labour accommodation is also related to the issue of forced labour, but as above, it is discussed separately to highlight the issue.

Labour accommodation for migrant workers will be provided by individual contractors. A project specific labour camp for construction workers is not proposed. This means that the standard of labour accommodation is likely to be variable. At its worst sub-standard labour accommodation can be unhygienic, and a potential source of disease or illness, or dangerous (e.g. fire hazard). Therefore, the standard of labour accommodation is a key issue for the project and a potential Major Adverse issue that will require active management to mitigate its potential impacts.

9.5.4 Child Labour

Child labour is banned in Bahrain. Child labour is considered to be a Negligible impact for the project. This is because the majority of the work force comprises expatriate workers who must meet national legal requirements to qualify for work and also because child labour is unlikely to go unnoticed on site or at contractor yards.

9.5.5 Public Health

The employment of male, expatriate workers has the potential to cause an increase in prostitution, alcohol and drug abuse and violence particularly in the vicinity of labour accommodation camps.

The labour camps in Bahrain are typically sited in commercial or industrial areas not near centres of population or in suburban areas. Thus the potential for workers to congregate in local populated areas and cause unrest is low. Also as individual contractors are providing labour accommodation from the existing stock, the accommodation facilities are spread across the surrounding area and are not concentrated in one place. Thus their impact is dispersed.

Contractor's also have prevention and control measures regarding the use of drugs and alcohol within accommodation facilities. Contractors ban the use of drugs by employees and within the labour accommodation facilities and being drunk at a labour accommodation facility can result in dismissal.

Workers do have the right to leave the accommodation facilities during their free-time and are likely to do so, particularly at the weekends. It is likely that some will engage with prostitutes and so there is a risk of spreading Sexually Transmitted Diseases (STDs). This is considered to be a potentially Minor Adverse impact.

9.6 Management and Mitigation

9.6.1 Human Resources Policy and Procedures

It is recommended that Alba should prepare a specific employment policy and procedures to be implemented on the project to ensure it is compliant with Bahraini law and IFC PS2 requirements (**see Table 9.1**.). The requirements should be applicable to direct employees, main contractors and sub-contractors.

Alba should ensure that all direct employees, contractor and sub-contractor employees are provided with a clear and understandable written statement of their rights under national labour and employment law, and any applicable collective agreements including their rights to hours of work, wages, overtime, compensation and benefits upon beginning the working relationship and when any material changes occur. Educational campaigns should be run to raise awareness of workers' rights.

Compliance with the policy and procedures should be audited for all (sub) contractors prior to their mobilisation. Thereafter compliance should be audited annually.

The mitigation measures detailed in the following sections should be addressed in the policy and procedures.

9.6.2 Contracts with Suppliers

Alba should ensure that all (sub) contracts with suppliers include clauses:

- Banning forced labour.
- To only use recruitment companies, in the workers country of origin, that are accredited.
- Banning payment of recruitment or other fees by the worker (e.g. for accommodation or transport).
- Allowing workers to retain access to their passports.

9.6.3 Minimum Requirements for Individual Employment Contracts

All employees working on the Port Upgrade Project should be provided with a Contract of Employment which meets the requirements of Bahrain's Labour Law 2012. Alba should ensure that the items in **Table 9.3** are included in all worker contracts.

Table 9.3 Minimum Requirements for Worker Contracts

Subject	Requirements from Bahrain Labour Law (with Article No.)
Employment Contract	• Article 19: A contract of employment shall be signed by both parties; • Article 20: The contract of employment shall contain: o Parties to the contract; o Type of employment; o Nature of the job; o Agreed wage; o Method and time of payment; o Benefits agreed upon. • Article 21: A probation period shall be no more than 3 months. 1 days' notice of termination by either party is required during this time.
Wages	• Article 40: Wages shall be paid at least once per month. • Article 44: An employer shall not deduct more than 10% of a workers' wages in repayment of any loans (unless the loan for the building of houses). An employer is not permitted to charge interest on any such loans.
Working Hours	• Article 50: Workers engaged on a night shift basis shall receive compensation for the nature of their job. • Article 51: The maximum working hours per week is 48 (excluding Ramadan for Muslim workers). • Article 52: A worker may not work more than 6 hours without a break. • Article 54: Any hours worked in excess of 48 hours per week is to be paid at 125% of the worker's wage entitlement. • Article 57: Friday is deemed the weekly day of rest. No employee shall work the weekly day for rest more than 2 successive times without his written consent. • Article 64: An employee required to work on official occasions issued by the Council of Ministers (public holidays) are entitled to his/her wage for such day in addition to overtime wages of 150%, or

Subject	Requirements from Bahrain Labour Law (with Article No.)
	another day off in lieu as elected by the worker.
Leave	• Article 58: A worker who has completed at least 1 years' service shall be entitled to annual leave of no less than 30 days. • Article 65: A worker who has completed 3 months of service, shall be granted 15 days sickness per year on full pay.
Notice of Termination	• Article 40: If a worker leaves employment, all wages and entitlements must be paid within 7 days. • Article 96: A contract of employment for a specified period ends at the end of its stated duration. • Article 105: Outside of probation and serious misconduct, either party may terminate a contract of employment with 30 days' notice.
Dismissal	• Article 104: A dismissal shall be deemed as unfair if for any of the following reasons: o Sex, colour, religion, belief, social status, family responsibility, pregnancy, child birth, suckling an infant; o Membership of our representation in a trade union or participation in its activities as prescribed by relevant laws; o Filing complaint, report or court case against the employer unless it is of a vexatious nature; o Placement of an attachment upon the workers entitlements held by employer.
Discrimination	• Article 29: Discrimination on the basis of gender is prohibited. • Article 39: It is prohibited to discriminate in the payment of wages on basis of sex, ethnic origin, language, religion or belief.
Workplace Injuries	• Article 87: A worker injured at the workplace is entitled to receive treatment in a government medical institution or other appropriate care facility at the employers cost. Unless the injury is self-inflicted, caused by deliberate misbehaviour or violation of employers instructions.

9.6.4 Payment of Wages

Alba should put in place payroll audits for construction contractors and the supply chain to provide evidence on a monthly basis that all workers have been paid in accordance with their contracts and no illegal fees are deducted from salaries. Auditing should include the provision of terms and conditions of employment for all workers for auditing, as needed. This will reduce the potential impact of this issue to Negligible.

9.6.5 Grievance Mechanism

All workers, and migrant workers in particular, should have access to grievance mechanisms that allow them to voice concerns without fear of punishment or retribution. Alba will develop a specific workers' grievance mechanism for the project to provide a transparent and easily accessible way for workers to raise and address grievances. The mechanism should include procedures for the following:

- Registering the grievance;
- Screening and assessing the complaint;
- Formulating a response and settling the issue;
- Evaluate and monitor the results; and

- Sharing results for the purpose of 'lessons learnt'.

The grievance mechanism should be available in a language understandable to the workers and awareness campaigns should be implemented to raise awareness of the worker grievance mechanism. Contractors and sub contractors should report regularly to Alba regarding any grievances raised and if/how these were resolved.

9.6.6 Labour Accommodation

All immigrant construction workers should be housed in accommodation which meets in full the requirements of *Ministerial Order No. 40 of 2014 with respect to the requirements and specification of workers' accommodation*.

Workers should also have access to the following:

- medical and dental facilities;
- places of worship;
- a range of sports and leisure facilities including indoor and outdoor facilities;
- shops and banking facilities;
- internet and telecommunications; and
- organised transportation to allow them to leave the accommodation and have access to Manama centre and major shopping centres, on non-working days.

Worker accommodation should be inspected and approved before contractor mobilisation to site. Thereafter the labour camps should be audited every three months to ensure they meet legal and guidance requirements. These measures should reduce the potential impacts to Negligible.

9.6.7 Public Health

It is recommended that Alba require all construction contractors to provide health education campaigns to their workers to provide information on the policies regarding sexually transmitted diseases, their impacts, symptoms and prevention measures.

9.6.8 Child Labour

Child labour is not likely to be a significant issue for the project, but Alba should ensure that the project human resource policy and procedures should have specific requirements banning child labour and these are incorporated into supplier contracts and they are obligated to apply these to their sub contractors. Contractors and sub contractors should be audited prior to mobilisation and annually to ensure compliance.

9.7 Summary

Table 9.4 shows a summary of the potential impacts and identified mitigation and monitoring requirements.

Table 9.4 Summary of Impacts for Labour and Working Conditions

Issue / Impact	Impact Significance	Mitigation / Monitoring / Enhancement Measures	Residual Impacts
Use of forced labour Payment of Wages Labour Accommodation	Major Adverse	• Establishing HR policy and procedures for Project in compliance with IFC PS2 requirements, including provision of a clear and understandable written statement of rights to each employee. • Application of mitigation in respect of human resource policy and procedures to employees of all (sub) contractors. • Ensuring all procurement contracts contain clauses banning forced labour. • Ensure (sub) contractors only use accredited local recruitment companies (in country of worker origin) to recruit workers. • Forbid the use of recruitment and other fees (such as payment for accommodation and transportation to/from home country). • Workers to retain access to their passport. • Run campaigns to raise awareness of worker rights, particularly in the context of forced labour; • Provide all employees with a Contract of Employment which contains all the items in Table 1.1. • Establishment of a grievance mechanism for employees of all (sub) contractors. • Make the grievance mechanism available in a language understandable to the worker. • Run campaigns to raise awareness of the worker grievance mechanism. • (sub) contractors to report regularly on grievances raised through the grievance mechanism and if/how these were resolved. • Alba to put in place requirements to conduct payroll audits on a monthly basis to ensure that (sub) contractors pay workers wages in full and no illegal fees are deducted from workers salaries. Payroll audits should include an audit of worker contracts to determine if they meet the required terms and conditions of employment. • Auditing of (sub) contractor to ensure relevant policy, procedures and contract requirements are in place prior to mobilization. • Auditing of (sub) contractors annually to ensure relevant policy procedures and contract requirements remain in force.	Negligible

Issue / Impact	Impact Significance	Mitigation / Monitoring / Enhancement Measures	Residual Impacts
		• Labour accommodation should be inspected and approved to ensure labour camps meet Bahraini law and IFC / EBRD guidelines before (sub) contractor mobilization. • For long-term contractors working on the project, labour accommodation should continue to be audited every six months to confirm continued compliance with Bahraini law and IFC / EBRD guidelines.	
Use of child labour	Negligible	• Establishing HR policy and procedures for Project in compliance with IFC PS2 requirements, including provisions banning child labour • Ensuring all procurement contracts contain clauses banning child labour. • Auditing of (sub) contractors to ensure relevant policy, procedures and contract requirements are in place prior to mobilization. • Auditing of documents annually to confirm continued compliance with relevant policy, procedures and contract requirements.	Negligible
Public Health: increase in STDs amongst workers and the local communities	Minor Adverse	• Alba to require contractors to implement public health campaigns on STD impacts, symptoms and prevention.	Negligible

10 MARINE AND COASTAL ECOLOGY

10.1 Introduction

The Port Upgrade has the potential to impact the marine biological environment within the immediate Project area during its construction, operation, and eventual decommissioning. Although marine biological and coastal resources in close proximity to the jetty have been significantly adversely influenced by historical and existing industrial and commercial activities, regionally, the marine environment of Bahrain exhibits diverse habitats supporting species (including fish and megafauna[19]) that contribute to the ecological, cultural, and economic wellbeing of the region.

For the purpose of assessment of marine ecological impacts, two main study areas are defined as follows:

1. Immediate project area (i.e. that within direct influence of the project) which does not exceed 150 m from any point of the existing and proposed marine infrastructure (**Figure 10.2**). This area was determined as the maximum extent where physical impacts arising from jetty works (construction, operation, decommissioning) could arise. Note this does not include impacts arising from marine noise which are addressed within a wider study area (see point 2).
2. An Area of Interest (AOI) which extends in a 7 km radius from the existing Alba Port (**Figure 10.3**). This area allows for those activities which may impact ecological resources further afield (e.g. marine noise arising from piling works and vessel operation) and is in line with SCE guidance *EA-8 Guidelines of the Ecological Study Conducted as Part of the EIA Study of Large-Scale Projects Involving (GES).*

10.2 Assessment Methodology

10.2.1 Environmental Baseline

The baseline has been derived following review of existing data sets and completion of primary surveys within the immediate project area.

A Drop Down Video (DDV) survey was conducted at 30 equidistantly spaced stations (100 m) on the 30th April 2018 and 7th May 2018, using a composite digital video camera (Deep Blue Pro) interfaced, via an umbilical, with an onboard laptop computer and hand-held GPS system. At each station both digital still and video images of the seafloor were obtained; notes made by the surveyor were recorded and are presented in **Section 10.3.2**. A map showing the distribution of the survey stations and seafloor habitats is presented in **Figure 10.2**.

Following an internal EACS risk assessment it was deemed that conducting SCUBA dives at the operational Alba jetty would represent a significant risk to health and safety and that the data likely to be collected would not warrant such a risk. As such all primary data was obtained using remote methods only.

[19] May include marine mammals (e.g. dolphins, dugongs) and turtles.

10.2.2 Environmental Assessment

IFC Performance Standard (PS) 1 requires Projects to perform an environmental and social impact assessment that addresses "all relevant environmental and social risks and impacts of the project, including the issues identified in IFC Performance Standards 2 through 8, and those who are likely to be affected by such risks and impacts." This includes an assessment of biodiversity which has been undertaken with reference to IFC PS 6 (2012) - Biodiversity Conservation and Sustainable Management of Living Natural Resources.

10.2.3 ESIA Significance Criteria

Impact significance has been 'calculated' as a product of sensitivity criteria and the magnitude of an impact, each determined by pre-defined criteria. Sensitivity of marine habitats and/or species of note takes into account it's rarity (e.g. IUCN Red List status), diversity, size, naturalness, vulnerability, representativeness and recoverability. Sensitivity criteria have been devised to be consistent over extended time periods; however, the value of receptors may increase temporally where cumulative impacts increase the rarity of resources. **Table 10.1** presents the sensitivity criteria developed by EACS for marine ecological and avian receptors.

Table 10.1 Marine Ecological and Avian Interests – Sensitivity Criteria

Scale	Sensitivity
High	The marine or coastal habitat(s) and/or one or more species (i.e. Dugong, turtles, the dolphin *Sousa plumbea*) within the potentially impacted area are of national and/or international importance, and may constitute, in part or whole, a national or internationally designated conservation/protected site and/or conservation priority species which is/are considered to be sparsely represented nationally and beyond. The habitat(s) may be an extremely good example of its type such as an intertidal flat, coastal lagoon, seagrass meadow or coral reef. The habitat(s) is likely to constitute a key primary producer and/or support highly diverse or unique assemblages of associated biota including avifauna.
Medium	The marine or coastal habitat(s) and/or one or more species (e.g. the dolphin *Tursiops aduncus*) are of importance within a national context. The habitat(s) supports moderately diverse assemblages of epibiota, infauna and/or fishes. Examples of such marine habitats may include rock with sand veneer, patchy seagrass and macroalgal beds, and are representative of a largely undisturbed marine environment. The marine or coastal habitat(s) and/or one or more associated avian species are of importance within a national context. The habitat(s) will support a moderately diverse assemblage of avifauna and/or concentrations of one or more species not present in comparable abundance elsewhere.
Low	The marine or coastal habitat(s) and its associated species (the 'receptor') within the potentially impacted area are of lower importance as conservation features and/or primary producers, both locally and nationally, and may have been subjected to previous anthropogenic disturbance or be well represented as a national resource, for example, deep-water mud habitats. The habitat(s) may possess low biodiversity. The marine or coastal habitat(s) and its associated avian species within the

Scale	Sensitivity
	potentially impacted area are of low importance, both locally and nationally. The habitat(s) is characterised by a low diversity of avifauna, comprising common species frequently sighted, and may have been previously subjected to anthropogenic disturbance.
Negligible	The marine or coastal habitat(s) and associated biota, including avian species, are of negligible national importance as a conservation feature, primary producer or exploitable resource as result of having been severely impacted by present and/or past anthropogenic activities. Examples of such degraded habitats may be within dredged areas in the marine environment or reclaimed/industrialised coastal fringes.

Quantifying the magnitude of an impact is defined via a number of sub-criteria. Typically, these may be informed following specialist studies, expert opinion, review of contractor's methodologies, and reference to published data (e.g. water quality guidelines, thresholds of marine mammals to varying sound pressure levels). Criteria include:

- **Extent:** whether the impact would occur onsite, in a limited (Li) area (within 1 km of the site); local (Lo) area (within, say, 5 km of the site or within the relevant Municipality); nationally (Na) or internationally (In). May also refer to number of individuals (e.g. megafauna) i.e. Li – a few individuals, Lo – may experience small aggregations but not of national importance, Na – represents a significant proportion of national inventory, In – numbers influence international populations.
- **Duration:** whether the impact would be short-term (ST- ≤1 year), medium term (MT- 1 - 5 years), long-term (LT- 5 - 20 years), or permanent (P - ≥20 years).
- **Intensity:** the quantifiable effects of impacts, measured where appropriate against an appropriate environmental standards (national, regional or international), threshold criteria (e.g. marine noise), or based on expert judgment.

In order to classify impacts, EACS has developed a scoring system against which the magnitude of an impact is determined (**Table 10.2**). When this is applied to a specific impact, the sum of the features (extent, duration, intensity) is used to determine the category of the magnitude (**Table 10.3**).

Table 10.2 Scale of Impact Magnitude

Feature	Scale of Magnitude			
Extent	Limited	Local	National	International
Score	1	2	3	4
Duration	Short term	Medium term	Long term	Permanent
Score	1	2	3	4
Intensity	Negligible	Low	Medium	High
Score	1	2	3	4

Table 10.3 Determining Impact Magnitude[20]

	Magnitude of Impact			
	High	**Medium**	**Low**	**Negligible**
Score	12	> 9	>6	≤6

Furthermore, additional criteria is used to further define features of the impact, although are not used in the quantification process, these include:

- **Likelihood/ Risk:** based on the best available information (primary and secondary data), the likelihood of an impact is assigned a classification based upon the probability of an event occurring (i.e. unlikely (U), likely (L), and definite (D)).
- **Direct** (D): impacts that result from direct interaction between a project activity and the receiving environment (e.g. physical impact on an ecological habitat).
- **Indirect** (I): impacts that result from other activities as a consequence of the project (e.g. reduction in water quality due to dredging may impact ecological receptors).

The level of impact significance is presented as the product of impact magnitude and receptor sensitivity (**Table 10.4**). **Table 10.5** defines the scale of impact.

Table 10.4 Calculation of Impact Significance

MAGNITUDE	**High**	Minor/Moderate	Moderate	Moderate/Major	Major
	Medium	Minor	Minor/Moderate	Moderate	Moderate/Major
	Low	Negligible/Minor	Minor	Minor/Moderate	Moderate
	Negligible	Negligible	Negligible	Negligible/Minor	Minor/Moderate
		Negligible	**Low**	**Medium**	**High**
		VALUE AND SENSITIVITY			

Table 10.5 Scale of Impact Significance

Impact significance	**Impact Description**
Negligible	Very short term and of limited spatial extent typically limited to the immediate area adjacent to the source of impact. The loss is negligible and unlikely to register on a national scale.
Minor Adverse	Short term, temporary impacts where natural recovery is very likely over a very short time period (e.g. less than 1 year), or where the receptor has low level physiological responses to identified stressors (e.g. behavioural responses, etc.). The loss is small compared to national resources.
Moderate Adverse	Medium to long term (3-5 years) or spatial extent of the stressor (e.g. extent of plume) with regards its level of impact (e.g. physical damage). This may result in the displacement of species on a temporary basis; the loss represents a significant proportion of the national resource.
Major Adverse	Long term (i.e. five years) or permanent loss of the receptor. Recoverability is unlikely even in the event of cessation of stressor. The loss represents a major proportion of the regional resource.

[20] Where a magnitude value falls between two categories, expert opinion is used to finalise the scale.

10.2.4 Mitigation and Management

Where the assessment identifies adverse impacts, management and mitigation measures are proposed to reduce the impact to an acceptable level. Management and mitigation measures will include as a matter of course recommendations for good practice in construction and environmental management. Where successfully implemented, mitigation may result in the reduction in the magnitude of an impact by lowering one, or all, of its contributing factors (i.e. duration, intensity or extent – **Table 10.2**). The resulting residual impact is therefore quantified and qualified.

10.3 Baseline

10.3.1 General Setting

Primary ecological surveys (**Section 10.3.2**) indicate that the entire study area (and much of that adjacent) comprises deep water (i.e. >12 m), soft silty substrate with little to no conspicuous epibiota. Similar observations were made by EACS for adjacent areas and as documented in EACS (2015) *East Sitra Housing Project Bahrain, Dredging, Reclamation and Shoreline Protection Works - Borrow Areas D and R*, and Geomatec (2006).

Much of the seabed within the 7 km radius is considered of low ecological importance (Geomatec, 2006), comprising deep water and shallow water mixed habitat, the latter which has, in recent years, experienced significant land reclamation and dredging (e.g. NOGA platform, East Sitra Housing Project, Bahrain Defence Force (BDF) base). The waters in this area serve the heart of Bahrain's industrial areas including:

- Khalifa bin Salman Port;
- Bahrain Steel Pelletizing plant;
- Arab Ship Repair Yard (ASRY) dry docks;
- Hidd Industrial Area (HIA);
- Bahrain Investment Wharf (BIW);
- Sitra Industrial Area (SIA); and
- Mina Salman Commercial Port.

Numerous jetties, wharfs and quays are associated with the above with regularly dredged navigational channels serving each. Marine sediment loading is further increased by the operation of numerous sand washing plants which discharge sediment laden waters to the marine environment. As such, although some mechanically un-disturbed areas of seabed remain, increasing anthropogenic activities has severely degraded their productivity.

There are no Marine Protected Areas (MPAs) within the immediate study area. Those areas which are protected nationally (and internationally) include those identified in **Table 10.6**.

Table 10.6 Marine Protected Areas in the Kingdom of Bahrain

Name	Distance[21] (km) to Alba Jetties (not less than)	Within influence of the project
Tubli Bay	6	No
Arad Bay	12	No
Mashtan and *Halat Noon* island	35	No
Hawar islands	48	No
Reef *Bul Thalma*	89	No
Hayr Amamah	81	No
Hayr Shytaya	56	No
Hayr Bul Thalma	86	No
R'as Mumtallah	31	No

10.3.2 Primary Surveys

Review of the survey data has enabled us to define three seabed habitat codes within the immediate study area as presented in **Table 10.7**; **Figure 10.1** provides a visual reference to key features of each.

Table 10.7 Habitats Present Within the Immediate Study Area

Habitat	Habitat Description
Rock with sand	Medium grained sand clear signs of sedimentation of fine materials. Frequent presence of rocks (5-10 cm) with broken shell and rubble. Algal turf present on larger rocks along with macro algae (e.g. *Padina* sp., *Sarconema* sp.) observed rarely.
Silty sand	Largely flat homogenous seabed with no conspicuous vertical relief or rocky outcrops. Some accumulation of broken shells in places and conspicuous algal matt. No conspicuous biota.
Silt/mud	Flat homogenous seabed with numerous polychaete burrows present and which is indicative of muddy seabed. No conspicuous biota.

All observations indicate significant past environmental impact upon seabed ecology with conspicuous flora and fauna restricted to two species of algae (*Padina* sp. and *Sarconema filiforme*), some bivalves (*Chama* sp.) and one individual blue swimming crab (*Portunis pelagicus*); these species have not been assessed on the IUCN Red list[22] and hence are not considered as being of national, regional or international importance.

The seabed habitat within the immediate study area can be considered highly disturbed and of low ecological importance which does not harbour any significant epibiota. A habitat map which shows the geographical representation of each of the habitat is shown in **Figure 10.2**.

[21] As the crow flies.

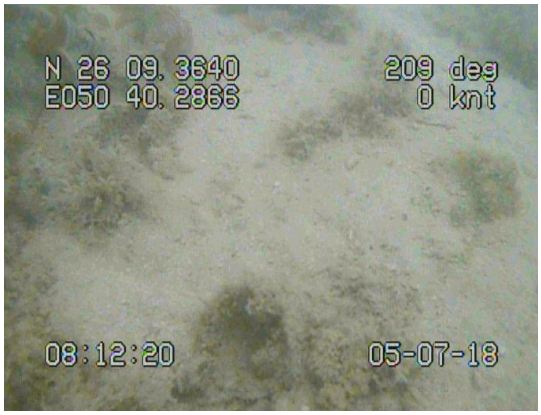
[22] Accessed 4th June 2018.

Figure 10.1 Key Features of the Immediate Study Area

AP01 – *Padina* sp.

AP04 – Algal matt

AP06 – Silty mud

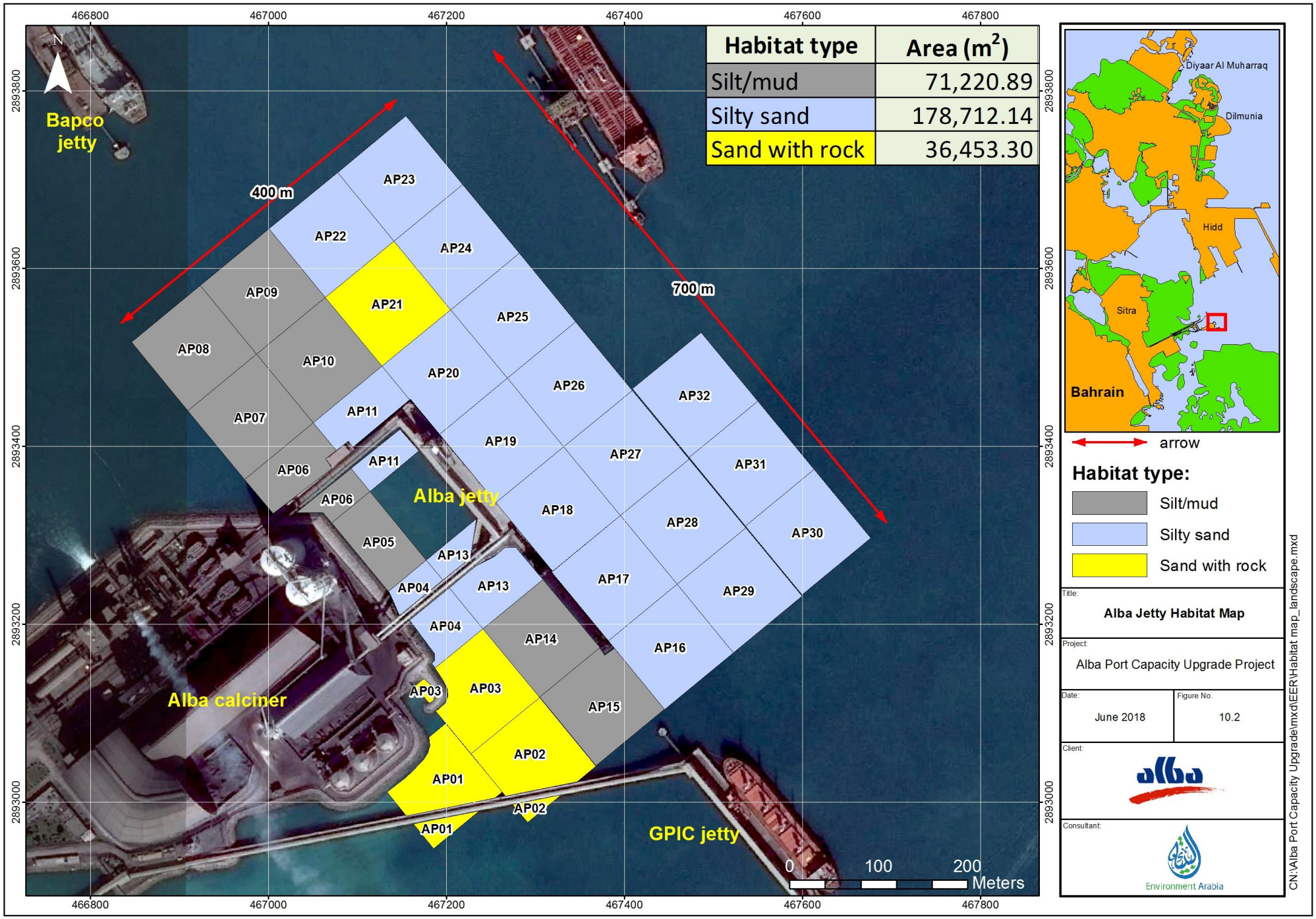


AP01– Sand with rock

Table 10.8 Drop Down Video Notes (Coordinates in WGS84-UTM)

Station	Date	Time	Depth (m)	Easting	Northing	Observations	Habitat Code
AP01	07.05.18	11:12	4.8	467192	2893018	Sand and scattered rocks. The brown alga *Padina* sp. and the red alga *Sarconema filiforme* observed.	Sand with rock
AP02	07.05.18	11:15	9.4	467298	2893048	Sand and scattered rocks with broken shells. No conspicuous epibiota	Sand with rock
AP03	07.05.18	11:30	5.3	467234	2893125	Sand and scattered rocks with broken shells. No conspicuous epibiota	Sand with rock
AP04	07.05.18	11:27	3.8	467170	2893202	Soft silty looking substrate with algal matt throughout. Individual of *Padina* sp. noted. No other conspicuous epibiota	Silty sand
AP06	30.04.18	12:37	12.1	467107	2893279	Soft silty substrate with numerous burrows. No conspicuous epibiota	Silt/mud
AP07	30.04.18	12:34	12.0	467043	2893356	Soft silty substrate with numerous burrows. No conspicuous epibiota	Silt/mud
AP08	30.04.18	12:31	10.8	466980	2893433	Soft silty substrate with some scattered rocks and broken shells	Silt/mud
AP09	30.04.18	12:25	12.4	466916	2893511	Soft silty substrate with numerous burrows. No conspicuous epibiota	Silt/mud
AP10	30.04.18	12:16	12.5	466993	2893574	Soft silty substrate with numerous burrows. No conspicuous epibiota	Silt/mud
AP11	30.04.18	12:21	12.5	467057	2893497	Silty sand with no conspicuous epibiota	Silty sand
AP13	07.05.18	11:24	7.4	467120	2893420	Silt sand no conspicuous epibiota	Silty sand
AP14	07.05.18	11:21	10.5	467184	2893343	Soft silty substrate with numerous burrows. No conspicuous epibiota	Silt/mud
AP15	07.05.18	11:18	10.8	467248	2893266	Soft silty substrate with numerous burrows. No conspicuous epibiota	Silt/mud
AP16	07.05.18	11:33	14.3	467311	2893188	Silty sand with rocks and rubble and bivalves and some debris	Silty sand
AP17	07.05.18	11:55	14.9	467388	2893252	Silty sand with rocks and rubble and bivalves and some debris	Silty sand
AP18	07.05.18	11:59	15.2	467325	2893329	Silty sand with broken shells and some rubble	Silty sand

Station	Date	Time	Depth (m)	Easting	Northing	Observations	Habitat Code
AP19	07.05.18	12:39	14.9	467261	2893406	Silty sand with noticeable water current	Silty sand
AP20	30.04.18	11:55	13.1	467198	2893483	Silt sand with numerous broken shells	Silty sand
AP21	30.04.18	12:13	12.2	467134	2893561	Sand with some scattered rock with no conspicuous epibiota	Sand with rock
AP22	30.04.18	12:10	12.9	467070	2893638	Silty sand with no conspicuous epibiota	Silty sand
AP23	30.04.18	12:07	13.6	467148	2893701	Silty sand with no conspicuous epibiota	Silty sand
AP24	30.04.18	12:03	12.6	467211	2893624	Silty sand with broken shells and some rubble, no conspicuous epibiota	Silty sand
AP25	30.04.18	11:59	13.1	467275	2893547	Silty sand with broken shells and some rubble, no conspicuous epibiota	Silty sand
AP26	07.05.18	12:35	15.2	467338	2893470	Silty sand with broken shells and some rubble, no conspicuous epibiota	Silty sand
AP27	07.05.18	12:03	15.4	467402	2893393	Silty sand some burrows, no conspicuous epibiota	Silty sand
AP28	07.05.18	11:50	15.2	467466	2893315	Silty sand and some scattered rubble, no conspicuous epibiota	Silty sand
AP29	07.05.18	11:37	15.1	467529	2893238	Silty sand and some scattered rubble, no conspicuous epibiota	Silty sand
AP30	07.05.18	11:41	15.0	467606	2893304	Silty sand and some scattered rubble, no conspicuous epibiota	Silty sand
AP31	07.05.18	11:46	15.0	467543	2893381	Silty sand and some scattered rubble, no conspicuous epibiota	Silty sand
AP32	07.05.18	12:08	12:0	467479	2893458	Silty sand and some scattered rubble, *Portunis pelagicus* noted.	Silty sand


466800
467000
467200
467400
467600
467800
2893800
2893600
2893400
2893200
2893000
N
Bapco jetty
400 m
700 m
AP23
AP22
AP24
AP21
AP25
AP09
AP08
AP10
AP20
AP26
AP32
AP07
AP11
AP19
AP27
AP31
AP06
AP11
AP06
Alba jetty
AP18
AP28
AP30
AP05
AP13
AP04
AP13
AP17
AP29
AP04
AP14
AP16
AP03
AP03
AP15
AP02
AP01
AP02
AP01
GPIC jetty
Alba calciner
0
100
200
Meters
Habitat type
Area (m2)
Silt/mud
71,220.89
Silty sand
178,712.14
Sand with rock
36,453.30
Diyaar Al Muharraq
Dilmunia
Hidd
Sitra
Bahrain
arrow
Habitat type:
Silt/mud
Silty sand
Sand with rock
Title:
Alba Jetty Habitat Map
Project:
Alba Port Capacity Upgrade Project
Date:
June 2018
Figure No.
10.2
Client:
Consultant:
Environment Arabia
CN:\Alba Port Capacity Upgrade\mxd\EER\Habitat map_landscape.mxd

10.3.3 Secondary Data - AOI

Figure 10.3 identifies seabed habitats within a 7 km radius AOI of the project area as presented in Geomatec, 2006. Much of the study area exhibits an environmental sensitivity value of between 2-3 on a five point scale (1-least important, 5-most important) and as such is not considered to be sensitive. The scale takes into account a number of criteria including habitat productivity, presence of endangered species, contribution to national fisheries and avifauna (Geomatec, 2006).

The AOI covers a wide area most of which does not fall under the influence of the project; however, it is in included for completeness and to conform to PS6. Key inclusions in this AOI include:

1. *Qulay'ah* bay and *Qassar Al Qulay'ah*
2. Sections of Tubli Bay
3. Ma'ameer Channel
4. *Fasht al Adhm*

Qulay'ah Bay and Qassar Al Qulay'ah

This area to the north and west of the study area leads to Tubli bay and is bordered to the north by the Sheikh Khalifa Crossing and to the west by Sitra Causeway. It is represented by mixed habitat (Geomatec, 2006) and based on EACS previous studies in the area (*EACS, 2016 Input to the Hydrodynamic Modelling Study of Reclamation Plans Impact on Hydrodynamic Conditions and Seawater Quality at the Intake and Outfall of Power and Water Plants*), comprises soft mobile substrate with isolated sparse patches of seagrass (including *Halodule uninvervis* and *Halophila ovalis*), shallow rocky areas supporting a low coverage of macro algae and deeper muddy/silty habitats associated with dredged navigational channels leading to the port of Mina Salman. Water quality is generally turbid with high levels of suspended solids.

Towards the centre of the bay, the island of *Qassar Al Qulay'ah* was recognized as an important breeding site for the Lesser-crested Tern *Sterna bengalensis* and the White-cheeked Tern *Sterna repressa*, among other species, and outside the summer breeding season a roosting site for shorebirds during high tide. In the last five years, a Bahrain Defence Force (BDF) base has been constructed on the island and hence the status of avifauna on the island is not known (access to the island is restricted). Hard corals which once (likely decades ago) bordered the island are now dead and only skeletal fragments of Acropora spp. can be found (EACS, 2010 SULB Integrated Steel Complex Hidd Industrial Area, Bahrain).

Historically, areas to the north of the Alba jetty and within *Qulay'ah* bay represented important habitats for many bird species, mainly waders associated with extensive shallow and intertidal mudflats off the east coast of Sitra Island. With the reclamation of the NOGA platform and the East Sitra Housing Development almost all of these areas have been permanently lost.

Tubli Bay

Tubli Bay is a nationally designated Marine Protected Area (MPA) under Law No. 53 of 2006 and is also internationally recognized as a RAMSAR site (no. 921). The Bay includes three protected areas namely:

1. Tubli Bay wetlands (RAMSAR);
2. Ras Sanad Mangrove Reserve; and
3. Tubli National Park.

Tubli Bay includes open sea habitat, forest habitat (subtropical and tropical mangrove comprising the sole species *Avicennia marina*) and coastline habitat (intertidal lagoon with marshes, mud, sand and salt flats, rocky shoreline, shallow waters with sea grass and subtidal aquatic beds). Tubli Bay is an important staging and wintering area for birds and is identified as an Important Bird Area (IBA) by BirdLife International. Tubli Bay is approximately 7 km north west of the project area.

Ma'ameer Channel

Historically, *Ma'ameer* channel acted as a drainage wetland for Tubli Bay although in recent decades the imposition of bridges and culverts has somewhat demarked the channel from Tubli. It remains an ecologically sensitive site and is nationally protected as a nature reserve under law No. 53 of 2006. The waters of the channel are shallow, typically 1 m or less and do not host conspicuous biota other than algae and invertebrates associated with the muddy sediments. Stands of sparse *Avicennia marina* are present in varying coverage along the flanks of the channel.

Fasht Al Adhm

Fasht Al Adhm represents the nearest sensitive ecological habitat (sensitivity rating of 4-5) within the project AOI (located approximately 1.5 km to the south east of the existing Alba jetty). At approximately 210 km^2, *Fasht Al Adhm* comprises mixed habitats including seagrass beds (*Halodule uninervis*, *Halophila* spp), macro algae (including key species, *Hormophysa cuneiformis*, *Cystoseira trinodis*, *Sargassum* spp), soft substrate (sand) and, in low coverage, hard corals (key coral areas are located along the north eastern fringe).

The diversity and geographical extent of habitats present contributes to the biodiversity of the system (and its supporting role with regards harbouring biota and fish) and as such *Fasht Al Adhm* is recognised as the country's main fishing ground; fishing methods including *Gargoor*, *Haddrah*, hook and line, and nylon nets are regularly used.

In the 1980s the reef was considered rich with a high coverage of live reef building corals and with a coverage of 50–75% in most measured locations (Alkuzai et al., 2009); today it supports almost no living coral at all (Shepherd *et. al*, 2010). Much of the coral coverage of *Fasht Al Adhm* was severely damaged during the global bleaching events, due to increased water temperatures, of 1998 (Shams, 2002) and increased suspended solids within the water column due to coastal development. In 2009, coral cover in *Fasht Al Adhm* was found to comprise less than 5% of the reef areas (Alkhuzai *et al.,* 2009) and the reef is believed to support minimal living coral recently (Riegl and Purkis, 2012).

Subsequent years had seen the limited localised growth of some more hardier species e.g. *Cyphastrea* spp., *Porites* spp. *Favia* spp and *Platygyra* spp. although the branching corals of the Acropora spp. are not to be seen[23]. In 2015 EACS conducted three line transects along the north eastern fringe of *Fasht al Adhm* (an area known to contain higher coverage of live corals) and recorded a maximum live coral cover of 46.25% at

[23] Personal observations Michael Arora, 2018.

E0476835 N2887930 (10.5 km from the Alba jetty). EACS subsequently revisited the site in August 2017 and noted that much of the corals had bleached again.

Megafauna

Dugong and Cetaceans

The Dugong, listed as a 'vulnerable' species on the IUCN Red List[24], is native to the waters of the Kingdom of Bahrain. The Arabian Gulf contains the most important dugong habitat within the western half of the dugong's range (Marsh *et al.*, 2002) and the Persian Gulf, spanning the territorial waters of Bahrain, Qatar, Saudi Arabia and the UAE, and contains the second largest population of sea cows, totalling approximately 7,300[25] (+/- 1,310), following only the numbers present in Australian waters (~80,000)[26].

The Gulf of *Salwah* including the waters to the south-east of Bahrain, between *Ras al Bar* and the *Hawar* Islands is a principal area for the regional dugong population, amounting to between 2,500 and 3,500 individuals. Preen (1989) demonstrated the aforementioned conclusions of Marsh *et al.* (2002) through works largely based upon aerial surveys conducted in 1986 for the waters of Bahrain, Qatar and the UAE. The surveys revealed that dugongs are largely restricted in range to the southern and south-western coastline between *Ras Tannurah*, Saudi Arabia and Abu Dhabi in the UAE, with an estimated population of 5,800 animals. The relevant key areas of importance with regard to dugong populations identified by Preen *et al* in 1989 in the Arabian Gulf are:

- Between Bahrain and Qatar, south of *Fasht al Adhm*;
- North of the *Hawar* Islands; and
- Between Saudi Arabia and Bahrain, south of the Saudi Arabia-Bahrain (King Fahd Causeway) and north of *Uqair* (in the eastern province of Saudi Arabia).

The study area is therefore not known to support Dugong either directly (i.e. as a feeding or breeding habitat) or as an area in which they may pass or frequent (Geomatec, 2006). That said it is remotely possible that individuals may on the very rare occasion be seen.

Cetaceans are further represented in Bahrain's waters by two regularly occurring species, namely the Indo-Pacific humpback dolphin (*Sousa plumbea*) and the Indian Ocean bottle nose dolphin (*Tursiops aduncus*) (Baldwin *et al*, 1999 and Preen, 1989). Both these species are known to regularly frequent the immediate study area and AOI. Baldwin *et al.* also account records of the finless porpoise. Common dolphins (*Delphinus cf. capensis*) have also been reported off Bahrain (M. Hill, pers. comm.) which is documented in nearby Saudi Arabian and UAE waters (Baldwin *et al,* 1999).

Indo-Pacific humpback dolphins, Indian Ocean bottlenose dolphins and finless porpoises are all shallow–water species which commonly occur in water depths of 1-10 m in the region (Baldwin 2003). Their prey is likely to include small benthic fishes and crustaceans (Baldwin 2003) and all three species are known to be breeding residents of the wider region and probably Bahrain's waters. The seasonality of breeding is not known and neither are their seasonal movements understood.

[24] www.iucnredlist.org/details/6909/0

[25] www.hans-rothauscher.de/dugong/afr_e.htm

[26] www.hans-rothauscher.de/dugong/afr_e.htm

In addition, Killer whales (*Orcinus orca*) have also been sighted in January 2004 (Jassim Al Qaseer, pers. comm.) and are likely to be an uncommon visitor as they are present in the adjacent waters of Abu Dhabi (Baldwin, 2003).

The conservation status of the species confirmed to occur in Bahrain's waters is provided in **Table 10.9**; this also indicates is likely presence within the immediate study area. The presence of those species indicated is possible within the larger AOI in greater occurrence. The possible presence of each within the immediate area and the larger AOI is stated based on EACS experience and observations made over several decades.

Table 10.9 Potential Presence of Marine Mammals in the Immediate Study Area

Scientific name	Common Name	IUCN Conservation Status	Potential Occurrence
Dugong dugon	Dugong	VU	Individuals very rarely
Neophocaena phocaenoides	Finless porpoise	VU	
Tursiops aduncus	Indian Ocean bottlenose dolphin	DD	Moderate
Sousa plumbea	Indo-Pacific humpback dolphin	EN	High
Delphinus capensis	Long-beaked common dolphin	DD	Very low
Orcinus orca	Killer whale	DD	Sighted once in 2004

Key: DD – Data Deficient, EN-Endangered, VU – Vulnerable

Marine Turtles

The most common species to occur in Bahraini waters are the green (*Chelonia mydas*) and the hawksbill turtle (*Eretmochelys imbricata*) which occur as foraging populations in shallow waters (Miller *et al,* 1989; Al Zayani, 2003). The loggerhead turtle (*Caretta caretta*) also occurs, though with less frequency and presumably in much lesser abundance (Miller 1989). There appears to be little data on the spatial and seasonal distribution of turtles in Bahrain though various reports suggest concentrations in shallow seagrass areas (presumably mostly green turtles) to the east and west of Bahrain, more or less mirroring primary dugong distribution (Abdulqader, 2000; Geomatec, 2006). The study area is not considered important for turtles (Geomatec, 2006), although in the rare occasion individuals may be sighted. **Table 10.10** defines those species present within Bahrain's waters but also indicates the likelihood of each present within the immediate study area.

Table 10.10 Potential Presence of Marine Turtles in the Immediate Study Area

Scientific Name	Common Name	IUCN Conservation Status	Potential Occurrence	Preferred Habitat
Chelonia mydas	Green turtle	EN	Individuals rarely	Highly migratory and use a wide range of broadly separated localities and habitats during their lifetimes.
Eretmochelys imbricata	Hawksbill turtle	CR		
Caretta caretta	Loggerhead turtle	VU	Most unlikely	

Key: CR – Critically endangered, EN – Endangered, VU-Vulnerable

Invertebrates

Thirteen species of invertebrates considered as 'at risk' (i.e. those classified as being Extinct in the Wild, Critically Endangered, Endangered or Vulnerable and as listed by the IUCN (2015)) are potentially found in Bahrain waters. None of those identified are considered to be present in the immediate study area primarily due to insufficient habitat and poor water quality (**Table 10.11**).

Table 10.11 Potential for Presence of Invertebrate 'Species at Risk' in the Region

Scientific Name	IUCN Conservation Status	Insufficient Habitat in the Study Area
Acropora horrida	Vulnerable	✓
Acropora pharaonis	Vulnerable	✓
Anomastraea irregularis	Vulnerable	✓
Fungia curvata	Vulnerable	✓
Heliopora coerulea	Vulnerable	✓
Pavona cactus	Vulnerable	✓
Pavona decussata	Vulnerable	✓
Pavona diffluens	Vulnerable	✓
Pavona venosa	Vulnerable	✓
Physogyra lichtensteini	Vulnerable	✓
Turbinaria mesenterina	Vulnerable	✓
Turbinaria peltata	Vulnerable	✓
Turbinaria reniformis	Vulnerable	✓

Fish

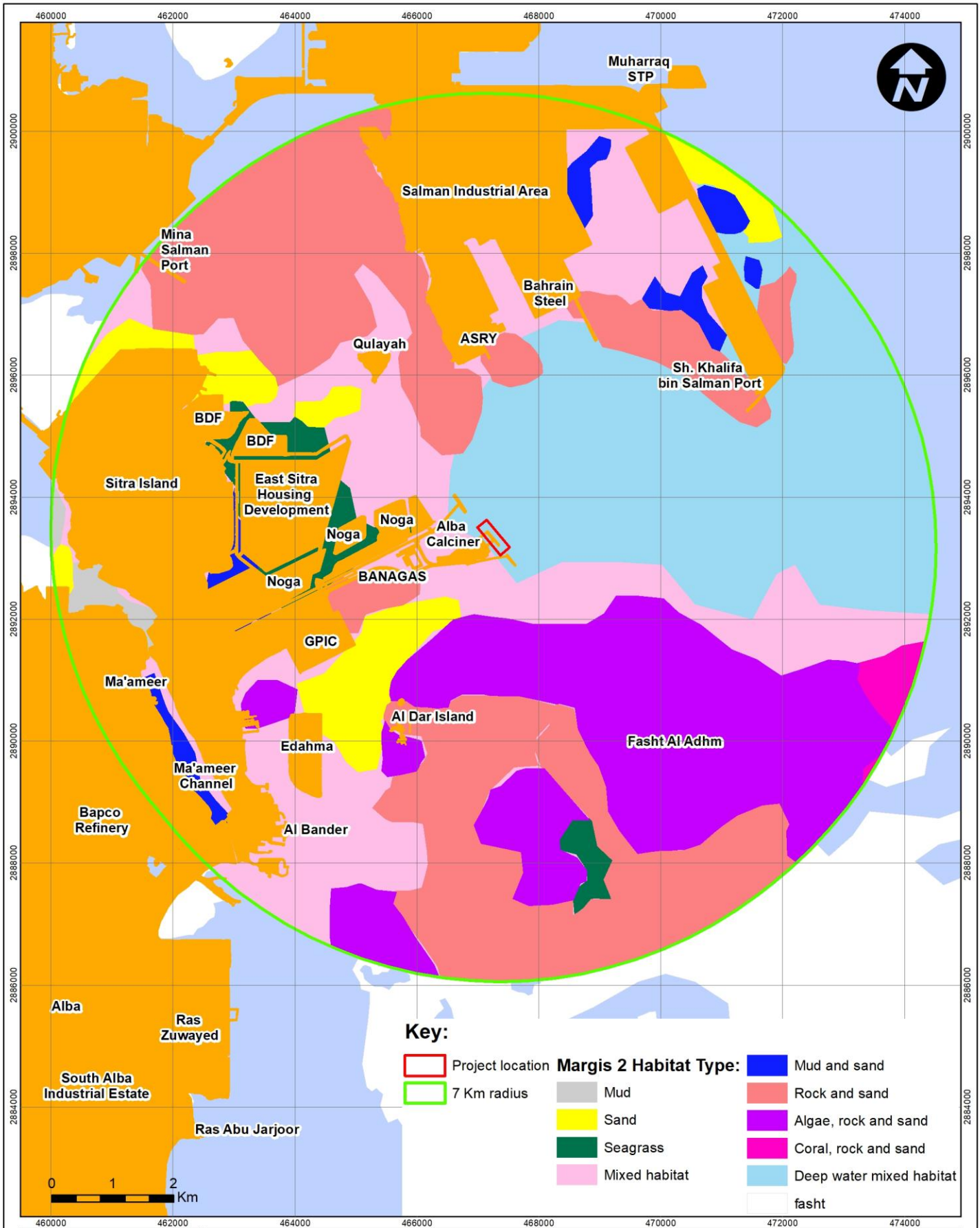
Of fish, eight species are considered 'at risk' (i.e. as per IUCN Red List - Extinct in the Wild, Critically Endangered, Endangered, Vulnerable, (IUCN 2018)), are potentially present within Bahrain waters. Although considered extremely unlikely, the potential remains that six species may occur (based on habitat availability), at some discrete time, within the proximity of the immediate study area (**Table 10.12**).

Table 10.12 Potential for Presence of Fish 'Species at Risk' in the Region[27]

Scientific Name	Common Name	IUCN Conservation Status	Reason for Exclusion		Included	
			Locally Out of Range	Insufficient Habitat	Potential Occurrence	Preferred Habitat
Hemipristis elongata	Fossil Shark, Snaggletooth Shark	VU			low	Inhabit inshore and offshore on the continental and insular shelves. Feed on sharks, rays and bony fishes.
Nebrius ferrugineus	Tawny Nurse Shark	VU		✓		
Pristis zijsron	Green Sawfish, Olive Sawfish, Narrowsnout Sawfish, Longcomb Sawfish	CR			low	Inhabit shallow bays, estuaries and lagoon. Feed on fishes and shellfishes.
Rhina ancylostoma	Shark Ray, Mud Skate, Bowmouth Guitarfish	VU			low	Found primarily on sand and mud bottoms, although sometime in the water column, in coastal areas and coral reefs. Feed mainly on crustaceans and molluscs.
Rhincodon typus	Whale Shark	VU			low	Often occur offshore but sometimes come close to shore. Feed on small fishes (e.g., sardines, anchovies, mackerel, juvenile tunas and albacore), small crustaceans and squids.
Sphyrna lewini	Scalloped Hammerhead	EN	✓			
Sphyrna zygaena	Smooth Hammerhead	VU			low	Inhabit inshore or offshore, over continental and insular shelves. Often associated with bottom at 1-139m. Prefer to feed on small sharks, skates and stingrays, but also prey on bony fishes, shrimps, crabs, barnacles and cephalopods.
Stegostoma fasciatum	Zebra Shark, Leopard Shark	VU			low	Inhabit sand, rubble, coral bottoms of continental and insular shelves. Feed primarily on molluscs, but also small bony fishes, crabs, shrimps and sea snakes.

VU-vulnerable, CR-critically endangered, EN-endangered

[27] HATCH (2016) BLNG Project Environmental Impact Assessment Addendum. Rev.02.



Title: **Margis 2 Habitat within 7 Km Radius of the Project Area**		Client: alba
Project: Alba Port Capacity Upgrade Project		
Date: January 2018	Figure No.: 10.3	Consultant: Environment Arabia
Datum: WGS 84 - UTM 39N	Scale: 1:60,000 (A4)	

CN:\Alba Port Capacity Upgrade\mxd\Margis 2.mxd

10.4 Impact Assessment – Construction

Jetty 2 will be extended towards the existing dolphin by 37.5 m. Jetty 1 will be extended by 65 m. The new extensions will be realised by driven piles arranged on equidistant alignments of 10 m (with the exception of the last section towards the dolphin); for each alignment there will be a prefabricated steel beam that will stand on 3 piles. Hence a total of 30 piles, each with an external diameter of 900 mm will need to be installed for jetty 2 and a further 60 for jetty 1. Driven piles will be augured such that sediments contained within are removed (by Re-circulatory Drilling methods (RCD)) and reinforcing caging and concrete installed at the pile bottom section to anchor it in place. Potential impacts during construction are identified as:

1. Loss of marine habitat due to installation of pile structures.
2. Marine sediment loading and subsequent deposition of sediment arising from pile drilling and its effects on flora and fauna.
3. Marine noise and impacts upon marine mammals, turtles and fish.
4. Potential spillages of fuels (i.e. diesel) stored on construction vessels and or during re-fuelling.

10.4.1 Loss of Habitat due to Piling Operations

Critical habitats are defined by the World Bank's IFC PS 6 as areas with high biodiversity value, including:

(i) habitat of significant importance to Critically Endangered and/or Endangered species;
(ii) habitat of significant importance to endemic and/or restricted-range species;
(iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species;
(iv) highly threatened and/or unique ecosystems; and/or
(v) areas associated with key evolutionary processes.

The sensitivity of the habitat lost is valued as negligible as it has been significantly impacted by past coastal development (i.e. has been dredged to approximately -14 m CD, experiences significant deposition of fines and high levels of suspended solids) and does not host sensitive marine ecological receptors. The magnitude of the impact is similarly classed as negligible as the direct loss of seabed is estimated at a total of only 19 m^2 for a total of 30 piles. **Table 10.13** presents the key characteristics of the impact.

Table 10.13 Impact Summary Loss of Marine Habitat Due to Piles

<table>
<tr><th rowspan="2">Sensitivity of Receptor</th><th colspan="3">Magnitude of Impact</th><th colspan="2">Features of Impact</th><th colspan="2" rowspan="2">Impact Significance</th></tr>
<tr><th>Extent</th><th>Duration</th><th>Intensity</th><th>Risk</th><th>Direct / Indirect</th></tr>
<tr><td rowspan="4">Negligible</td><td>1</td><td>4</td><td>1</td><td rowspan="4">Definite</td><td rowspan="4">Direct</td><td rowspan="2">Design mitigation</td><td rowspan="2">Negligible</td></tr>
<tr><td colspan="3">Negligible (6)</td></tr>
<tr><td>1</td><td>4</td><td>1</td><td rowspan="2">Residual</td><td rowspan="2">Negligible</td></tr>
<tr><td colspan="3">Negligible (6)</td></tr>
<tr><td colspan="8">Mitigation (to achieve residual impact & best practice)</td></tr>
<tr><td colspan="8">– None required.
– No monitoring required.</td></tr>
</table>

The addition of the 90 piles to the study area will represent a total increase in hard substrate, to which marine invertebrates (fouling communities) may attach, of approximately 3,564 m^2 (assuming a total pile height of 14 m from seabed). The piles will, to some degree, act as an artificial reef structure and likely provide a coincidental beneficial impact to the study area in particular to invertebrates and fish. Additional benefit is afforded by the protected nature of the facility which prevents any form of fishing.

10.4.2 Marine Sediment Loading due to Pile Drilling

Once driven into the seabed, the core of each pile will be drilled out using RCD techniques; water will be used as the drilling fluid and will be re-used for each pile. Given that piles may extend to –15 m below seabed, an estimated volume of sediments discharged to sea is 9.5 m^3/ pile; a total volume for 90 piles of 855 m^3.

Piles will be drilled one at a time with the duration of drilling not likely to exceed 24-hours. As such a release rate of 0.4 m^3/hr could be realised although it is very likely that this will vary. This amount relates to a very low sediment loading rate as compared to capital and maintenance dredging works and is therefore unlikely to significantly impact water quality.

Marine sediment loading from pile drilling can result in temporary adverse impacts on those species which utilise specific feeding modes, particularly suspension/filter-feeding organisms, including bivalves (Newell *et al*, 1998), tubeworms, sponges, hydroids and ascidians. Sediment suspension and deposition may, where present, also impair photosynthesis by macro algae/sea grass (Preen *et al.*, 1995), where sufficiently elevated, can impede the respiratory functions and feeding behaviour of fish (Al-Ghadban and Price, 2002).

Baseline seabed ecology of the study area is considered poor and of low sensitivity to additional sediment loading; sea grass was not identified in the immediate study area and the macro algae that was identified was in sparse quantities (individuals). Baseline surveys did not show any sensitive epibiota which would be affected by increased TSS and/or sediment deposition. Furthermore, given the depths of water in the area the deposition of material will spread such that its deposition is likely to be immeasurable[28].

The physical extent of such a low sediment release rate is unlikely to register beyond 50-100 m and, given the number of piles, is considered a temporary impact. The features of the impact are presented in **Table 10.14**.

[28] Note sediment plume dispersion was deemed unwarranted given the limited number of piles and small volumes of sediment released to sea.

Table 10.14 Increased Suspended Solids on Marine Habitats

<table>
<tr><th rowspan="2">Sensitivity of Receptor</th><th colspan="3">Magnitude of Impact</th><th colspan="2">Features of Impact</th><th colspan="2" rowspan="2">Impact Significance</th></tr>
<tr><th>Extent</th><th>Duration</th><th>Intensity</th><th>Risk</th><th>Direct / Indirect</th></tr>
<tr><td rowspan="4">Negligible</td><td>1</td><td>1</td><td>1</td><td rowspan="4">Definite</td><td rowspan="4">Direct</td><td rowspan="2">Design mitigation</td><td rowspan="2">Negligible</td></tr>
<tr><td colspan="3">Negligible (3)</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td rowspan="2">Residual</td><td rowspan="2">Negligible</td></tr>
<tr><td colspan="3">Negligible (3)</td></tr>
<tr><td colspan="8">Mitigation (to achieve residual impact & best practice)</td></tr>
<tr><td colspan="8">– The contractor is to prepare a Marine Water Quality Management Plan (MWQMP) which defines appropriate standards based on SCE (2010) EIA-9 Guidelines on TSS Monitoring Programme of Large Scale Projects Involving Intensive Dredging and Reclamation Operations (Section 11).
– Should TSS values breach national standards, consider the strategic deployment of silt curtains to contain suspended solids.
– Discharge pile cuttings 3-5 m below water surface (if permitted) or collect and dispose on land.</td></tr>
</table>

10.4.3 Marine Noise on Marine Mammals due to Piling Activities (Hammering)

The potential for impulsive underwater noise associated with in-water pile driving to impact sensitive marine mammals both physically and behaviourally exists. It should be noted that the study area is not identified as one hosting populations of dugong (*Dugong dugon*); however, dolphins (*Sousa plumbea* and *Tursiops aduncus*) are likely to be encountered both in the immediate project area and the larger AOI on a regular basis.

Increased marine noise has the potential to temporarily compromise physical habitats within a localized area in the vicinity of piling works. Behavioural responses to noise can cause stress (Hastings and Popper, 2005), which may then cause physiological responses, such as reduced immunities and diminished reproductive efforts (Southall et al., 2007), interfere with communication (Popper and Hawkins, 2012; Southall et al., 2007), trigger avoidance that can interrupt migration (Southall et al., 2007) or foraging patterns (Slotte et al., 2004). Excessive noise may also result in physical injury (e.g. damage to auditory systems) or even death.

Impacts associated with marine noise are highly variable depending on a number of factors, including the type, magnitude and duration of the noise, species affected and distance from sound source (Popper and Hawkins, 2012[29]; Southall *et al*., 2007). Hence, the impacts of noise on marine mammals are difficult to predict, and may vary substantially between species and individuals.

Temporary effects on hearing (i.e. auditory fatigue) are referred to as Temporary Threshold Shifts (TTS), while permanent effects on hearing are referred to as Permanent Threshold Shifts (PTS). A number of metrics are commonly used to measure TTS and PTS (i.e., Sound Pressure Level (SPL) and Sound Exposure Level (SEL; cumulative - SEL_{cum} or root mean square - SEL_{rms}). TTS relates to temporary auditory fatigue and marine mammals are expected to recover from this effect shortly

[29] Popper A.N., Hawkins, A.D., Fay, R.R., Mann, D., Bartol, S., Carlson, T., Coombs, S., Ellison, W.T., Gentry, R., Halvorsen, M.B., Løkkeborg, S., Rogers, P., Southall, B.L., Zeddies, D.G. and Tavolga, W.N. 2014. Sound Exposure Guidelines for Fishes and Sea Turtles. A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI.

after exposure. PTS relates to permanent auditory injury and published thresholds for marine mammals are shown in **Table 10.15**.

Table 10.15 Permanent Auditory Injury (PTS) Criteria for Cetaceans

Species Group	Southall et. al. (2007)			NOAA
	SPL_{peak} (dB re: 1µPa)	SEL_{cum} (dB re: 1µPa^2s)		SPL_{rms} (dB_{rms} re: 1µPa)
Cetacean	230	198 (pulse)	215 (non-pulse)	180

SPL_{peak} values apply to single, multiple and on-pulse sources. SPL_{rms} values do not distinguish between different types of sound.

NOAA (2016) has established interim behavioural thresholds for marine of 160 dB (RMS) re:1µPa – Pulse sounds (e.g. impulsive pile driver). Typically, driving of a single steel pile (1-1.5m in diameter) using an impact hammer at a water depth of 10m in the coastal waters emits a Sound Pressure Level (SPL_{peak}) of between 208-210dB, a Sound Exposure Level (SEL_{cum}) of between 180-185dB, a Sound Exposure Level (SEL_{rms}) of 190-195dB in an underwater distance of 10m from the sound source (Illinworth & Rodkin, 2007). Studies carried out by EACS during the construction of an offshore LNG terminal in Bahrain (EACS, 2017 *Bahrain LNG Import Terminal Project Marine Noise Monitoring undertaken 13-15 July 2017 Piles 331, 003 and 333*) indicated that for piling of a 1.2 m diameter pile in 17 m of water the following noise levels were experienced at 20 m from point source with recordings taken at midwater (i.e. at 8.5 m) column:

1. SPL_{peak} in the order of 180-200 dB.
2. SPL_{rms} in the order of 155 dB.
3. SEL_{cum} in the order of 185 dB.

With the assumption that piling operations at the Alba jetty are in the same order as those experienced above, it is considered unlikely that physical injury or mortality to marine mammals will occur. The regular presence of dolphins (predominantly *S. plumbea*) does increase the risk that behavioural responses be experienced; however, this would likely entail their temporary avoidance of the area with a return upon cessation of piling works. **Table 10.16** presents the impact assessment of marine noise on marine mammals.

Table 10.16 Marine Noise on Marine Mammals

<table>
<tr><th rowspan="2">Sensitivity of Receptor</th><th colspan="3">Magnitude of Impact</th><th colspan="2">Features of Impact</th><th colspan="2" rowspan="2">Impact Significance</th></tr>
<tr><th>Extent</th><th>Duration</th><th>Intensity</th><th>Risk</th><th>Direct / Indirect</th></tr>
<tr><td rowspan="4">High</td><td>2</td><td>1</td><td>3</td><td rowspan="4">Possible</td><td rowspan="4">Direct and indirect</td><td rowspan="2">Design mitigation</td><td rowspan="2">Minor to Moderate adverse</td></tr>
<tr><td colspan="3">Negligible (6)</td></tr>
<tr><td>2</td><td>1</td><td>1</td><td rowspan="2">Residual</td><td rowspan="2">Minor adverse</td></tr>
<tr><td colspan="3">Negligible (4)</td></tr>
<tr><td colspan="8">Mitigation (to achieve residual impact & best practice)</td></tr>
<tr><td colspan="8">– The contractor is to develop a Marine Noise Management Plan (MNMP) which outlines how he intends to adhere to the project standard of 30 kPa (equivalent to ~210 dB re 1µPa) at 20 m from piling works. The MNMP should define roles and responsibilities, mitigation to be employed by the contractor and importantly his monitoring protocol.</td></tr>
</table>

- The requirements for the monitoring protocol include:
  1. Should be conducted for a period which clearly demonstrates that the project standards are met (we recommend that at least 10 piles are monitored during which recordings are taken for a period of 10-minutes prior to impulsive piling, 10-minutes during impulsive piling, and 10-minutes following impulsive piling).
  2. The hydrophone is to be deployed at mid water column and values recorded for SPL (dB_{rms}), Max SPL (dB), Min SPL (dB), SEL_{cum}(Pa) and SEL_{cum} (dB).
  3. Reports to be prepared which provide a log of all recordings (time, date, weather conditions, etc.)
  4. Data to be provided in .wav and log files but also presented graphically within regular reports.

- Key mitigation may include
  1. Appropriate mitigation may include conducting a visual search for marine mammals to ensure no visible animals are within 500 m of the piling works prior to commencing operations. If animals enter the zone during piling, works may continue. Should piling works cease for more than 30 minutes then a new visual search is required prior to re-commencement of works.
  2. A soft start is to be carried out at the start of all works so as to allow any animals within the zone to leave the area.
  3. Should observations indicate injurious impact or project standards are breached, then works may be stopped and additional mitigation implemented by the contractor. This may include the use of dampening material at the point of impact and/or use of bubble curtains.

10.4.4 Marine Noise on Turtles due to Piling Activities (Hammering)

The immediate study area does not provide a valuable habitat or food sources for marine turtles; however, it is possible that individuals may pass by the area or within the larger AOI. Their presence, if at all, would be temporary and transient in nature. During the baseline surveys and previous EACS experience in the immediate area, turtles have not been observed.

Behavioural responses in turtles are as presented with marine mammals (**Section 10.4.3**). Increased noise will temporarily compromise physical habitat within a localized area; upon completion of piling, conditions will return to baseline conditions and individuals return. Noise criteria for marine turtles is not developed however it is understood that the US Fish and Wildlife Service (USFWS) has employed a criteria of 150 dB re:1µPa (RMS) as the threshold for behavioral effects on fish and that this provides the closest resemblance to sound exposure levels of turtles and is being used until criteria for turtles are established.

When considerations are given to the lack of suitable habitat and the temporary nature of pile driving and other construction activities, potential underwater noise impacts to occasional transient marine turtles are not expected to be high; regardless measures are proposed to minimize any potential impacts (**Table 10.17**).

Table 10.17 Marine Noise on Turtles

<table>
<tr><th rowspan="2">Sensitivity of Receptor</th><th colspan="3">Magnitude of Impact</th><th colspan="2">Features of Impact</th><th colspan="2" rowspan="2">Impact Significance</th></tr>
<tr><th>Extent</th><th>Duration</th><th>Intensity</th><th>Risk</th><th>Direct / indirect</th></tr>
<tr><td rowspan="4">High</td><td>2</td><td>1</td><td>3</td><td rowspan="4">Possible</td><td rowspan="4">Direct and indirect</td><td rowspan="2">Design mitigation</td><td rowspan="2">Minor to Moderate adverse</td></tr>
<tr><td colspan="3">Negligible (6)</td></tr>
<tr><td>2</td><td>1</td><td>1</td><td rowspan="2">Residual</td><td rowspan="2">Minor adverse</td></tr>
<tr><td colspan="3">Negligible (4)</td></tr>
<tr><td colspan="8">Mitigation (to achieve residual impact & best practice)</td></tr>
<tr><td colspan="8">– Refer to Table 10.16.</td></tr>
</table>

10.4.5 Marine Noise on Fish due to Piling Activities (Hammering)

The immediate study area is not known to support significant numbers of fish and certainly not on a commercial scale. That being said fish are likely to be present in and around the existing jetty piles which are likely to act as an artificial reef (provision of hard substrate for fouling communities which may act as food but also shaded area providing protection from the sun).

As with marine mammals and turtles, impulsive underwater noise associate with pile hammering will temporarily compromise the physical habitat within a localised area. Upon construction completion, conditions in the area will quickly return to baseline conditions and organisms will repopulate the areas of displacement.

Underwater noise generated from impulsive pile driving could potentially cause physical injury or mortality to fish, especially those with a swim bladder (e.g. snapper, rabbitfish, perch, grouper). Impulsive noise could potentially result in swim bladder tissue damage, including rupture of the swim bladder that will lead to death, if a fish is in the vicinity of where impulsive pile driving occurs. This of course is dependent upon a number of factors including locations, energy from piling and type of fish.

Fish may potentially experience auditory tissue damage (i.e., damage to the sensory hair cells of the ear) or temporary hearing loss where exposed to high levels of sound for short durations or lower levels of sound for longer period of time. The extent of tissue damage varies depending on a number of factors, including pressure level, frequency, duration, repetition rate of the sound, size and development stage of the fish (i.e. juvenile, adult, etc.).

It has been found that fish are able to recover from varying levels of substantial auditory tissue damage within a period of less than 18 hours after exposure (Popper *et al*., 2006). However, severe damage could lead to permanent loss of hearing. Indirect effects of hearing damage or loss in fish may relate to the fish's reduced fitness, which may increase its vulnerability for predation and result in the reduction or elimination of its ability to locate prey, communicate, and sense the physical environment (Popper *et al*., 2006).

Interim underwater noise guidance criteria for physical injury to fish have been developed (Popper et al., 2006) and accepted by the US Fisheries Hydroacoustic Working Group in 2008. The criteria states Sound Pressure Levels (SPL) of 206 dB-peak and accumulated Sound Exposure Levels (SEL) of 187 dB for fish greater than 2 grams and an accumulated SEL of 183 dB, for fish less than 2 grams. Recent research

summarized in Popper et al. 2014, however, suggests that cumulative SEL thresholds for injury to fish may be well above 200 dB.

The United States has generally used 150 dB re:1µPa (RMS) as the threshold for behavioral effects on species at risk for evaluating pile driving. This assumes noise pressure levels exceeding this criterion could potentially cause temporary behavioural changes (startle and stress) that might reduce the predation avoidance ability of a fish. Based on these levels and those noise levels likely to be generated during the piling operations (**Section 10.4.3**), **Table 10.18** summarises the key features of marine noise impacts on fish.

Table 10.18 Marine Noise and Fish

<table>
<tr><th rowspan="2">Sensitivity of Receptor</th><th colspan="3">Magnitude of Impact</th><th colspan="2">Features of Impact</th><th colspan="2" rowspan="2">Impact Significance</th></tr>
<tr><th>Extent</th><th>Duration</th><th>Intensity</th><th>Risk</th><th>Direct / Indirect</th></tr>
<tr><td rowspan="4">Medium</td><td>2</td><td>1</td><td>3</td><td rowspan="4">Possible</td><td rowspan="4">Direct and indirect</td><td>Design mitigation</td><td>Minor adverse</td></tr>
<tr><td colspan="3">Negligible (6)</td><td rowspan="3">Residual</td><td rowspan="3">Minor adverse</td></tr>
<tr><td>2</td><td>1</td><td>3</td></tr>
<tr><td colspan="3">Negligible (6)</td></tr>
<tr><td colspan="8">Mitigation (to achieve residual impact and/or best practice)</td></tr>
<tr><td colspan="8">– Refer to Table 10.16.
– Observe and note occurrence of stunned or killed fish at the site of marine piling. All sightings are to be reported as per the MNMP.
– If significant fish kill is observed, consider use of absorbent material to dampen hammer blows and/or use of bubble curtains.</td></tr>
</table>

10.4.6 Release/Spill of Hydrocarbons due to Incident

Marine piling operations will require the use of marine vessels and plant in order to carry out construction works. Although the full inventory is yet to be defined by the appointed contractor it is likely that the following vessels will be required:

- Pile barge – may comprise a flat top spud barge fitted with a stationary crane and percussive pile hammer rig.
- Tug boat to move the barge into place.
- Small work vessels (fibreglass vessels in the order of 10 m).

As such the presence of fuel/oils will be limited to that required to operate on board plant (e.g. generators, compressors, etc.) and of course the fuel inventory of the tug itself. No fuelling will take place at the work site. A conservative estimate is that up to 2,000 litres of fuel may be stored on board the work barge at any one time.

In terms of toxicity to water-column organisms, diesel is considered to be one of the most acutely toxic oil types. Fish, invertebrates and seaweed that come in direct contact with a diesel spill may be killed. However, small spills[30] in open water are so rapidly diluted that fish kills have never been reported. Fish kills have been reported for small spills in confined, shallow water (NOAA, 2006). Marine mammals and other air breathing marine organisms (e.g. sea snakes, turtles) may, if they come into direct contact, experience irritation to eyes and respiratory membranes although the number of

[30] According to NOAA (see footnote above), small spills are defined at 500-5000 barrels.

individuals which would be at risk is considered extremely low. Subtidal marine habitats are not considered to be at risk hence are not discussed further.

A risk assessment on events resulting in the uncontrolled release has not been conducted; however, the assessment presented in **Table 10.19** makes the assumption that the full inventory of fuel is lost but that the physical extent of impact is limited and very short term (i.e. less than 24 hours).

Table 10.19 Spills of Diesel Fuel and Marine Ecology

<table>
<tr><th rowspan="2">Sensitivity of Receptor</th><th colspan="3">Magnitude of Impact</th><th colspan="2">Features of Impact</th><th colspan="2" rowspan="2">Impact Significance</th></tr>
<tr><th>Extent</th><th>Duration</th><th>Intensity</th><th>Risk</th><th>Direct / Indirect</th></tr>
<tr><td rowspan="4">High</td><td>1</td><td>1</td><td>1</td><td rowspan="4">Possible</td><td rowspan="4">Direct</td><td>Design mitigation</td><td>Minor adverse</td></tr>
<tr><td colspan="3">Low (3)</td><td rowspan="3">Residual</td><td rowspan="3">Negligible</td></tr>
<tr><td>1</td><td>1</td><td>1</td></tr>
<tr><td colspan="3">Low (3)</td></tr>
<tr><td colspan="8">Mitigation (to achieve residual impact & best practice)</td></tr>
<tr><td colspan="8">– Ensure that a fuel spill contingency plan is in place and that workers are trained in how to implement it.
– Ensure that all fuel is stored within an impermeable base and that stores greater than 200 L are stored within a bunded area capable of containing 150% of the stored volume.
– Ensure spill kits (absorbent materials) are strategically located on marine vessels.
– An oil boom of suitable length to fully enclose offshore vessels should be available on site and staff and vessels required to deploy it should be trained and available 24-hrs a day.</td></tr>
</table>

10.5 Summary

Table 10.20 provides a summary of the impacts of the Port Upgrade on marine ecology.

Table 10.20 Summary of Impacts on Marine Ecology

Issue / Impact	Impact Significance	Mitigation / Monitoring / Enhancement Measures	Residual Impacts
Loss of habitat due to piling operations	Negligible	• None required.	Negligible
Impact of marine sediment loading due to pile driving	Negligible	• The contractor is to prepare a Marine Water Quality Management Plan (MWQMP) which defines appropriate standards based on SCE (2010) EIA-9 Guidelines on TSS Monitoring Programme of Large Scale Projects Involving Intensive Dredging and Reclamation Operations. • Should TSS values breach national standards, consider the strategic deployment of silt curtains to contain suspended solids. • Discharge pile cuttings 3-5 m below water surface (if permitted) or collect and dispose on land.	Negligible
Impact of noise on marine mammals due to piling activities	Minor to Moderate Adverse	• The contractor is to develop a Marine Noise Management Plan (MNMP) which outlines how he intends to adhere to the project standard of 30 kPa (equivalent to ~210 dB re 1µPa) at 20 m from piling works. The MNMP should define roles and responsibilities, mitigation to be employed by the contractor and importantly his monitoring protocol. • The requirements for the monitoring protocol include: i. Should be conducted for a period which clearly demonstrates that the project standards are met (we recommend that at least 10 piles are monitored during which recordings are taken for a period of 10-minutes prior to impulsive piling, 10-minutes during impulsive piling, and 10-minutes following impulsive piling). ii. The hydrophone is to be deployed at mid water column and values recorded for SPL (dB rms), Max SPL (dB), Min SPL (dB), SELcum(Pa) and SELcum (dB). iii. Reports to be prepared which provide a log of all recordings (time, date, weather conditions, etc.) iv. Data to be provided in .wav and log files but also presented graphically within regular reports. • Key mitigation may include: i. Appropriate mitigation may include conducting a visual search for marine mammals to ensure no visible animals are within 500 m of the piling works prior to commencing operations. If	Minor Adverse

Issue / Impact	Impact Significance	Mitigation / Monitoring / Enhancement Measures	Residual Impacts
		animals enter the zone during piling, works may continue. Should piling works cease for more than 30 minutes then a new visual search is required prior to re-commencement of works. ii. A soft start is to be carried out at the start of all works so as to allow any animals within the zone to leave the area. iii. Should observations indicate injurious impact or project standards are breached, then works may be stopped and additional mitigation implemented by the contractor. This may include the use of dampening material at the point of impact and/or use of bubble curtains.	
Impact of noise on turtles due to piling activities	Minor to Moderate Adverse	• See above measures.	Minor Adverse
Impact of noise on fish due to piling activities	Minor Adverse	• See above measures and: • Observe and note occurrence of stunned or killed fish at the site of marine piling. All sightings are to be reported as per the MNMP. • If significant fish kill is observed, consider use of absorbent material to dampen hammer blows and/or use of bubble curtains.	Minor Adverse
Impact of release/spill of hydrocarbons	Minor Adverse	• Ensure that a fuel spill contingency plan is in place and that workers are trained in how to implement it. • Ensure that all fuel is stored within an impermeable base and that stores greater than 200 L are stored within a bunded area capable of containing 150% of the stored volume. • Ensure spill kits (absorbent materials) are strategically located on marine vessels. • An oil boom of suitable length to fully enclose offshore vessels should be available on site and staff and vessels required to deploy it should be trained and available 24-hrs a day.	Negligible

11 MARINE SEDIMENT AND WATER QUALITY

11.1 Introduction

Once a pollutant enters a water body it is difficult to remove; its direct effect upon the physical, chemical and biological properties of seawater can have deleterious indirect impacts not only on marine ecology, but also indirectly upon the operational efficiency of industrial facilities (e.g. seawater intakes), and the social interface with populations residing on bounding land masses (e.g. effects of eutrophication). Marine sediment serves as an important habitat for ecological receptors and any changes in its physical, chemical or biological characteristics (which could be influenced in water quality) may have significant impacts.

For the purpose of the ESIA, two study areas have been defined as described in **Section 10.1** and include the immediate study area in the vicinity of the port where the construction works will take place (**Figure 11.1**). The far field AOI covers a much larger area (radius of 7 km from the existing jetty) and considered to be a suitable potential zone of impact in the event of a large scale spill from a marine vessel.

11.2 Assessment Methodology

The assessment of impacts was approached by first defining the quality of marine waters and sediments within the immediate study area by undertaking field surveys. Subsequently, significance criteria were developed (see **Section 11.2.3**). A systematic approach of defining impacts, following review of the project construction programme/methodologies and operational project design, employed to quantitatively assess impacts.

11.2.1 Baseline Sediment Quality

Site specific baseline sediment quality samples were collected and analysed for a number of parameters at 5 locations (see **Figure 11.1**). The results have been compared with relevant regional and international sediment quality standards (see **Section 11.3** results) as there are no applicable national standards.

Sediment samples were collected using a Van Veen grab and analysed at Australian Laboratory Services (ALS) in the Kingdom of Saudi Arabia. Containers were provided by the laboratory and samples were stored in cool boxes on ice for delivery to the laboratory.

All analytical procedures were developed from established internationally recognized procedures such as those published by the United States Environmental Protection Agency (US EPA), American Public Health Association (APHA) and National Environment Protection Measures (NEPM) and can be found in the data sheets provided by the laboratory in **Appendix 11A**.

Information Box 1

Marine sediment and water samples were taken with appropriate equipment thoroughly cleaned prior to each sample being taken. This precaution minimises the risk of cross-contamination occurring. Samples were stored in laboratory-provided containers and spiked with preservatives as required. All samples were kept in cool conditions (i.e. <4°C) until delivered to the laboratory. Holding times for samples were adhered to and delivery to the laboratory from the time of collection is not expected to exceed 4 hours.

On arrival at the laboratory a Sample Receipt Notification (SRN) plus *return* CoC (Chain of Custody) form will be issued upon receipt of samples, detailing the condition of the samples, anticipated turnaround time and internal tracking or batch number. Samples are analysed according to international standards (APHA, USEPA, AS, ASTM); analytical details for each parameter are provided in the raw data sheets in **Appendix 11A**.

Reporting of results included a Certificate of Analysis (CoA), and Quality Control (QC) interpretive reports. ALS provides an internal 'QCS3' schedule, which includes Laboratory Control Samples (LCS), Method Blanks (MB), Matrix Spikes (MS), Laboratory Duplicates (Dups) and Surrogates (for target organics) where applicable, at frequencies at or above international guidelines. In the QC Interpretive Report, the Laboratory Information Management System (LIMS) reviews, duplicate RPDs, Blanks, LCS Standards, Matrix Spikes, Surrogates, Sample Preservation and Holding Times are highlighted.

The following summarises the frequency QC samples processed:

- 5% Method Blanks (MB) – 1 analysed within each process lot of 20 samples. Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC type is to monitor potential laboratory contamination. MB for seawater samples consist of Ultra High Purity (UHP) water and for sediment samples this consists of washed and baked sand.
- 10% Laboratory Duplicates (Dups) – 2 analysed within each process lot of 20 samples. Laboratory Duplicates refers to an intra-laboratory split sample randomly selected from the sample batch. Laboratory duplicates provide information on method precision and sample heterogeneity.
- Surrogate Spikes on all 'target' organics analyses.
- 5% Laboratory Control Samples (LCS) – 1 analysed within each process lot of 20 samples. The quality control term Laboratory Control Sample (LCS) refers to a known, interference free matrix spiked with target analytes or certified reference material. The purpose of this QC type is to monitor method precision and accuracy independent of sample matrix.
- 5% Matrix Spikes (MS) – 1 analysed within each process lot of 20 samples (except for dioxins). Matrix Spike (MS) refers to an intra-laboratory split sample spiked with a representative set of target analytes. The purpose of this QC type is to monitor potential matrix effects on analyte recoveries.

Sediment quality guidelines that are published around the world are generally drawn up with reference to the offshore *disposal of dredged material* and are specific to the bio-geographic region that they are addressing. This can account for considerable variation in guideline values, both between countries and at a sub-national level. Care must therefore be taken when selecting which guidelines to use as a first approximation in assessing whether organisms are at risk from concentrations of potentially toxic substances in sediment. For the purposes of the present study, the following guidelines have been referred to:

- Australian Government National Assessment Guidelines for Dredging (NAGD) (Commonwealth of Australia, 2009) and ANZECC/ARMCANZ 2000 for substances not listed in the aforementioned document (as recommended).
- The Interim Marine Sediment Quality Guidelines (ISQGs) issued by CCME (Canadian Council of Ministers of the Environment, 2002).
- The UK Centre for Environment, Fisheries and Aquaculture Science (CEFAS) guideline 'action levels' for the disposal of dredged material at sea (DEFRA, 2012).
- Dutch Target and Intervention Values, 2000.

Australian Interim Sediment Quality Guidelines (ISQGs) were initially developed as part of the ANZECC/ARMCANZ Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000). These ISQGs are largely based on biological-effects based guidelines developed by Long et al. (1995), with some modifications. The 'Screening Levels' referred to in this report are the same as the ISQG-Low values presented in ANZECC/ARMCANZ (2000), as updated in draft by Simpson et al. (2005). The Screening Level (or 'ISQG Trigger Value') is a threshold concentration below which the frequency of adverse biological effects is expected to be very low. Exceeding the screening level does not necessarily mean that adverse biological effects will occur in the sediments, but that further investigations should be carried out to confirm this.

The Canadian ISQGs include Threshold Effect Levels (TELs) and Probable Effect Levels (PELs). The TEL is the threshold value below which concentrations of sediment-associated chemicals are unlikely to represent a significant hazard to aquatic organisms. The PEL represents the lower limit of the range of chemical concentrations that are almost always associated with adverse biological effects (CCME, 1995).

For the CEFAS standards, if concentrations are between CEFAS Action Level 1 and 2 then assessment is required. If concentrations exceed Level 2 then the sediment may not be acceptable for disposal at sea.

In the Netherlands Soil Policy is administered by the Ministry of Housing, Spatial Planning and the Environment, which issues a Soil Remediation Circular describing the allowable concentrations of a wide range of contaminants in soil, as well as describing the decision making process to decide whether remediation is urgent or not. All of the aforementioned sediment quality guideline values are provided in **Table 11.1**.

Table 11.1 International Sediment Quality Standards

Parameter	Australian NAGD	Canadian ISQGs		CEFAS (UK)		Dutch	
	ISQG trigger value	TEL	PEL	Action Level 1	Action Level 2	TV[31]	IV[32]
Arsenic	20.0	7.24	41.6	20	70	29.0	55.0
Cadmium	1.5	0.7	4.2	0.4	4	0.8	12.0
Chromium	80.0	52.3	160.0	50	370	100.0	380.0
Cobalt	-	-	-			9.0	240.0
Copper	65.0	18.7	108.0	30	300	36.0	190.0
Lead	50.0	30.2	112.0	50	400	85.0	530.0
Mercury	0.15	0.13	0.70	0.25	1.5	0.3	10.0
Nickel	21.0	-	-	30	150	35.0	210.0
Vanadium	-	-	-	-	-	-	-
Zinc	200.0	124.0	271.0	130	600	140.0	720.0
Sum of C10-C40 (TPH)	550	-	-	100	-	-	-

11.2.2 Baseline Water Quality

EACS collected water samples for laboratory analysis at the locations highlighted in **Figure 11.1**. Samples were collected using a Niskin sampler and analysed at ALS laboratory. Samples were collected and stored according to strict protocol and using CoC forms.

Water Quality Objectives (WQO), derived by many countries internationally, indicate a preferred water quality based on key criteria (e.g. sustenance of marine ecology, industrial use, recreational bathing, etc.). Although not necessarily supported by legislation, such guidance provides a valuable tool in assessing both baseline and predicted water quality (for chemical, biological and physical parameters) following anthropogenic input. We have identified water quality standards/objectives, which are derived from a variety of sources including national, regional, and international.

Standards for Water Quality Objectives

In the absence of national standards, the following identifies those which have been used to define ambient water quality within the study area.

- The KSA Environmental Quality Objectives (EQOs) for Ambient Marine Water Quality (Presidency of Meteorology and Environment, 2012). The KSA guidelines (Arabian Gulf) may be considered relevant to Bahrain based on the similarity of their marine environments; these two countries are very similar biogeographically. These

[31] TV - TARGET VALUE is the baseline concentration value below which compounds and/or elements are known or assumed not to affect the natural properties of the soil.

[32] IV - INTERVENTION VALUE is the maximum tolerable concentration above which remediation is required. This occurs if one or more compounds in concentrations equal to or higher than the intervention value is found in more than 25 m3 of soil or 1000 m^3.

ambient water quality standards are for 3 classifications of marine waters; Coastal Marine, Coastal High Value and Coastal Industrial

- United States Environmental Protection Agency (USEPA) National Recommended Water Quality Criteria (USEPA, 2014). The US EPA have 2 guideline values, the Criteria Maximum Concentration (CMC), and the Criterion Continuous Concentration (CCC). The CMC ('acute' scenario) is an estimate of the highest concentration of a material in surface water, which an aquatic community can be briefly exposed to without resulting in an unacceptable effect. The CCC ('chronic' scenario) is an estimate of the highest concentration of a material in surface water which an aquatic community can be exposed indefinitely to without resulting in an unacceptable effect.
- Canadian Council of the Ministers of the Environment – Canadian Water Quality Guidelines for the Protection of Aquatic Life (CCME, 2014).
- UK Environment Agency – Environmental Quality Standards (EQS) − based upon substances detailed in the European Union's Dangerous Substances Directive (76/464/EEC and Daughter Directives). The EQS have been developed for the protection of aquatic life.
- Dubai Municipality - Marine Water Quality Objectives (Dubai Municipality, 2003).
- Australian Government - Department of Environment and Resource Management – Queensland Water Quality Guidelines (DERM, 2009).

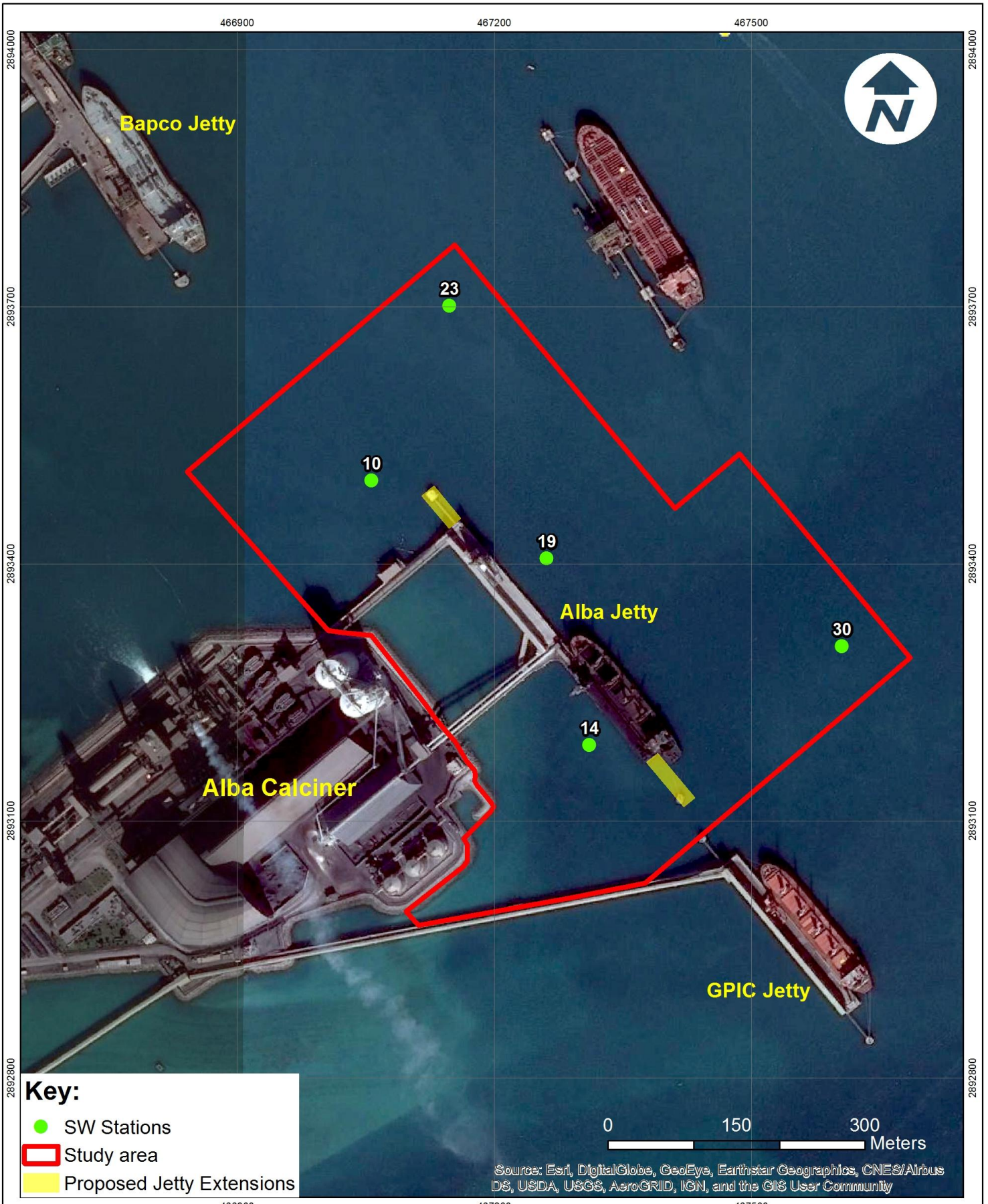
Industrial Discharge Standards[33]

The following presents those standards applicable to any discharges made to sea.

- Kingdom of Bahrain Ministerial Order No. 3 of 2001 – Amendments to Tables in Ministerial Order No. 10 of 1999 with Respect to Environmental Standards (Air and Water) and its Amendments in Ministerial Order No. 2 of 2001[34].
- SCE (2010) EIA-9 Guidelines on TSS Monitoring Program of Large Scale Projects Involving Intensive Dredging and Reclamation Operations.
- The International Convention for the Prevention of Pollution from Ships (MARPOL).

[33] Including ship-borne.

[34] Note that SCE has revised these as a Draft V3.0 dated 29th September 2015. However as these have not been passed into law, they are not applicable to this project.



Title: **Sediment and Water (SW) Quality Stations**		Client:
Project: Alba Port Capacity Upgrade		
Date: June 2018	Figure No.: 11.1	Consultant: Environment Arabia
Datum: WGS 84 - UTM 39N	Scale: 1:6,000 (A4)	

CN:\Alba Port Capacity Upgrade\mxd\EER\SWQ1.mxd

Table 11.2 Water Quality Objective Guidelines (all values in mg/l)

Parameter		Saudi Arabian PME			USEPA		CCME	UK EQS	Australia DERM	Dubai WQO
		C1[a]	C2[a]	C3[a]	CMC	CCC				
Metals - Total	Arsenic	0.05	0.05	0.1	0.069	0.036	-	-	-	-
	Cadmium	0.005	0.005	0.05	0.04	0.0088	0.00012 (long term)	0.0025	-	0.003
	Chromium	0.05	0.05	0.1	-	-	-	-	-	0.01
	Copper	0.05	0.05	0.15	0.0048	0.0031	-	0.005	-	0.005
	Iron	0.5	0.1	1.0	-	-	-	-	-	0.2
	Lead	0.05	0.005	0.2	0.21	0.081	-	0.025	-	-
	Mercury	0.0004	0.0004	0.001	0.0018	0.00094	0.000016	0.0003	-	0.001
	Nickel	0.05	0.05	0.2	0.074	0.0082	-	0.03	-	-
	Zinc	0.8	0.2	2.0	0.090	0.081	-	0.040	-	0.02
Nutrients	Nitrate as N	1.5	1.2	2.0	-	-	1500 mg/l (short-term), 200 mg/l (long-term)	-	-	0.5
	Nitrite as N	1.5	1.2	2.0	-	-	-	-	-	-
	Total Phosphorus (P)	0.5	0.25	1.0	-	-	-	-	0.025	-
Total Petroleum Hydrocarbons (TPH)	Sum of C10 – C40 Fraction	0.3	0.2	0.5	-	-	-	-	-	-

[a] **C1 = Coastal waters** - those that are under the jurisdiction of KSA (the territorial coastal waters being 12 international nautical miles (22.2 kilometres) of the shoreline). The subdivision 'marine' is the default when the coastal water body does not meet the criteria for 'high-value' or 'industrial'.

C2 = High value - areas of coastal water shall be classified as 'high value' if they are designated as locally, nationally or internationally protected areas by any Concerned Agency (this includes but is not limited to the Competent Agency, ROPME, NCWCD and PERGSA).

C3 = Industrial - water bodies shall be classified as industrial if they are adjacent to terrestrial zones or surrounding fixed offshore platforms that that are classified as industrial through local or national planning regulation. The extent of the aquatic environment classified as industrial will represent a seaward extension of the terrestrial boundary provided that it does not impinge upon high areas classified as C1 or C2. Furthermore, industrial ambient conditions will extend no more than a 500 meter radius from the edge of any mixing zone.

11.2.3 Assessment Criteria and Methodology

Impact significance is quantified as a product of the sensitivity of the parameter and the perceived magnitude of the impact (**Table 11.3**). The formula provides a better appreciation that as the sensitivity of the environment and the magnitude of the effect increases, so the significance of that effect increases.

Table 11.3 Calculation of Impact Significance

MAGNITUDE	**High**	Moderate	Moderate/Major	Major
	Medium	Minor/Moderate	Moderate	Moderate/Major
	Low	Minor	Minor/Moderate	Moderate
	Negligible	Negligible	Negligible/Minor	Minor/Moderate
		Low	**Medium**	**High**
		VALUE AND SENSITIVITY		

Table 11.4 presents the sensitivity criteria employed by EACS for marine sediment and water quality. Sensitivity criteria takes into account the importance of the parameter (biological, chemical, physical) and its influence on both the natural environment and human interface and based upon three classes[35] of water.

Table 11.4 Sensitivity Criteria for the Parameter of Marine Sediment and Water

Sensitivity	Marine Sediment	Marine Water
High	Marine sediments are uncontaminated and considered to be undisturbed by anthropogenic activities - they are in a natural state.	Coastal waters designated as locally, nationally or internationally protected areas by any Concerned Agency (e.g. National - SCE, International (e.g. RAMSAR). Ma'ameer Channel is an example. Furthermore, waters which serve industrial/utilities (e.g. power station intake) fall within this category or host exceptionally sensitive ecological receptors (e.g. coral reefs).
Medium	Marine sediments show no sign of elevated levels of contaminants. Signs of physical disturbance by past activities are noticeable (e.g. limited deposition of surface materials); however, the sediments remain largely undisturbed.	National marine waters which do not conform to either high or low classified waters. These may be indicative of open sea areas not holding exceptionally sensitive receptors/habitats.
Low	Sediments exhibit contamination at levels which may hinder marine biodiversity. Sediments show signs of physical disturbance (e.g. following dredging) and bear little resemblance to that previously present.	Waters adjacent to areas (either marine or terrestrial) which are classified as industrial through local or national planning regulation. The extent of these waters do not impinge upon higher classification of water bodies. The waters of the jetty area could be considered as low importance.

[35] These conform to those classes identified in PME (2012).

Quantifying the magnitude of an impact is defined via a number of sub-criteria. Typically, these may be informed following specialist studies (e.g. hydrodynamic modelling), expert opinion, review of contractor's methodologies, and reference to published data (e.g. water quality guidelines). Criteria include:

- **Extent:** whether the impact would occur onsite, in a limited (Li) area (within 1 km of the site); local (Lo) area (within, say, 5 km of the site or within the relevant Municipality); nationally (na) or internationally (in).
- **Duration:** whether the impact would be short-term (ST- ≤1 year), medium term (MT- 1 - 5 years), long-term (LT- 5 - 20 years), or permanent (P - ≥20 years).
- **Intensity:** the quantifiable effects of impacts, measured where appropriate against an appropriate environmental standard (national, regional or international) or based on expert judgment.

For each impact assessed, some or all of the above criteria are used as applicable. In order to mitigate subjectiveness, EACS has developed a scoring system to which the magnitude of an impact is determined. This is shown in **Table 11.5**. When this is applied to a specific impact, the sum of the features is used to determine the category of the magnitude (**Table 11.6**).

Table 11.5 Scale of Impact Magnitude

Feature	**Scale of Magnitude**			
Extent[36]	Limited	Local	National	International
Score	1	2	3	4
Duration	Short term	Medium term	Long term	Permanent
Score	1	2	3	4
Intensity	Negligible	Low	Medium	High
Score	1	2	3	4

Table 11.6 Determining Impact Magnitude[37]

	Magnitude of impact			
	High	**Medium**	**Low**	**Negligible**
Score (3 features)	12	9	6	≤3
Score (2 features)	8	6	4	≤2

Additional criteria are used to further define features of the impact, although are not used in the quantification process, these include:

- **Likelihood/ Risk:** based on the best available information (primary and secondary data), the likelihood of an impact is assigned a classification based upon the probability of an event occurring (i.e. unlikely (U), likely (L), and definite (D)).
- **Direct** (D): impacts that result from direct interaction between a project activity and the receiving environment (e.g. direct source of pollution into a water body).

[36] Note: Extent is not used for all impact assessment (e.g. where the impact falls directly on a receptor - seawater intake).
[37] Where a magnitude value falls between two categories, expert opinion is used to finalise the scale.

- **Indirect** (I): impacts that result from other activities as a consequence of the project (e.g. reduction in water quality affects fish and therefore impairs fisheries activities).

Using a combination of these factors, a consistent set of impact significance levels has been applied (**Table 11.7**).

Table 11.7 Significance of Impact

Impact Significance	Impact Characteristic
Negligible	Impact is virtually imperceptible over baseline.
Minor Adverse	Impacts are of low intensity with short-term duration. The potential for recovery to existing conditions is good with return to baseline conditions over a short period of time.
Moderate Adverse	Activities are likely to result in significant physical/chemical/biological impacts in the medium term.
Major Adverse	Activities will result in significant long term/permanent change to existing physical, chemical or biological conditions of marine waters.

Residual impact is quantified by quantifying the reduction in the impact magnitude following mitigation and as per the scale presented in **Table 11.5** and **Table 11.6**; this may arise due to a decrease in impact extent, duration or intensity.

11.3 Baseline Marine Sediment Quality Results

Table 11.8 provides baseline sediment quality results along with the Limits of Reporting (LOR). The results have been compared against the sediment quality standards highlighted in **Table 11.1** where applicable.

11.3.1 Total Organic Carbon (TOC)

Three basic forms of carbon may be present in sediments: elemental, inorganic and organic. The quality of organic matter in sediments is critical to the partitioning and bioavailability of sediment-associated contaminants (USEPA, 2002). However, the total carbon contribution from contaminants to the total organic carbon content of sediment is often negligible unless a fresh spill has occurred or a hot spot is sampled (USEPA, 2002).

Previous studies undertaken within the Arabian Gulf have indicated that the TOC of surface sediments ranges from 0.46% to 3.2% (Hartmann *et al.*, 1971; Al-Ghadban, 1994; Basaham, 2010), and typically 1.5-2.0% throughout Bahrain's territorial waters (Al-Ghadban, 1994). TOC values within the project study area ranged from 1.0 % (station 10) to 1.7 % (station 19) thus largely in accordance with those expected within the Arabian Gulf and within Bahrain.

11.3.2 Metals – Total

Arsenic values ranged from 'not detected' (<5.0 mg/g) to a maximum of 7.7 mg/kg at station 10. All values were therefore less than all guideline values highlighted in **Table**

11.1 with the exception of station 10 which breached the stringent Canadian ISQGs TEL which is set at 7.24 mg/kg. Cadmium values were 'not detected' (<1.0 mg/kg) at all stations which is less than some of the guideline values highlighted in **Table 11.1**[38] including the Australian NAGD trigger value which is set at 1.5 mg/kg for this parameter.

Chromium ranged from 12.5 mg/kg (station 23) to a maximum of 19.4 mg/kg (station 10). All results for the aforementioned parameter are less than all of the guideline values highlighted in **Table 11.1**.

Copper values from the marine sediments ranged from 36.4 mg/kg (station 23) to a maximum of 48.5 mg/kg (station 30). All stations sampled breached the Canadian ISQG TEL (set at 18.7 mg/kg), the CEFAS AL 1 (set at 30 mg/kg) and the Dutch TV (set at 36.0 mg/kg). None of the stations sampled breached the Australian NAGD ISQG trigger value (65 mg/kg), Canadian ISQG PEL (108 mg/kg), CEFAS LA 2 (300 mg/kg) or the Dutch IV (190 mg/kg).

The values for iron in the marine sediments sampled ranged from 3,740 mg/kg (station 23) to 5,860 mg/kg (station 10). As far as EACS is aware there are no standards for this parameter. The values for iron ranged from 6.1 mg/kg (station 14) to a maximum of 8.6 mg/kg (stations 10 and 23) which is lower than all of the guideline values highlighted in **Table 11.1** including the stringent Canadian ISQG TEL which is set at 30.2 mg/kg for this parameter.

All stations sampled for mercury were less than the detection limits of the laboratory (<0.1 mg/kg) which is less than all guideline values highlighted in **Table 11.1**, the most stringent of which is set at 0.13 mg/kg (Canadian ISQG TEL).

The results for nickel ranged from 12.2 mg/kg (station 14) to 19.4 mg/kg (station 10) which is lower than all the guideline values highlighted in **Table 11.1**.

The results for the parameter zinc ranged from 39.8 mg/kg (station 23) to a maximum of 59.4 mg/kg (station 10) which is significantly lower than all of the guideline values highlighted in **Table 11.1**.

11.3.3 Total Petroleum Hydrocarbons (TPH)

The term 'Total Petroleum Hydrocarbons' (TPHs) refers to any mixture containing one or more of several hundred chemical compounds found in crude oil. Crude oil is used to make petroleum products which can contaminate the environment. Since so many different chemicals comprise both crude oil and other petroleum products, it is not practical to measure each one separately. In the present study, Total Petroleum Hydrocarbons (TPHs) refers to all hydrocarbons containing between 6 and 40 carbon atoms (i.e. C6 to C40). The TPH components are broken down into three fractions (a total of five 'C*n*' bands):

- Gasoline Range Organics or 'GRO' (C6-C9);
- Diesel Range Hydrocarbons or 'DRH' and (C10-C14 and C15-C28); and
- The 'heavy' fraction (C29-C36 and C37-C40).

[38] Note is it not possible to determine if the laboratory samples are less than the Canadian ISQG TEL (0.7 mg/kg), CEFAS AL 1 (0.4 mg/kg) if Dutch TV) as these are lower than the detection limit of the laboratory.

TPHs enter the marine environment from many sources including natural processes; offshore oil production; marine transportation; atmospheric sources; coastal municipal and industrial wastes, runoff and ocean dumping.

At detection levels of < 10.0 mg/kg (C6-C9 fraction), < 50 mg/kg (C10 – C14 and C37 – C40 fraction) and < 100 mg/kg (C15 – C28 and C29 – C36 fraction) none of the Total Petroleum Hydrocarbon (TPH) fractions (i.e. GRO, DRH or the 'heavy' fraction), were detected in any of the sediment samples collected. The C10-C40 fraction (SUM of all the fractions) was <100.0 mg/kg for all stations and thus did not exceed the CEFAS AL 1 (100 mg/kg) or the Australian NAGD (550 mg/kg).

11.3.4 Volatile Organic Compounds

VOCs from a variety of classifications (Fumigants, Halogenated Aliphatics, Halogenated Aromatics, Monocyclic Aromatics (MAH), Naphthalene and Trihalomethanes (THM) were analysed in the marine sediments from 5 locations within the AOI. All results were less than the detective limits of the laboratory. The full set of results can be found in **Appendix 11A**.

11.3.5 Particle Size Analysis

Particle Size Analysis (PSA) reveals the particle size-distribution in a sediment sample, providing an indication of sediment type. **Table 11.9** presents the sediment fractions (as per the descriptions based on ASTM D 2487) and provides a description of the material. It can be seen from the results that 4 out of 5 of the stations sampled were classified as 'silt' with combined silt and clay fraction ranging from 40.44 % to 61.24 %. A single location (station 23) was classified as 'well graded sand' with a very low silt / clay fraction (3.6 %) with the majority of the fractions falling into the 'sand' category (87.88%).

Table 11.8 Baseline Sediment Quality Results

Parameter	Units	LOR	Station ID				
			10	14	19	23	30
Inorganic Non-metallic Parameters							
Total Organic Carbon	%	0.5	1.5	1.2	1.7	1.0	1.3
Metals - Total							
Arsenic	mg/kg	5.0	7.7	<5.0	5.2	<5.0	5.2
Cadmium	mg/kg	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chromium	mg/kg	2.0	19.4	12.6	16.6	12.5	17.6
Copper	mg/kg	5.0	47.1	43.7	48.6	36.4	48.5
Iron	mg/kg	50	5,860	4,020	4,790	3,740	5,440
Lead	mg/kg	5.0	8.6	6.1	6.5	8.6	6.4
Mercury	mg/kg	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Nickel	mg/kg	2.0	19.4	12.2	15.9	12.1	16.6
Vanadium	mg/kg	5.0	24.1	19.7	21.2	15.0	21.9
Zinc	mg/kg	5.0	59.4	51.3	47.1	39.8	51.9
Total Petroleum Hydrocarbon (TPH)							
C6 - C9 Fraction	mg/kg	10	<10	<10	<10	<10	<10
C10 - C14 Fraction	mg/kg	50	<50	<50	<50	<50	<50
C15 - C28 Fraction	mg/kg	100	<100	230	<100	<100	<100
C29 - C36 Fraction	mg/kg	100	<100	240	<100	<100	<100
C37 - C40 Fraction	mg/kg	50	<50	<50	<50	<50	<50
C10 - C40 Fraction (sum)	mg/kg	100	<100	460	<100	<100	<100

Table 11.9 Particle Size Analysis (PSA)

Category	Sieve mesh size (mm)	Percentage of sediment passing through sieve mesh for each sample									
		10		14		19		23		30	
		% passing	Gr/Sa/Si	% passing	Gr/Sa/Si	% passing	Gr/Sa/Si	% passing	Gr/Sa/Si	% passing	Gr/Sa/Si
Pebbles	11.200	100	0.00	100	0.00	100	0.00	100	8.52	100	0.00
	8.000										
Granules	4.000							96.71			
	2.800							91.48			
V. coarse sand	2.000	99.30	59.56	99.38	38.76	98.76	40.82	83.90	87.88	99.42	51.26
	1.400	98.64		99.08		97.94		71.64		99.02	
Coarse sand	1.000	97.66		98.64		97.90		59.45		98.48	
	0.710	96.44		98.42		97.12		47.49		98.16	
Medium sand	0.500	94.48		97.82		95.98		36.51		97.42	
	0.355	91.88		96.40		94.24		29.33		95.90	
Fine sand	0.250	88.10		93.90		91.58		22.94		93.20	
	0.180	80.80		86.24		86.16		16.44		88.84	
V. fine sand	0.125	55.14		70.46		72.26		8.08		73.18	
	0.090	46.48		64.30		63.70		4.64		62.40	
silt	0.063	40.44	40.44	61.24	61.24	59.18	59.18	3.60	3.60	48.74	48.74
	0.033	24.00		28.03		36.43		-		18.10	
	0.021	22.00		26.02		34.40		-		14.08	
	0.013	16.00		20.02		30.35		-		8.04	
	0.009	8.00		10.01		8.09		-		6.03	
	0.007	6.00		8.01		4.05		-		4.02	
clay	0.003	2.00		2.00		2.02		-		2.01	
	0.001	2.00		2.00		2.02		-		2.01	
Description		Silty Sand		Silt		Silt		Well graded sand		Silt	

11.4 Baseline Marine Water Quality Results

Table 11.10 provides baseline water quality results along with the Limits of Reporting (LOR).

11.4.1 Chlorophyll-α

Chlorophyll-α values were lower than the detection limits of the laboratory in all samples (<5 µg/L). As far as EACS is aware there is no accepted guideline value for this parameter.

11.4.2 Ammonium

Ammonium values (as N) were all less than the detection limits of the laboratory (<0.01 mg/L) at all stations sampled within the study area. As far as EACS is aware there is no accepted guideline value for this parameter.

11.4.3 Metals - Total

For all metals tested, values are reported at less than the laboratory detection limits and the guidelines values highlighted in **Table 11.2**; with the exception of the CCME for mercury which is set at 0.000016 mg/L which is lower than the detection limits of the laboratory.

11.4.4 Nutrients

The values for Nitrate as N, Nitrite as NO_2 and Reactive Phosphate were all below the detection limits of the laboratory (<0.01, <0.03 and <0.03 mg/L respectively) at all 5 stations sampled. The results for Nitrite and Nitrate are below the guideline values highlighted in **Table 11.2**. The values for total Phosphate as P was similar across all stations and ranged from 0.66 mg/L at station 10 to 0.86 mg/L at station 23. These values are higher than the Australian DERM which is set at 0.025 mg/L and the Saudi Arabian PME WQO for C1 (coastal) and C2 (high value) waters. All 5 samples for total Phosphate as P are less than the Saudi Arabian PME WQO for C3 (industrial waters) which is set at 1.0 mg/L.

11.4.5 Total Suspended Solids (TSS)

The term 'Total Suspended Solids' (TSS) is a measure of the suspended solids in wastewater, effluent, or water bodies. The TSS levels of the samples collected at all six survey stations were <5 mg/l. Based on EACS observations of baseline TSS values around the Kingdom of Bahrain this value can be considered to be low for coastal waters.

11.4.6 Total Petroleum Hydrocarbons (TPH)

None of the TPH fractions were recorded above their respective detection levels. For the sum of TPH, all values were recorded as < 100 µg/l (<0.1 mg/l) which is below all three KSA guideline values (C1 – coastal waters 0.3 mg/l, C2 – high value waters 0.2 mg/l, and C3 – Industrial waters 0.5 mg/l).

11.4.7 Volatile Organic Compounds

The 5 water samples were analysed for VOCs from a variety of classifications (Fumigants, Halogenated Aliphatics, Halogenated Aromatics, Monocyclic Aromatics (MAH), Naphthalene and Trihalomethanes (THM). As with the sediment samples, all parameters were less than the respective detection limits of the laboratory. The full set of results can be found in **Appendix 11A**.

Table 11.10 Baseline Water Quality Results

Parameter	Units	LOR	Station ID				
			10	14	19	23	30
Biological Parameters							
Chlorophyll-α	µg/L	5	<5	<5	<5	<5	<5
Inorganic Non-metallic Parameters							
Ammonium as N	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Metals - Total							
Arsenic	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nickel	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Nutrients							
Nitrate as N	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrite as NO_2	mg/L	0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Reactive Phosphate	mg/L	0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Total Phosphate	mg/L	0.03	0.66	0.69	0.67	0.86	0.73
Physical Parameters							
Total Suspended Solids	mg/L	5	<5	<5	<5	<5	10
Total Petroleum Hydrocarbon (TPH)							
C6 - C9 Fraction	µg/L	20	<20	<20	<20	<20	<20
C10 - C14 Fraction	µg/L	50	<50	<50	<50	<50	<50
C15 - C28 Fraction	µg/L	100	<100	<100	<100	<100	<100
C29 - C36 Fraction	µg/L	50	<50	<50	<50	<50	<50
C37 - C40 Fraction	µg/L	50	<50	<50	<50	<50	<50
C10 - C40 Fraction (sum)	µg/L	100	<100	<100	<100	<100	<100

11.5 Impact Assessment – Construction

Section 10.4 provides a description of the works that will impact the marine environment including the extension of Jetties 1 and 2 with the placement of piles using RCD methodologies. During construction works there will be a number of vessels on site that will be operating in the marine environment n addition to the existing vessels that frequent the port during routine operation as the port will remain fully operational during the construction phase. Impacts during construction are identified as follows:

5. Marine sediment loading and deposition of sediment arising from RCD activities and the potential for the spread of contaminated marine sediment into the water column and further afield (see **Section 11.5.1**).
6. Potential impact of increased suspended solids in the water column upon intakes (e.g. Alba intake within the primary AOI or any other identified further afield) due to RCD activities or from propeller wash from marine vessels (see **Section 11.5.2**).
7. Construction activities (either on land at the waters' edge or at sea) can result in spillages of fuels and oils which, depending on the property of the fuel or oil and/or effectiveness of spill response, can result in contamination of marine sediments and contamination of the water column (see **Section 11.5.3**).

With reference to the criteria highlighted in **Section 11.2.3** and **Table 11.4** the marine sediments and marine waters within the immediate study area can be considered to be of low sensitivity. Due to the presence of Fasht al Adhm and other sensitive receptors (coastline, EWA intakes, other industrial facilities etc) within the larger AOI, the sensitivity of the receptor for both marine sediment and marine water is considered to be high. Any intakes within either AOI are considered to be of high sensitivity.

11.5.1 Marine Sediment Loading (Impact of Spread of Potentially Contaminated Sediments)

Pile drilling will result in limited disturbance to marine waters and existing marine sediments within the port area. Baseline studies indicate that the sediments are largely uncontaminated albeit with a minor elevation of arsenic at a single station and copper (all stations).

The duration of the RCD works are considered to be short term and temporary across a small spatial extent with the potential to impact only the near field AOI. Where present, elevated levels of arsenic and copper are likely to be restricted to surface sediments only and hence represent very small quantities (assume top 20 cm contains elevated levels, the volume per pile is estimated at 0.13 m^3) have the potential to be released.

Table 11.11 describes the impact of sediment loading from contaminated sediments into the water column (a temporary event) and **Table 11.12** describes the impact of sediment loading from contaminated sediments on the seabed. In both instances the impact is considered to be negligible with no project specific mitigation required.

Impacts upon the far field AOI are not considered based on the assumption that RCD activities and resulting sediment loading would have no impact (i.e. the sediments would fall out of suspension within a short geographical distance) upon the receptors. The physical extent of RCD activities will result in a low sediment release rate and is unlikely to register beyond 50-100 m and, given the number of piles, is considered a temporary impact.

Table 11.11 Impact of Marine Sediment Loading – Contaminated Sediments on localised Water Quality

Sensitivity of Receptor	Magnitude of Impact			Features of Impact		Impact Significance	
	Extent	Duration	Intensity	Risk	Direct / Indirect		
L (water column)	1	1	1	Definite	Direct	None required	Negligible
	Negligible (3)						
	1	1	1			None required	Negligible
	Negligible (3)						
Mitigation (to achieve residual impact & best practice)							
– If materials are to be disposed on land, conduct additional testing of sediments as per Ministerial Order No. 3 of 2006 (i.e. Toxicity characteristic leaching procedure).							

Table 11.12 Impact of Marine Sediment Loading – Spread of Contaminated Sediments on Seabed Sediments in the near field AOI

Sensitivity of Receptor	Magnitude of Impact			Features of Impact		Impact Significance	
	Extent	Duration	Intensity	Risk	Direct / Indirect		
L (seabed sediment)	1	1	1	Definite	Direct	None required	Negligible
	Negligible (3)						
	1	1	1			None required	Negligible
	Negligible (3)						
Mitigation (to achieve residual impact & best practice)							
– None required – sediments are considered largely uncontaminated and will be released adjacent to the point of drilling.							

11.5.2 Impact of Suspended Solids on Intakes

The potential impact of sediments on nearby intakes is limited because the project does not involve any reclamation or dredging activities. Limited piling will take place, and this will result in a temporary increase in suspended solids into the water column from the release of an estimated 855 m^3 into the water column over a short time frame.

As stated in **Section 11.5.1**, the far field AOI, which includes EWA's intakes at Ezzel and Hidd Power Stations, is not considered due to the low rate of sediment release into the water column and the anticipated small spatial extent (50-100 m) of the potential zone of influence. The Ezzel and Hidd Power Station intakes are over 6km away from the Port and so will be unaffected by the project. Due to the proximity of the Alba intake (estimated to be within 100 m of piling works) the potential impact of suspended solids must be considered. From previous consultation[39] with Alba, EACS understands that a TSS threshold at the Alba intake should not to exceed 6 mg/l at 7 m below water surface in front of the intake.

Dispersion modelling has not been carried out given the low release rates associated with RCD works and the inherit accuracies which can be experienced when dealing with

[39] Email correspondence from SHE Department, Aluminium Bahrain Wed 11/02/2015 09:19: Threshold limit for Total Suspended Solids (TSS) at the intake is 6 ppm (6.0 mg/l) undertaken as part of the Environmental Impact Assessment for the dredging operations within Borrow Area D and R.

such low values. In any case, given the high sensitivity associated with waters at the Alba intake, the strategic use of silt curtains and TSS monitoring (is required by default and is considered appropriate. The contractor is to develop a Marine Water Quality Management Plan (MWQMP) based on SCE (2010) EIA-9 and which address the TSS within marine waters. **Table 11.13** describes the features of the impact upon this sensitive receptor and the proposed project mitigation.

Table 11.13 Impact of Suspended Solids Upon the Alba Intake

<table>
<tr><th rowspan="2">Sensitivity of Receptor</th><th colspan="3">Magnitude of Impact</th><th colspan="2">Features of Impact</th><th colspan="2" rowspan="2">Impact Significance</th></tr>
<tr><th>Extent</th><th>Duration</th><th>Intensity</th><th>Risk</th><th>Direct / indirect</th></tr>
<tr><td rowspan="4">High</td><td>-</td><td>1</td><td>2</td><td rowspan="4">Definite</td><td rowspan="4">Direct</td><td>Design mitigation</td><td>Minor adverse</td></tr>
<tr><td colspan="3">Negligible (3)</td><td rowspan="3">Residual</td><td rowspan="3">Negligible</td></tr>
<tr><td>-</td><td>1</td><td>1</td></tr>
<tr><td colspan="3">Negligible (3)</td></tr>
<tr><td colspan="8">Mitigation (to achieve residual impact & best practice)</td></tr>
<tr><td colspan="8">– Contractor to prepare a MWQMP which amongst others presents:
1. His management structure tasked to address marine water quality.
2. Specific mitigation to reduce TSS levels within marine waters. In this regard the use of silt curtains at the Alba intake is to be included within the contractor's plan.
3. Monitoring protocol for TSS based on SCE (2010) EIA-9 and the Alba intake threshold of 6 mg/l @ 7m below water surface.
4. Project standards of TSS not exceeding 10mg/l above baseline 200 m downstream from piling works (note this may be superseded by Alba intake requirements).</td></tr>
</table>

The potential for suspension of solids associated with construction related vessel propeller wash is not considered of significance due to the depth of waters in the area and size of vessels.

11.5.3 Limited Release of Hydrocarbons from Construction Vessels on Water Quality

The potential for hydrocarbons (fuels, oils) to be released during construction activities exists although the volumes of which are likely to be negligible (e.g. small spillage / run off from vessel decks). In the event of a major incident (e.g. vessel collision or sinking) significantly larger volumes may be released. Such a scenario is considered most unlikely and has only been qualitatively assessed within this document. Should a more detailed quantitative assessment be required, spill dispersion modelling would be required in order to determine the extent of resulting oil slicks.

Spills of hydrocarbons and degradation of water quality poses a risk to both ecological receptors and nearby infrastructure (e.g. ALBA intake). Diesel fuel is a light, refined petroleum product with a relatively narrow boiling range, meaning that, when spilled on water, most of the oil will evaporate or naturally disperse rapidly. It has a very low viscosity and is readily dispersed into the water column/evaporated following agitation due to wave and wind action. As such it is anticipated that there would be no impact of a small spill of hydrocarbons on marine sediments.

Operation of marine vessels will be required to adhere to national regulations. As the vessels involved with construction activities are likely to be small (pile barge, tug and other support vessels), adherence to MARPOL 73/78 convention and Ship Oil Pollution

Emergency Plan (SOPEP) is unlikely to be required (this relates to vessels >400 GT), however this can be included for completeness.

The SOPEP addresses readiness in the event of an oil spill. A separate Tactical Response Plan (TRP) has been prepared for the project (see **Appendix 11B**). Such management is considered appropriate mitigation in the event of large spills; however, additional measures can be implemented to address smaller, less significant events.

Table 11.14 Impact Summary Table - Limited Release of Hydrocarbons from Construction Vessels on Water Quality

Sensitivity of Receptor	Magnitude of Impact			Features of Impact		Impact Significance	
	Extent	Duration	Intensity	Risk	Direct / Indirect		
L (water column)	1	1	1	Unlikely	Direct	Design mitigation	Negligible
	Negligible (3)						
	1	1	1			Residual	Negligible
	Negligible (3)						
Mitigation (design)							
– Adhere to MARPOL 73/78 and SOPEP if applicable. – Refuelling of vessels to take place at correct facilities. – Fuel/oil stored on deck to be lashed to prevent spills. – Fuel less than 200 l to be stored in drip trays. – Clean spills immediately with absorbent material. – Oily rags etc. to be disposed of appropriately (do not dispose in the sea). – Ensure TRP is in place and adhered to.							

Table 11.15 Impact Summary Table - Limited Release of Hydrocarbons from Construction Vessels on Intakes

Sensitivity of Receptor	Magnitude of Impact			Features of Impact		Impact Significance	
	Extent	Duration	Intensity	Risk	Direct / Indirect		
H (water column)	1	1	1	Unlikely	Direct	Design mitigation	Negligible
	Negligible (3)						
	1	1	1			Residual	Negligible
	Negligible (3)						
Mitigation (design)							
– As **Table 11.14**							

11.6 Impact Assessment – Operation

As with any industrial operation and one that involves the presence of large marine vessels, a risk exists that an event may occur whereby large amounts of fuel is released into the marine environment contaminating waters and, in the event of beaching, marine sediments. This risk is considered to increase following the port upgrade due to the increased frequencies of vessels visiting the facility.

At this time impacts are not assessed other than a large scale catastrophic event would results in significant risks, and potential impacts, on sensitive receptors (e.g. Alba intake) and as such a Tactical Response Plan (TRP) has been prepared (**Appendix**

11B) to ensure adequate procedures and equipment are put in place to manage such an unlikely event.

11.7 Impact Assessment – Decommissioning

The decommissioning of the Alba Port and impacts upon marine waters and sediments is something that is unable to be accurately assessed at this time, although the impacts of dismantling the jetties will be very similar to those for construction. Decommissioning works would likely require the removal of piles by cutting them at the seabed and hence some localised disturbance of sediments. Impacts are expected to be limited to the immediate area and of negligible significance.

11.8 Mitigation and Monitoring

Construction and operational activities are considered relatively minor and associated impacts mostly at acceptable levels. However, to conform to best practice the contractor is required to adhere to the mitigation outlined in this section but importantly to present and define additional mitigation, and his monitoring approach, within a Marine Water Quality Management Plan (MWQMP).

Table 11.16 summarises the requirements of the contractor.

Table 11.16 Summary of Impacts, Mitigation and Monitoring Requirements – Marine Sediments and Waters

Activity	Impact Description	Significance	Residual	Mitigation
Construction				
Pile drilling	Contamination of waters by copper and arsenic	Negligible	Negligible	– If materials are to be disposed on land, conduct additional testing of sediments as per Ministerial Order No. 3 of 2006 (i.e. Toxicity characteristic leaching procedure).
	Contamination of seabed by copper and arsenic	Negligible	Negligible	– None.
	Sediment loading	Negligible	Negligible	– Contractor is to prepare a Marine Water Quality Management Plan (MWQMP) as per the guidance presented in **Table 11.13**. – Contractor to conduct monitoring of TSS as per the MWQMP. – If permitted release drill cuttings 3-5 m below water surface. Dispose cuttings to land where necessary.
General	Spills of hydrocarbons	Negligible	Negligible	– Adhere to Tactical Response Plan (TRP). – Adhere to MARPOL 73/78 and SOPEP if applicable. – Refuelling of vessels to take place at correct facilities. – Fuel/oil stored on deck to be lashed to prevent spills. – Fuel less than 200 l to be stored in drip trays. – Clean spills immediately with absorbent material. – Oily rags, etc. to be disposed of appropriately (do not dispose in the sea).
Operation – refer to **Section 11.6**				
Decommissioning – refer to **Section 11.7**				

12 OCCUPATIONAL HEALTH AND SAFETY

12.1 Introduction

The nature of any construction and/or industrial operation is such that personnel will be exposed to the risk of injuries and it is the duty of the employer to ensure that working conditions are safe and such risks are minimised.

This section discusses the potential occupational health and safety hazards associated with the Alba Port Upgrade and provides an overview of the control and mitigation measures that will be put in place. The main sources of physical hazards at ports are associated with materials handling and the use of related equipment, machinery and vehicles.

For descriptive purposes, health and safety aspects have been grouped according to the type of activity, i.e. demolition, construction, operation, emergency situations.

Labour accommodation requirements are addressed in **Section 9.** This section is not a comprehensive health and safety assessment or health and safety plan for the project. It provides an overview of key health and safety issues and management requirements.

12.2 Legislation and Guidance

Legislation and guidance relating to occupational health and safety has been included in the Project Standards document in **Appendix 1A**.

12.3 Assessment Methodology

A qualitative health and safety assessment has been carried out on the likely activities during demolition, construction, operation and decommissioning. Likely hazards and risks, mitigation measures to be implemented and the residual impacts of these activities are presented in the following sections. A summary of the main H&S risks is provided, together with the means by which Alba and their contractors intend to manage and mitigate these issues.

The following characteristics (**Table 12.1**) have been used to attribute significance to potential impacts to health and safety from the proposed development.

Table 12.1 Criteria for Impact Significance for Occupational Health and Safety

Impact Significance	Impact Characteristic
Major Adverse	Accident or incident resulting in loss of life or major injury.
Moderate Adverse	Accident or incident resulting in operational lost time and/or off site treatment of personnel is required.
Minor Adverse	Minor accident or incident.
Negligible	No impact.

12.4 Baseline

The Alba Safety, Health, Environment (SHE), Security and Fire Department is headed by the departmental Senior Manager and its organizational structure (in 2017) is divided into responsibilities for safety, security & fire, environment and industrial hygiene. The department produces monthly and annual SHE statistics which are reported to Executive meetings. The health, safety and environmental management systems are certified to OHSAS 18001:2007 and to ISO14001:2004, and externally audited by Bureau Veritas. The systems are underpinned by Codes of Practice (COP), which apply to all Alba operations including the Port. The Job Safety Practice within the COP identify a training needs analysis, which in turn informs the individual employee training plan and links to internal, and where applicable, external training provision. Alba has an on-site clinic and each employee undergoes an annual health check.

12.5 Assessment of Impacts

The workforce of the project will be exposed to a number of different hazards and associated risks through the project lifetime. If no risk controls or ineffective risk controls are implemented, injuries and fatalities could possibly occur during the demolition and construction process, and injuries could also occur during the inspection and maintenance activities that are necessary during operation.

The following sections discuss the risks associated with the main stages of the project, i.e. demolition, construction, operation and decommissioning.

12.5.1 Demolition Activities

A method statement for the demolition of the shed was not available at the time of writing. The demolition activities must be carefully planned and carried out in a way that prevents danger by specialists with the relevant skills, knowledge and experience. Key risks for consideration during the shed demolition are falls, being struck or buried in falling material or by the unintentional collapse of the structure, elevated noise levels, dust emissions and risks from connected services. As the shed is in an existing operational area, there are risks associated with the protection of existing infrastructure and the management of vehicles.

Table 12.2 presents the specific H&S impacts and mitigation measures specific to the shed demolition.

Table 12.2 Occupational Health and Safety Impacts Associated with Demolition Activities

Description of Impact	Risk of occupational health and safety hazards on site (e.g. accidents, injury, falling, falling equipment, unscheduled collapse, hot-work, electrical exposure, heat stress during summer). Risk of collision with existing operational plant and machinery as well as from trucks conducting routine operations of transferring raw materials to the smelter.
Receptor(s)	Site workers.
Features of Impact	Local, avoidable risk but impact could be long-term or permanent (or could even result in death) if safety measures are breached; very high sensitivity of receptor, national & international legislation relating to occupational health and safety including Ministerial Orders 8 of 2013 and No. 3 of 2005.
Significance of Impact	**Minor to Moderate Adverse** depending on type of accident/injury. **Major Adverse** significance if serious accidents or fatalities occur.
Mitigation Advice	• Development of a Project HSE Plan for demolition. • Project HSE Plan to consider existing Alba operations at marine terminal. • Auditing of all sub-contractors against compliance with Project HSE Plan. • Training and awareness of workers regarding occupational safety issues on site. • Continuously monitor worker performance. • Provision of safety facilities, emergency equipment, and first aid facilities together with personnel trained in its use. • Provide Personal Protective Equipment (PPE) as appropriate for tasks undertaken. • Ensure the contractor specification adequately covers the assessment of risk of their employees for all construction activities, such as in a Construction Code of Practice (e.g. safe use of vehicles on construction sites). • Continuous provision of drinks and sheltered/shaded areas for labourers, especially during the summer months to avoid heat stress. • Preparation of Emergency Response Plan to cover working in close proximity to existing plant and machinery. • Operate a permit to work system as applicable.
Residual Impact	**Negligible impact.** Robust management and control of all aspects of health and safety, including appropriate training for staff and contractors, during the demolition activities should provide a safe working environment.

12.5.2 Construction Activities

As described in **Section 2**, construction of the Port Upgrade will include the extension of the existing jetties and the construction of new conveyors, silos, etc. Some of the work required will be undertaken in the sea and some will be on land within the existing

calciner plant. This section provides information for the terrestrial and marine environments.

There are general activities associated with construction sites such as the storage and delivery of fuels for onsite generators and plant, storage and delivery of chemicals and other materials, storage and delivery of water for site and personnel use and removal of wastewaters and wastes.

Construction activities will involve moving plant and vehicles, unloading of potentially hazardous materials and manual handling. Key H&S risks will include: working in confined spaces; working at height; lifting operations; working with mobile machinery; manual handling; trip hazards; safe access and egress. There is also the health risk associated with working outdoors in hot climatic conditions. During the hot months of July and August, working outdoors between the hours of 12pm and 4pm is prohibited by law in the Kingdom of Bahrain.

Coastal and maritime construction work is particularly hazardous due to the sometimes hostile and unpredictable nature of the environment. The main sources of hazards associated with marine activities during construction include all the above as well as ship and equipment collision, drowning and diving work risks.

Table 12.2 presents the specific H&S impacts and mitigation measures specific to the Port Upgrade project for both the terrestrial and marine environments.

Table 12.3 Occupational Health and Safety Impacts Associated with Working in the Terrestrial and Marine Environments

Description of Impact	Risk of occupational health and safety hazards on site (e.g. accidents, injury, falling, drowning, falling equipment, hot-work, electrical exposure, confined spaces, heat stress during summer). Risk of collision with ships. Risk of collision with existing Alba jetty and Bapco and GPIC jetties. Risk of collision with existing operational plant and machinery as well as from trucks conducting routine operations of transferring raw materials to the smelter.
Receptor(s)	Site workers.
Features of Impact	Local, avoidable risk but impact could be long-term or permanent (or could even result in death) if safety measures are breached; very high sensitivity of receptor, national & international legislation relating to occupational health and safety including Ministerial Orders 8 of 2013 and No. 3 of 2005 and US OSHA Standard Nos. 1929,106 Working Over or Near Water.
Significance of Impact	**Minor to Moderate Adverse** depending on type of accident/injury. **Major Adverse** significance if serious accidents or fatalities occur.
Mitigation Advice	• Development of a Project HSE Plan for construction. • Project HSE Plan to consider existing Alba operations at marine terminal.

	• Auditing of all sub-contractors against compliance with Project HSE Plan. • Training and awareness of workers regarding occupational safety issues on site. • Continuously monitor worker performance. • Provision of safety facilities, emergency equipment, and first aid facilities together with personnel trained in its use. • Safety facilities to include a marine safety vessel equipped with flotation devices, life buoys and life hooks with appropriately trained rescue personnel. • Provide Personal Protective Equipment (PPE) as appropriate for tasks undertaken. • Ensure the contractor specification adequately covers the assessment of risk of their employees for all construction activities, such as in a Construction Code of Practice (e.g. safe use of vehicles on construction sites). • Continuous provision of drinks and sheltered/shaded areas for labourers, especially during the summer months to avoid heat stress. • Preparation of Emergency Response Plan to cover working in close proximity to existing plant and machinery. • Operate a permit to work system as applicable. • Ensure the contractor specification adequately covers the assessment of risk of their employees for all construction activities following guidance such as OSHA Working Over or Near Water.
Residual Impact	**Negligible impact.** Robust management and control of all aspects of health and safety, including appropriate training for staff and contractors, during the construction activities should provide a safe working environment.

12.5.3 Port Operation

As detailed in **Section 2,** during operation approximately 150 employees will be based on site. Once upgraded the Port will handle close to 100 ships per year.

Specific occupational health and safety issues relevant to port operations include physical hazards associated with cargo handling, use of equipment, machinery and vehicles. Port workers may also be exposed to dust particulates associated with handling alumina and GPC. Additional risks posed by port operations include exposure to noise and risk of falling into the water. **Table 12.4** provides information on the potential impacts associated with general port activities.

Table 12.4 Occupational Health and Safety Impacts Associated with General Port Operational Activities

Description of Impact	Risk of occupational health and safety hazards on site (e.g. accidents, injury, falling, falling equipment, hot-work, electrical exposure, collision with vehicles and moving equipment, confined spaces, heat stress during summer, noise, exposure to alumina and GPC dust).
Receptor(s)	Site workers.
Features of Impact	Local, avoidable risk but impact could be long-term or permanent (or could even result in death) if safety measures are breached; very high sensitivity of receptor, national legislation relating to occupational health and safety including Ministerial Orders 8 of 2013 and No. 3 of 2005.
Significance of Impact	**Minor to Moderate Adverse** depending on type of accident/injury, **Major Adverse** significance if serious accidents or fatalities occur.
Mitigation Advice	• Preparation of H&S plan and codes of practice specific to the Port. • H&S plan to include marine rescue plan in the event of personnel falling into the sea. • Training and awareness of workers regarding occupational safety issues on site. • Provision of safety facilities, emergency equipment, and first aid facilities together with personnel trained in its use. • PPE as appropriate for tasks undertaken. • Continuous provision of drinks and sheltered/shaded areas for staff, especially during the summer months to avoid heat stress. • Preparation of Emergency Response Plan to cover working in close proximity to existing plant and machinery. • Operate a permit to work system as applicable.
Residual Impact	**Negligible impact.** Robust management and control of all aspects of health and safety, including appropriate training for staff and contractors, during operations should provide a safe working environment.

12.5.4 Shipping

Clause 28 of IFC Performance Standard No. 2, states that where there is a high risk of significant safety issues related to supply chain workers, the client will introduce procedures and mitigation measures to ensure that primary suppliers within the supply chain are taking steps to prevent or to correct life-threatening situations.

At the Port, shipping constitutes the major supply chain to Alba. Specific occupational health and safety issues relevant to operation of ships primarily include the following: crew accommodations and working spaces; physical hazards; confined spaces; chemical hazards (including risks of fire and explosions); security issues.

If not controlled, there is the risk of a major adverse impact relating to employer health and safety onboard the ships delivering raw materials to Alba's jetties.

Alba should send a HSE pre-qualification questionnaire to the shipping companies and this should be included as part of the qualification criteria. This will allow Alba to assess the HSE performance of the contractor before they are selected.

The vendors should be requested to respond before a required deadline or they will not be selected for future work.

At the end of the contract, the Alba SHE team should complete a Contractor Performance Report. This provides feedback on a number of items including safety and environment and a rating for these based on performance. Alba SHE team can provide suggestions on whether to renew and retender.

12.6 Mitigation

In order to mitigate potential occupational health and safety risks, a formal H&S management system should be implemented including the following general requirements:

- Development of a Project HSE Plan (including method statements, standard operating procedures and risk assessments).
- Use of health and safety assessment of contractors and sub-contractors during pre-qualification and qualification stages to ensure they have the technical skills to manage H&S to the required standards. Inclusion of H&S management requirements into formal contract documents.
- Auditing of all sub-contractors against compliance with Project HSE Plan.
- Speed limits and warning signs should be respected at all times on the local road network.
- On busy roads, consideration should be given to the use of flag-men for vehicles with large loads entering the road network.
- Maintenance of roads should be implemented at all times to ensure that they are kept clear of any sand and debris that may obstruct easy access and safety.
- A permit to work system should be implemented for higher risk activities, e.g. hot work, working with electricity, mixing chemicals, working in confined spaces, etc.
- The Project HSE Plan should also cover general aspects such as control of dusts including what to do during dust storms or high winds, working in hot conditions, working at night, lighting, noise and hearing controls, hygiene, etc.
- Emergency aspects such as spills and leaks, fire, rescue at height, from confined spaces or from storage pits, falling into the water, medical emergencies and vehicle accidents should also be covered.
- Induction training and awareness training of workers regarding occupational safety issues on-site.
- Provision of safety facilities.
- Provision of safety tools and clothing (i.e. PPE) such as hard hats, safety boots, eye protection, ear protectors, respiratory protection against emissions and fumes, gloves for handling certain types of materials and waste, life vests, etc.
- Provision of emergency response equipment such as first aid boxes (which need to be checked frequently), adequate water supply, and eye wash stations and emergency showers if appropriate.
- Include sea rescue plan including provision of safety vessel during jetty construction.
- Correct storage and handling of hazardous materials.
- Continuous provision of drinks and sheltered/shaded areas for workers, especially during the summer months to avoid heat stress.

- Supervisors should provide frequent breaks for employees, air conditioned refuges for breaks where practicable, and electrolyte solutions to maintain body chemistry in order to minimize the effects of heat stroke.

12.7 Monitoring

The mitigation measures identified are included in the project CESMP and OESMP as appropriate. Adherence to the mitigation measures should be checked as part of the regular auditing of the implementation of the CESMP and OESMP.

12.8 Summary

Table 12.5 provides a summary of the impacts relating to occupational health and safety identified for the Port Upgrade Project.

Table 12.5 Summary of Occupational Health and Safety Impacts and Mitigation Measures

Issue / Impact	Impact Significance	Mitigation / Monitoring / Enhancement Measures	Residual Impacts
General Construction and Demolition Activities – Terrestrial	Major to Minor	• Development of a Project HSE Plan for demolition/construction. • Project HSE Plan to consider existing Alba operations at marine terminal. • Auditing of all sub-contractors against compliance with Project HSE Plan. • Training and awareness of workers regarding occupational safety issues on site. • Continuously monitor worker performance. • Provision of safety facilities, emergency equipment, and first aid facilities together with personnel trained in its use. • Provide PPE as appropriate for tasks undertaken. • Ensure the contractor specification adequately covers the assessment of risk of their employees for all construction activities, such as in a Construction Code of Practice (e.g. safe use of vehicles on construction sites). • Continuous provision of drinks and sheltered/shaded areas for labourers, especially during the summer months to avoid heat stress. • Preparation of Emergency Response Plan to cover working in close proximity to existing plant and machinery. • Operate a permit to work system as applicable.	Negligible
General Construction Activities - Marine	Major to Minor	• Development of a Project HSE Plan for marine construction operations. • Project HSE Plan to consider existing Alba operations at Jetty 1 and 2. • Auditing of all sub-contractors against compliance with Project HSE Plan. • Training and awareness of workers regarding occupational safety issues on site. • Provision of safety vessel with appropriately trained rescue personnel. • Provision of life-saving equipment, e.g. flotation devices, life buoys, life hooks) together with personnel trained in its use. • Provision of first aid facilities together with personnel trained in its use. • Ensure the contractor specification adequately covers the assessment of risk of their employees for all construction activities following guidance such as OSHA Working Over or Near Water.	Negligible

Issue / Impact	Impact Significance	Mitigation / Monitoring / Enhancement Measures	Residual Impacts
		• Emergency Response Plan. • Operate a permit to work system as applicable.	
Port Operation	Major to Minor	• Preparation of H&S plan and codes of practice specific to the Port. • H&S plan to include marine rescue plan in the event of personnel falling into the sea. • Training and awareness of workers regarding occupational safety issues on site. • Provision of safety facilities, emergency equipment, and first aid facilities together with personnel trained in its use. • Provide PPE as appropriate for tasks undertaken. • Continuous provision of drinks and sheltered/shaded areas for staff, especially during the summer months to avoid heat stress. • Preparation of Emergency Response Plan to cover working in close proximity to existing plant and machinery. • Operate a permit to work system as applicable.	Negligible
Shipping	Major to Minor	• Alba should send a HSE pre-qualification questionnaire to the shipping companies and this should be included as part of the qualification criteria. • Feedback on the performance of the contractor should be obtained by Alba's SHE team.	Negligible

13 TRAFFIC AND ACCESS

13.1 Introduction

The Port Upgrade Project will lead to additional vehicle movements on the local road network both during construction and operation. The area within which the port operates is becoming increasingly congested. There will be traffic associated with the construction of the extended jetties, new silos and associated conveyors, both in terms of construction plant & equipment and personnel. There will also be increased vehicle movements associated with the additional amount of raw materials.

This section describes the baseline with regard to local traffic conditions and presents the potential impact of the project from a traffic perspective for both the construction (including demolition) and operation phases.

13.2 Legislation and Guidance

The project standards are included in **Appendix 1A**, and two additional guidelines are presented below.

13.2.1 World Bank Group General Environmental Health and Safety Guidelines

Section 3 regarding Community Health and Safety contains a section on Traffic Safety that includes general good practice H&S measures, e.g. limiting vehicle speeds, maintaining vehicles, providing driver training, etc.

13.2.2 Transportation of Abnormal Loads

Transportation of abnormal loads or indivisible loads is regulated by the Ministry of Works, Road Projects and Maintenance Directorate (RPMD). A load is considered an Abnormal Load when the total trailer plus load) exceeds the following criteria:

i. Gross weight – 40 tons.
ii. Length – 18 metres.
iii. Height – 4 metres.
iv. Width – 2.5 metres.

For loads exceeding these criteria, an application form must be completed and the approval obtained. The load must be accompanied by the police and transportation is usually authorised for night-time to avoid day-time traffic.

13.3 Assessment Methodology

Potential hazards relating to traffic have been assessed qualitatively and are based on: visits to the study area to identify traffic conditions; consultations with the RPDD; interviews with the EPC contractor to identify traffic routes and proposed management measures; and a review of predicted traffic movements during construction and operation.

In this assessment, impact significance is considered to fall into one of only two categories: Significant or Negligible. In the absence of established significance criteria for traffic and access impacts, professional judgement has been used to assess whether

the impacts on traffic and access are considered to be significant or not. Professional judgement has considered the magnitude and duration of the impact.

Mitigation and monitoring measures proposed include any specific measures indicated by the assessment as well as good international industry practice measures in respect of traffic management and road safety.

The receptors considered in this assessment are the users of local roads. There are no residential communities that are considered receptors in the context of traffic impacts, although there are several road users which have the potential to be impacted by the project. Construction and operation traffic will utilise the existing established road network.

13.4 Baseline

Alumina, CPC and liquid pitch are delivered to the Smelter by road. The current vehicle movements for these deliveries are shown in **Table 13.1**. In total there are currently 243 trips over a 24 period; this equates to approximately one tanker every 6 minutes.

Table 13.1 Vehicle Movements Associated with Current Deliveries from the Port to the Smelter

Product	No. of Tankers	No of Trips* per Shift	No of Shifts	Total Trips*/24 Hours
Alumina	11	6	3	198
CPC	2	6	3	36
Liquid Pitch	1	3	3	9
			Total Trips/24 Hours	243
Notes: * A trip is equal to a round trip for one tanker, i.e. from the port to the smelter and back.				

From the port, specialist tankers/trucks use the private Sitra Wharf access road, and then join the public road network along Um Al Saad Avenue, before connecting with a private road south of Bapco Refinery known locally as the Alba Road (see **Figure 13.1**). Alba trucks use only a 2km section of this road. The general public is not permitted to access the Sitra Marine Terminal.

The section of Um Al Saad Avenue that the trucks use provides access to the Central Stores Directorate, Sitra Port, Bahrain Coastguard, Al Bandar Resort and Bahrain Yacht Club. This section of road is only lightly trafficked.

Access to the Alba Road is restricted to Alba vehicles only and extends from Um Al Saad Avenue to King Hamad Highway. At the King Hamad highway there is a signalised junction, allowing access to the Alba Main Gate. The King Hamad Highway is a major dual carriageway and is heavily trafficked with cars and HGVs, accessing the Sitra and Alba industrial areas and beyond.

There are other vehicle movements during operation associated with the transport of personnel to site, delivery of general office and maintenance supplies and removal of domestic and maintenance waste. These vehicle movements are not considered significant.

Title: **Traffic Map**			Client:
Project: Alba Port Capacity Upgrade Project			
Date: June 2018	Figure No.: 13.1		Consultant: Environment Arabia
Datum: WGS 84 - UTM 39N	Scale: 1:50,000 (A4)		

CN:\Alba Port Capacity Upgrade\mxd\EER\traffic map.mxd

13.4.1 Existing Road Construction

Road improvement construction work is ongoing on the Alba roundabout (**Figure 13.2**), Nuwaidrat roundabout (**Figure 13.3**) and around the Bapco Refinery. The Alba roundabout will consist of a 3-level interchange and the Nuwaidrat roundabout will be a 2-level interchange. The works were expected to be completed in 2018, but consultation with the CPO has indicated that the project is running two years behind schedule (**Appendix 5B**, Meeting Minutes).

Figure 13.2 Proposed Interchange at Alba Roundabout

Figure 13.3 Proposed Interchange at Nuwaidrat Roundabout

13.4.2 Future Road Development Plans

13.4.2.1 East Sitra Link Road

The RPDD has a proposal for development of the ESLR (letter refs: AUS-R/RPDD/ID/58/2018 & AUS-R/RPDD/SB/667/2018 **Appendix 5A**). This road is planned to provide enhanced connectivity for the proposed housing and investment projects in the East Sitra Region. Extending between the Fifth Crossing (Sitra-Hidd Causeway) Junction and King Hamad Highway (at Highway-96 junction), the ESLR will be the prominent road link with adequate road capacity for serving future traffic demands. All the major junctions along the ESLR are proposed to be grade separated. In the future, the ESLR will be extended northwards to connect with the Mina Salman

The RPDD has advised that a Feasibility Study has been completed and a preferred route has been recommended (see **Appendix 13A**). This alignment is still subject to agreement with NOGA and other stakeholders.

13.4.2.2 King Hamad Highway and Avenue 96 Widening

The Roads Directorate plans to upgrade King Hamad Highway from the Alba roundabout to Road 5156 at the southern end of the South Alba Industrial Estate at an unspecified date in the future. There will be 3-4 lanes in each direction together with grade separated junctions. There is no confirmed layout or programme of work. In addition, it is planned to upgrade Avenue 96 and the junction of it with King Hamad Highway.

13.4.2.3 Bapco Modernization Programme

As part of the Bapco Modernization Programme, new roads are proposed to allow access to a planned laydown area south of the Refinery, and access for heavy vehicles off King Hamad Highway. A new roundabout would also be installed along the Alba Road from which a new access road would be constructed into the laydown area. Provision for pedestrians to cross the laydown area access road and Alba Haul Road from the camp site will be provided by means of a bridge.

Furthermore, a temporary construction labour camp will be provided on the most western of the NOGA plots off the Alba Haul road.

13.5 Assessment of Impacts

13.5.1 Demolition Phase

During demolition of the shed, there will be traffic movements associated with the removal of materials for either reuse, recycling or disposal to landfill. These may be significant for a short period of time and will require management strategies.

13.5.2 Construction Phase

Traffic during the construction phase will be mainly related to the transport of materials to the site as the workforce is limited for this project. An estimate of the numbers of expected vehicles during construction will not be available until the detailed design has been finalised. Construction vehicle numbers are unlikely to be significant, but they will

require careful management to avoid any conflict with existing road users including Alba's trucks. Furthermore, should Bapco's temporary construction labour camp be occupied during the construction phase, there may be conflicts during the morning and evening when the workers are transported to and from their work site. This will require liaison with Bapco to ensure there are no significant issues.

No significant amounts of abnormal loads are expected for this project. The ship unloader will be constructed in Dubai and transported to site by barge. The jetty extensions, silos and conveyors will be constructed in-situ, thus reducing the need for over-sized deliveries. The impact of abnormal loads is thus considered to be negligible. In the event that transport of an abnormal load is required, management and mitigation measures have been provided in **Section 13.6**.

13.5.3 Operation

13.5.3.1 Increase in Tanker Movements from Port to Smelter

As discussed in **Section 13.4**, alumina, CPC and liquid pitch are delivered to the Smelter from the Port by road. Currently there are 243 trips over a 24-hour period; this equates to approximately one tanker every 6 minutes. With the introduction of Line 6 and the Port Upgrade, the vehicle movements will increase. **Table 13.2** presents the future situation with regard to deliveries of raw materials to the smelter. With Line 6, there will be 405 trips over a 24-hour period, which equates to one tanker every 3.5 minutes. This is considered significant and mitigation and management measures will be needed to manage this additional traffic.

Table 13.2 Future Tanker Delivery Movements

Product	Current/ Line 6	No. of Tankers	No of Trips* per Shift	No of Shifts	Total Trips*/24 Hours
Alumina	Current	11	6	3	198
	Line 6	6	6	3	108
CPC	Current	2	6	3	36
	Line 6	2	6	3	36
Liquid Pitch	Current	1	3	3	9
	Line 6	2	3	3	18
				Total Trips/24 Hours Current	243
				Total Trips/24 Hours Line 6	162
				Total Trips/24 Hours Future	**405**
Notes: * A trip is equal to a round trip for one tanker, i.e. from the port to the smelter and back.					

13.5.3.2 East Sitra Link Road

The ESLR (as currently proposed) will be constructed directly on top of a section of the Alba haul route along Um Al Saad Avenue, and will cross the route in two places south of the Bapco Refinery. EACS has been advised that this road is unlikely to be constructed at the same time as the Port Upgrade.

During construction of the ESLR, there may be major adverse impacts on Alba's haul route for raw materials.

It is understood that provisions will be made for access/egress from the Sitra Marine Terminal onto the ESLR[40], and also that a dedicated slip road will be constructed for trucks at the junction of Highway 96 and King Hamad Highway. If the ESLR is constructed along the route currently provided, and Alba utilise it for their trucks, the impact of the additional tankers required once the upgrade is complete will be negligible.

However, no firm conclusions can be drawn at this stage, as the road alignment is subject to approval from stakeholders.

13.6 Mitigation and Management

13.6.1 Demolition and Construction Phase

Traffic Management Plans (TMPs) will be required for all demolition and construction activities and should be adopted by all construction contractors. Measures that should be incorporated into the TMP(s) are:

- Although not likely to be required, provision should be made for oversized loads which include consultation with concerned stakeholders, e.g. Banagas, GPIC and Bapco.
- Requirements to liaise with local law enforcement with respect to traffic management if required.
- Provision of a traffic access map to send to all contractors and suppliers involved in the construction phase.
- Consideration of the reduction of HGVs during the morning, afternoon and evening peak/rush hour times.
- Routing of construction plant and vehicles away from residential areas.
- Provision of designated delivery and loading/unloading areas.
- Inspection of local roads prior to construction and provision for the contractor to make good any damages.
- Sweeping of all roads contaminated with sand/dust.
- Fencing off frequently used haul routes within the construction zone to keep pedestrians out.
- Provision of clearly marked pedestrian walkways.
- Restricting the speed of construction vehicles to reduce dust generation.
- Switching off engines/equipment when not in use.
- Regular maintenance of vehicles.
- Ensuring all workers are familiar with the Traffic Management Plan and receive sufficient information, instruction, training and supervision.

13.6.2 Operation Phase

Due to the increase in traffic movements associated with the Port Upgrade, a TMP will be required for the operation phase. The purpose of the Plan will be to detail the control strategies for traffic movements both onsite and offsite and provide guidance on what to do in the event of an incident. The Plan should include the following:

[40] EACS meeting with traffic consultants SSH on 28.5.18.

- Roles and responsibilities;
- Description of operational activities, e.g. working hours, shifts, vehicle types, numbers of journeys, etc.;
- Description of haulage routes and any road restrictions;
- Risk identification;
- Driver management procedures and policies;
- Emergency and incident response;
- Communication with stakeholders; and
- Monitoring programme and performance review.

13.7 Monitoring

The implementation of the TMP(s) should be monitored routinely throughout the demolition and construction phases.

The TMP for the operation phase will need to be reviewed annually to ensure that any changes to the road network (e.g. ESLR) and any changes in neighbours operations (e.g. Bapco, Banagas, GPIC) are taken into consideration.

13.8 Summary

A summary of the predicted impacts for traffic and access is provided in **Table 13.3**.

Table 13.3 Summary of Traffic and Access Impacts

Impact	Significance	Mitigation/Enhancement Measures	Residual Impact
Demolition traffic	Short-Term Significant	Preparation and implementation of a TMP	Not Significant
Construction traffic	Not Significant		Not Significant
Transport of oversized loads	Not Significant		Not Significant
Increase in operational trucks	Significant		Not Significant

14 WASTE MANAGEMENT

14.1 Introduction

The chapter includes consideration of solid and liquid wastes generated from all phases of the Port Upgrade including: demolition (specifically existing GPC shed); construction; commissioning; operation; maintenance; and decommissioning, but not wastewaters discharged to surface waters or sewer, nor liquid wastes from ships. The latter are discussed in **Section 11** concerning Marine Sediment and Water Quality.

14.2 Legislation and Guidance

For legislation and guidance regarding waste management, the reader is directed to **Appendix 1A**, Project Standards.

14.3 Assessment Methodology

14.3.1 Impact Assessment Significance Criteria

Environmental impacts associated with waste disposal have been classified on a seven point scale from major adverse, moderate adverse, minor adverse through to negligible and on to minor beneficial, moderate beneficial and major beneficial. For a project to achieve beneficial impacts in respect of waste the project would need to be a net consumer of waste. Adverse impacts arise from the generation of waste from the project.

Significance criteria have been developed based on the waste type - hazardous, non-hazardous or inert (i.e. its potential to cause harm to human health and/or the surrounding environment), factored with the quantities of waste generated per year. The criteria are summarised in **Table 14.1**. The classification assumes that all solid waste is landfilled. Diversion of waste from landfill and up the waste hierarchy can be considered to be mitigation which will reduce its environmental impact and render it negligible. Where there is no other practicable option, then the disposal of waste to a licenced landfill under full Duty of Care requirements is considered suitable mitigation to reduce its environmental impact to negligible. In respect of liquid waste, the assessment criteria are not applicable and expert judgment has been used to determine the predicted scale of impact.

Table 14.1 Waste Management Significance Criteria

Waste Type	Impact Significance				
Hazardous	Minor adverse	Minor adverse	Minor adverse	Moderate adverse	Major adverse
Non Hazardous	Negligible	Negligible	Minor adverse	Minor adverse	Moderate adverse
Inert	Negligible	Negligible	Negligible	Minor adverse	Minor adverse
Quantity (Tonnes per Year)	<10	10 - 100	100 – 1,000	1,000-10,000	>10,000 or requiring export from Bahrain

14.4 Baseline

There are limited waste types generated at the Port. Alba presents waste statistics to the SCE annually for the whole site and so waste quantities and types for just the Port are not available. Typical waste streams are canteen waste, office waste, metal waste, packaging and waste oil/oily rags and general maintenance waste. Wastes are segregated and stored in skips prior to disposal off site by a licenced contractor who at present is Crown Industries.

There is no clinic at the Marine Terminal and so all medical waste is generated at the Alba Health Centre within the Smelter site.

14.5 Impact Assessment

14.5.1 Demolition Waste

The final method statement for demolition of the shed is not available, but it is expected that the waste detailed in **Table 14.2** will be generated. The values quoted are estimates at this stage. **Table 14.2** also shows the proposed waste management option to be adopted and the predicted impact.

The storage shed is constructed with basic materials. All metal waste will be recycled through local recycling contractors, and where possible the waste concrete, bricks and blocks will be crushed and reused. There will, therefore, be a negligible impact for demolition waste. The contractor should produce a Waste Management Plan for demolition (see **Section 14.6.1**).

Table 14.2 Estimates of Demolition Waste

Waste Types	Category	Quantity	Handling/Storage	Impact Before Mitigation	Mitigation/Management Strategy	Impact After Mitigation
Steel	Inert	1.5 t	Stored in designated area	Negligible	Recycling offsite	Negligible
Larsen Sheet Piles	Inert	500 t	Stored in designated area	Negligible	Reuse and /or recycling	Negligible
Metal Cladding	Inert	37.5 t	Stored in designated area	Negligible	Recycling offsite	Negligible
Floor Concrete	Non-hazardous	1920 t	Stored in designated area	Minor adverse	Crushed and reused where possible, or disposal to landfill	Negligible
Other Concrete	Non-hazardous	1200 t	Stored in designated area	Minor adverse	Crushed and reused where possible, or disposal to landfill	Negligible

14.5.2 Construction Waste

Preliminary estimates of construction waste quantities are provided in **Table 14.3**, together with the proposed waste management option to be adopted during construction and the predicted impact. These waste quantities are order of magnitude estimates only and are based on professional judgment. These figures should be considered indicative of the likely quantities only.

Construction of the new ship unloader is not anticipated to generate large quantities of waste at the Port because it will be constructed off-site at the supplier's facilities and shipped to site on a barge.

The EPC contractor will be responsible for all waste arising during the construction phase. General, non-hazardous construction waste will be segregated to separate out metals, plastics and paper which will then be collected as separate waste streams and recycled. Wood should be reused within other construction projects, as it is not readily recyclable in Bahrain. It is expected that a residue of mixed general construction wastes will remain which cannot be effectively segregated. This material can be sent for disposal to Askar landfill which is authorized to receive non-hazardous commercial waste.

Construction will potentially give rise to a small amount of hazardous wastes comprising such things as used lubricating oils and used batteries from servicing construction plant. These materials can generally be recycled but otherwise landfilled. Transportation of hazardous waste can only be carried out by a licensed carrier and must be taken to a facility licensed to manage hazardous waste.

The majority of dry office and canteen wastes can be recycled provided they are segregated from each other at source. Food waste cannot be recycled and no suitable facilities exist in Bahrain to compost or otherwise treat food waste and this will require disposal to landfill.

The construction site offices will have sanitary portable toilet blocks. Wastewater will need to be collected in septic tanks which will require to be regularly emptied and wastewater tankered to a designated sewage treatment works for treatment.

Large quantities of waste will not be generated during the construction phase. Prior to the adoption of good waste minimisation and management practices, it is considered that there will be a minor adverse impact from construction waste. This can be reduced to negligible through the appropriate treatment and disposal of waste streams.

Table 14.3 Estimated Construction Waste Generation

Waste Types	Category	Quantity	Handling/Storage	Impact Before Mitigation	Mitigation/Management Strategy	Impact After Mitigation
Soils/sediments – inert	Inert	10,000 m^3	Taken off-site to sub-contractor yard	Minor adverse	Reuse in construction on or offsite	Negligible
Concrete waste	Inert	10-100 t	Stored in designated area	Minor adverse	Use to build temporary facilities or landfill	Negligible
Metal	Inert	1-10 t	Stored in designated area	Minor adverse	Recycling offsite	Negligible
Wood	Inert	1-10 t	Stored in designated area	Minor adverse	Reuse where possible, surplus to landfill	Negligible
Plastics and packaging	Inert	1-10 t	Stored in designated area	Minor adverse	Recycling	Negligible
Hazardous wastes – waste oils, solvents, batteries, etc.	Hazardous	1-10 t	Stored in designated hazardous waste storage area	Minor adverse	Dispose to authorised facility	Negligible
Paints and thinners	Hazardous	1-10	Stored in container within designated area	Minor adverse	Dispose to authorised facility	Negligible
Surplus chemicals	Hazardous	1-10	Stored in designated hazardous waste storage area	Minor adverse	Recycle for reuse if practical or dispose to licensed facility	
Wastewater from site offices to septic tanks – non-hazardous	Non-hazardous	150 (m^3)	Stored in septic tank	Minor adverse	Collection in septic tank and tinkering to municipal STP	Negligible
Site canteen wastes	Inert	10-100	Food waste stored in closed container, packaging segregated into type	Minor adverse	Packaging recycled. Food waste to landfill	Negligible

14.5.3 Commissioning Waste

As described in **Section 2.5**, there will be very little commissioning activities because the supplier of the ship-unloader will deliver it fully assembled and pre-commissioned. There may be some limited mechanical and electrical testing of the new ship unloader and associated conveyors and silos and so very few waste items will be generated. Any waste arising during commissioning will be dealt with using the same management principles as described above for the construction phase, and it is not anticipated that there will be any impact. Water will not be used in the commissioning phase.

14.5.4 Operation Waste

No new waste streams will be introduced as a result of the Port Upgrade; the waste streams will be the same as for the current operation which are described in **Section 14.4** above. It is expected that there will be minor increases in the following waste types: food waste, office waste, metal waste, packaging and waste oil.

In order to comply with the MARPOL Convention, Alba needs to install reception facilities for ship waste. According to MARPOL, the reception facilities must fully meet the needs of the ships regularly using them, do not provide mariners with a disincentive to use them and contribute to the improvement of the marine environment. They must also allow for the ultimate disposal of ships' waste to take place in an environmentally appropriate way. MARPOL also places an obligation on States Parties to provide adequate reception facilities for each type of MARPOL residue/waste, as follows:

- MARPOL Annex I: oil, oily waste, oily mixtures, oily bilge water, slops, sludge, oily tank washings, oily cargo residues, ballast water containing oily mixtures.
- MARPOL Annex II: tank washings and cargo residues containing noxious liquid substances.
- MARPOL Annex IV: sewage.
- MARPOL Annex V: garbage as defined in MARPOL Annex V* including cargo residues not governed by Annex I or II (such as dry/bulk cargo residues) and cargo-associated waste (such as dunnage and packaging).
- MARPOL Annex VI: ozone depleting substances and exhaust gas cleaning residues.

** All kinds of food wastes, domestic wastes and operational wastes, all plastics, cargo residues, incinerator ashes, cooking oil, fishing gear, animal carcasses generated during the normal operation of the ship and liable to be disposed of continuously or periodically except those substances which are defined or listed in other Annexes to the Convention.*

At this stage it is not possible to quantify how much waste will be generated from the ship reception facilities. Provided Alba manages it in line with its current waste management procedure and provides a specific Port Waste Management Plan, there will be no impact.

14.6 Mitigation

14.6.1 Demolition and Construction Waste

To implement the mitigation measures identified and to successfully divert demolition and construction wastes away from landfill, the following measures should be adopted by the relevant contractors:

- Appoint a member of the management team as the Waste Manager;
- All waste generated will be classified as either inert, non-hazardous or hazardous;
- Only wastes for which no other cost affordable route for disposal can be identified will go to a landfill; landfilling will be the last option considered;
- In order to minimise the quantity of hazardous waste generated, the EPC contractor will challenge the need for all hazardous materials, including chemicals and petroleum products, in an effort to eliminate, minimise or substitute with a less hazardous material;
- Waste minimisation will be evaluated throughout the construction phase, with the hierarchy of waste management practices to be as follows:
    - Eliminate or minimise the waste stream by choice of technology;
    - Re-use immediately as a material;
    - Re-use immediately as a fuel;
    - Recycle fore reuse as a material;
    - Recycle for reuse as a fuel; and
    - Landfill.
- All sub-contractors generating more than one skip of refuse per week will supply and maintain an adequate number of labelled receptacles to manage their waste;
- Waste receptacles in eating areas will be provided with lids;
- Project waste will only be disposed of at facilities that are authorised and licensed by the local Government to operate such facilities. Waste will not be burned or landfilled on site;
- Prior to transferring inert or non-hazardous waste streams to third parties for disposal the EPC contractor will evaluate potential adverse impacts that may result;
- All liquid waste will be appropriately treated prior to discharge to disposal at facilities that are licensed;
- Waste will only be stored in containers and/or areas that have been specially designed for the waste.

These measures will be contained within the Project CESMP.

14.6.2 Operation Waste

Alba should prepare a stand-alone Port Waste Management Plan specific to the Port operation. The Port Waste Management Plan should cover all waste arisings from operation of the Port and address the requirement to have Port Reception Waste Facilities for ships. Alba should develop the Plan to form part of The Alba Calciner Standard Operating Procedures – Marine Section. Alba should identify a staff member who has responsibility for this Plan.

Alba should use the guidance contained in the IMO's Consolidated Guidance for Port Reception Facility Providers and Users, 15 April 2014 when establishing reception facilities for ship waste.

14.7 Monitoring

The implementation of the recommended mitigation measures should be audited during the demolition and construction phases of the project.

14.8 Summary

A summary of the predicted impacts in respect of waste management is provided in **Table 14.4**.

Table 14.4 Summary of Waste Impacts

Impact	Significance (Minor/Moderate/Major) (Beneficial/Adverse/Negligible)	Mitigation / Enhancement Measures	Residual Impacts (Slightly/Moderate/Major) (Beneficial/Adverse/Negligible)
Demolition Waste	Minor Adverse	Implement a demolition and construction phase waste management plan. Proactively manage waste. Segregate waste at source to maximise recycling and reuse opportunities. Manage waste responsibly - maintain Duty of Care.	Negligible.
Construction Wastes	Minor Adverse		Negligible
Operation Wastes	Minor Adverse	Prepare specific Port Waste Management Plan.	Negligible

15 ENVIRONMENTAL MANAGEMENT AND MITIGATION

15.1 Introduction

The supplementary ESIA has undertaken an analysis of the environmental and social impacts that are predicted to arise from the construction and operation of all aspects of the project. Where adverse impacts have been identified, mitigation and management measures have been recommended to control and minimize them. This section presents a summary of the ESIA findings split into construction and operation. Construction includes commissioning of new plant.

15.2 Construction Phase

Construction phase impacts and mitigation measures are summarized in **Table 15.1**. This includes the different phase of the project, e.g. jetty extension, silo and conveyor construction and ship unloader erection. There is a general set of mitigation and GIIP measures that will apply to all construction work, but also each work area has specific mitigation requirements.

15.3 Operational Phase

Operational phase mitigation measures are summarized in **Table 15.2**.

Alba is a mature business and its day-to-day operations are managed by its own policies and procedures. Alba's environmental management system (EMS) is accredited to ISO 14001 and its occupational health and safety management system is accredited to OHSAS 18001 to ensure that it complies with internationally recognised standards. How the Port is operated once upgrade will not change.

During the operational phase Alba will be required to continue with reporting initiatives such as compliance reporting to the SCE and the PMA.

15.4 Summary of the Alba Port Upgrade

The supplementary ESIA has determined that the project will not lead to any substantive environmental impacts that cannot be managed or mitigated.

Whilst there are numerous potential environmental impacts, the great majority can be rendered negligible. In some cases it has been assessed that there will be residual minor adverse impacts and these are identified in relevant ESIA sections and **Tables 15.1 and 15.2**.

Table 15.1 Construction Phase Management and Mitigation Requirements

Construction Phase Impact	Impact Significance	Mitigation Summary	Residual Impact
Air Quality			
Demolition and Construction Dust	Negligible	• Best practice dust management and control measures in CEMP.	Negligible
Construction Vehicle Emissions	Negligible	• Contractor to provide a Construction Traffic Management Plan.	Negligible
Community Health, Safety and Security			
Impact on Local Fishermen	Minor to Major Adverse	• Alba should take measures to prevent the unauthorized access of fishing vessels in the jetty area. • Advance notice of construction works to be given via local press and the Bahrain Fishermen's Society.	Negligible
Management of Security Personnel	Minor Adverse	• Use of licenced, background checked and trained security personnel.	Negligible
Geology and Hydrogeology			
Impact on soil and groundwater from pet coke during demolition	Negligible	• Adoption of good practice measures for demolition that reduce dust arisings.	Negligible
Impact on soil and groundwater during piling	Minor Adverse	• Permission for piling should be sought from the AEWRD to verify that the proposed method and depth of piling will not adversely impact groundwater resources. • Any site investigation boreholes or piles should be sealed immediately following drilling. • Use of low environment impact, water-based muds for piling. • Residual mud will require to be disposed of responsibly to landfill.	Negligible
Impact on human health from pre-existing contamination during construction	Negligible	A procedure should be developed in the unlikely event that unexpected soil contamination be encountered including risk assessment handling, storage and disposal/ remediation arrangements of contaminated soils identified.	Negligible

Construction Phase Impact	Impact Significance	Mitigation Summary	Residual Impact
Dewatering	Negligible	Ensure a permit is obtained for all dewatering operations from the SCE.	Negligible
Spills of fuels, oils or chemicals causing soil and groundwater contamination during construction	Minor Adverse	Good environmental practice and correct storage and use of chemicals: • Storage and use of fuels, oil and chemicals should be in accordance with the MSDS. • MSDSs should be displayed at the point of storage for all chemicals. • All small quantities or containers of fuels and chemicals should be stored in drip trays. • No fuels or chemicals should be stored within 10 m of the sea. • Where fuel or chemical containers are in excess of 200 litres they should be stored in bunds capable of storing 110% of the volume of any single containers or 25% of the total volume where multiple containers are stored. • Bulk fuel containers should be double-skinned or should be stored within a bund with a capacity of 110% of the volume of the tank. • A spill kit should be available at each bulk fuel storage point. • A spill procedure should be prepared and displayed. The procedure should be drilled within 6 weeks of commencing construction. • Storage areas for fuels and other volatile chemicals should have a sun shelter. • All generators, power packs, compressors, etc. Should be underlain by a drip tray.	Negligible
Labour and Working Conditions			
Use of forced labour Payment of wages Labour accommodation	Major Adverse	• Establishing HR policy and procedures for Project in compliance with IFC PS2 requirements, including provision of a clear and understandable written statement of rights to each employee. • Application of mitigation in respect of human resource policy and procedures to employees of all (sub) contractors. • Ensuring all procurement contracts contain clauses banning forced labour. • Ensure (sub) contractors only use accredited local recruitment companies (in country of worker origin) to recruit workers. • Forbid the use of recruitment and other fees (such as payment for	Negligible

Construction Phase Impact	Impact Significance	Mitigation Summary	Residual Impact
		accommodation and transportation to/from home country). • Workers to retain access to their passport. • Run campaigns to raise awareness of worker rights, particularly in the context of forced labour; • Provide all employees with a Contract of Employment which contains all the items in Table 1.1. • Establishment of a grievance mechanism for employees of all (sub) contractors. • Make the grievance mechanism available in a language understandable to the worker. • Run campaigns to raise awareness of the worker grievance mechanism. • (sub) contractors to report regularly on grievances raised through the grievance mechanism and if/how these were resolved. • Alba to put in place requirements to conduct payroll audits on a monthly basis to ensure that (sub) contractors pay workers wages in full and no illegal fees are deducted from workers salaries. Payroll audits should include an audit of worker contracts to determine if they meet the required terms and conditions of employment. • Auditing of (sub) contractor to ensure relevant policy, procedures and contract requirements are in place prior to mobilization. • Auditing of (sub) contractors annually to ensure relevant policy procedures and contract requirements remain in force. • Labour accommodation should be inspected and approved to ensure labour camps meet Bahraini law and IFC / EBRD guidelines before (sub) contractor mobilization. • For long-term contractors working on the project, labour accommodation should continue to be audited every six months to confirm continued compliance with Bahraini law and IFC / EBRD guidelines.	
Use of child labour	Negligible	• Establishing human resources policy and procedures for Project in compliance with IFC PS2 requirements, including provisions banning child labour • Ensuring all procurement contracts contain clauses banning child labour. • Auditing of (sub) contractors to ensure relevant policy, procedures and contract requirements are in place prior to mobilization. • Auditing of documents annually to confirm continued compliance with relevant policy, procedures and contract requirements.	Negligible

Construction Phase Impact	Impact Significance	Mitigation Summary	Residual Impact
Public Health: increase in STDs amongst workers and the local communities	Minor Adverse	• Alba to require contractors to implement public health campaigns on sexually transmitted disease impacts, symptoms and prevention.	Negligible
Marine and Coastal Ecology			
Loss of habitat due to piling operations	Negligible	• None required.	Negligible
Impact of marine sediment loading due to pile driving	Negligible	• The contractor is to prepare a Marine Water Quality Management Plan (MWQMP) which defines appropriate standards based on SCE (2010) EIA-9 Guidelines on TSS Monitoring Programme of Large Scale Projects Involving Intensive Dredging and Reclamation Operations. • Should TSS values breach national standards, consider the strategic deployment of silt curtains to contain suspended solids. • Discharge pile cuttings 3-5 m below water surface (if permitted) or collect and dispose on land.	Negligible
Impact of noise on marine mammals due to piling activities	Minor to Moderate Adverse	• The contractor is to develop a Marine Noise Management Plan (MNMP) which outlines how he intends to adhere to the project standard of 30 kPa (equivalent to ~210 dB re 1µPa) at 20 m from piling works. The MNMP should define roles and responsibilities, mitigation to be employed by the contractor and importantly his monitoring protocol. • The requirements for the monitoring protocol include: v. Should be conducted for a period which clearly demonstrates that the project standards are met (we recommend that at least 10 piles are monitored during which recordings are taken for a period of 10-minutes prior to impulsive piling, 10-minutes during impulsive piling, and 10-minutes following impulsive piling). vi. The hydrophone is to be deployed at mid water column and values recorded. vii. Reports to be prepared which provide a log of all recordings (time, date,	Minor Adverse

Construction Phase Impact	Impact Significance	Mitigation Summary	Residual Impact
		weather conditions, etc.) viii. Data to be provided in .wav and log files but also presented graphically within regular reports. • Key mitigation may include: iv. Appropriate mitigation may include conducting a visual search for marine mammals to ensure no visible animals are within 500 m of the piling works prior to commencing operations. If animals enter the zone during piling, works may continue. Should piling works cease for more than 30 minutes then a new visual search is required prior to re-commencement of works. v. A soft start is to be carried out at the start of all works so as to allow any animals within the zone to leave the area. vi. Should observations indicate injurious impact or project standards are breached, then works may be stopped and additional mitigation implemented by the contractor. This may include the use of dampening material at the point of impact and/or use of bubble curtains.	
Impact of noise on turtles due to piling activities	Minor to Moderate Adverse	• See above measures.	Minor Adverse
Impact of noise on fish due to piling activities	Minor Adverse	• See above measures and: • Observe and note occurrence of stunned or killed fish at the site of marine piling. All sightings are to be reported as per the MNMP. • If significant fish kill is observed, consider use of absorbent material to dampen hammer blows and/or use of bubble curtains.	Minor Adverse
Impact of release/spill of hydrocarbons	Minor Adverse	• Ensure that a fuel spill contingency plan is in place and that workers are trained in how to implement it. • Ensure that all fuel is stored within an impermeable base and that stores greater than 200 L are stored within a bunded area capable of containing 150% of the stored volume.	Negligible

Construction Phase Impact	Impact Significance	Mitigation Summary	Residual Impact
		• Ensure spill kits (absorbent materials) are strategically located on marine vessels. • An oil boom of suitable length to fully enclose offshore vessels should be available on site and staff and vessels required to deploy it should be trained and available 24-hrs a day.	
Marine Sediment and Water Quality			
Contamination of waters by copper and arsenic during piling	Negligible	• If materials are to be disposed on land, conduct additional testing of sediments as per Ministerial Order No. 3 of 2006 (i.e. toxicity characteristic leaching procedure).	Negligible
Contamination of seabed by copper and arsenic during piling	Negligible	• None required.	Negligible
Impact of sediment loading during piling	Negligible	• Contractor is to prepare a Marine Water Quality Management Plan (MWQMP). • Contractor to conduct monitoring for total suspended solids as per the MWQMP.	Negligible
Impact of spills of hydrocarbons	Negligible	• Adhere to Tactical Response Plan (TRP). • Refuelling of vessels to take place at correct facilities. • Fuel/oil stored on deck to be lashed to prevent spills. • Fuel less than 200 l to be stored in drip trays. • Clean spills immediately with absorbent material. • Oily rags, etc. to be disposed of appropriately (do not dispose in the sea).	Negligible
Occupational Health and Safety			
General construction and demolition activities – terrestrial	Major to Minor	• Development of a Project HSE Plan for demolition/construction. • Project HSE Plan to consider existing Alba operations at marine terminal. • Auditing of all sub-contractors against compliance with Project HSE Plan. • Training and awareness of workers regarding occupational safety issues on site. • Continuously monitor worker performance. • Provision of safety facilities, emergency equipment, and first aid facilities	Negligible

Construction Phase Impact	Impact Significance	Mitigation Summary	Residual Impact
		together with personnel trained in its use. • Provide PPE as appropriate for tasks undertaken. • Ensure the contractor specification adequately covers the assessment of risk of their employees for all construction activities, such as in a Construction Code of Practice (e.g. safe use of vehicles on construction sites). • Continuous provision of drinks and sheltered/shaded areas for labourers, especially during the summer months to avoid heat stress. • Preparation of Emergency Response Plan to cover working in close proximity to existing plant and machinery. • Operate a permit to work system as applicable.	
General construction activities - marine	Major to Minor	• Development of a Project HSE Plan for marine construction operations. • Project HSE Plan to consider existing Alba operations at Jetty 1 and 2. • Auditing of all sub-contractors against compliance with Project HSE Plan. • Training and awareness of workers regarding occupational safety issues on site. • Provision of safety vessel with appropriately trained rescue personnel. • Provision of life-saving equipment, e.g. flotation devices, life buoys, life hooks) together with personnel trained in its use. • Provision of first aid facilities together with personnel trained in its use. • Ensure the contractor specification adequately covers the assessment of risk of their employees for all construction activities following guidance such as OSHA Working Over or Near Water. • Emergency Response Plan. • Operate a permit to work system as applicable.	Negligible
Traffic and Access			
Demolition traffic	Short-Term Significant	• Preparation and implementation of a TMP.	Not Significant

Construction Phase Impact	Impact Significance	Mitigation Summary	Residual Impact
Construction traffic	Not Significant		Not Significant
Transport of oversized loads	Not Significant		Not Significant
Waste Management			
Demolition waste	Minor Adverse	• Implement a demolition phase waste management plan. • Proactively manage waste. • Segregate waste at source to maximise recycling and reuse opportunities. • Manage waste responsibly - maintain Duty of Care.	Negligible.
Construction wastes	Minor Adverse		Negligible

Table 15.2 Operation Phase Management and Mitigation Requirements

Operation Phase Impact	Impact Significance	Mitigation Summary	Residual Impact
Air Quality			
Additional Shipping Emissions	Negligible	Implement Ports, Harbours and Terminals general EHS Guidelines, as relevant and appropriate.	Negligible
Additional Road Transport Emissions	Negligible	Not required.	Negligible
Nuisance Dust Emissions	Not yet determined.	A fugitive dust assessment is being carried out.	Supplementary dust monitoring report will be prepared.
Community Health, Safety and Security			
Management of security personnel	Negligible	• Use of licenced, background checked and trained security personnel.	Negligible

Operation Phase Impact	Impact Significance	Mitigation Summary	Residual Impact
Geology and Hydrogeology			
Impact on groundwater resources	None	• None required.	None
Marine and Coastal Ecology			
Habitat creation through jetty expansion (artificial reef)	Minor Beneficial	• None required.	Minor Beneficial
Marine Sediment and Water Quality			
Impact of spills to the marine environment during port operation from the jetties or ships	Major to Minor Adverse	• Preparation of a Tactical Response Plan.	Negligible
Occupational Health and Safety			
Port operation	Major to Minor	• Preparation of Health and Safety plan and codes of practice specific to the Port. • Health and Safety plan to include marine rescue plan in the event of personnel falling into the sea. • Training and awareness of workers regarding occupational safety issues on site. • Provision of safety facilities, emergency equipment, and first aid facilities together with personnel trained in its use. • Provide PPE as appropriate for tasks undertaken. • Continuous provision of drinks and sheltered/shaded areas for staff, especially during the summer months to avoid heat stress. • Preparation of Emergency Response Plan to cover working in close proximity to existing plant and machinery. • Operate a permit to work system as applicable.	Negligible
Shipping	Major to Minor	• Alba should send a HSE pre-qualification questionnaire to the shipping companies and this should be included as part of the qualification criteria. • Feedback on the performance of the contractor should be obtained by Alba's Safety, Health and Environment team.	Negligible

Operation Phase Impact	Impact Significance	Mitigation Summary	Residual Impact
Traffic and Access			
Increase in operational trucks	Significant	• Development of a specific Traffic Management Plan for operation.	Not Significant
Waste Management			
Operation wastes	Minor Adverse	Prepare specific Port Waste Management Plan.	Negligible

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APPENDIX 1A

Project Standards

Appendix 5A

Stakeholder Correspondence

Appendix 5B

Minutes of Meetings

Appendix 11A

Sediment and Water Results and Data Sheets

Appendix 11B

Tactical Response Plan

Appendix 13A

Preferred Route for East Sitra Link Road