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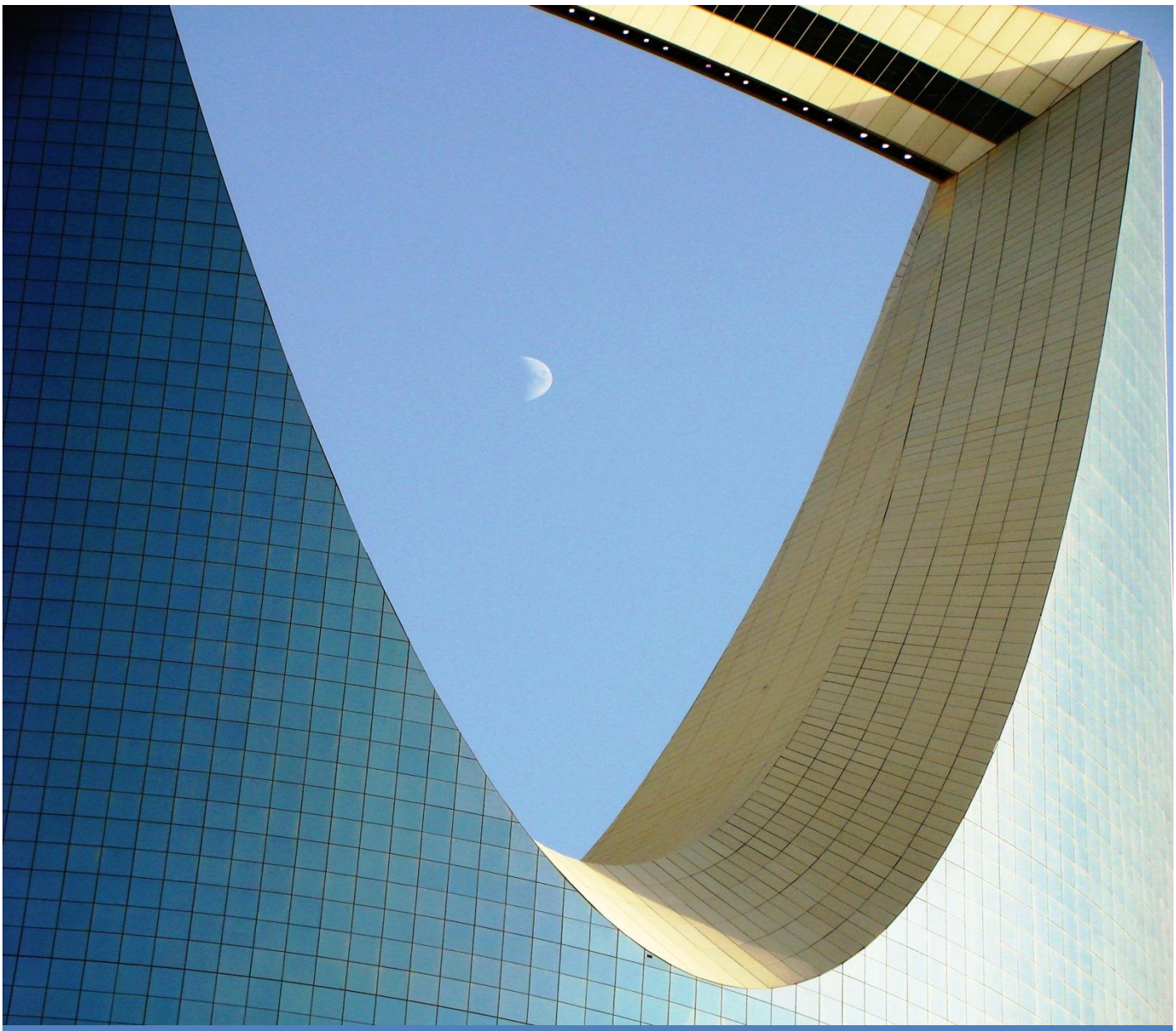
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WSP

RIYADH POWER PROJECT 13 COMBINED CYCLE POWER PLANT, KINGDOM OF SAUDI ARABIA

Environmental and Social Impact Assessment

Prepared for the Saudi Electricity Company

16/04/2015

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Riyadh Power Project 13 Combined Cycle Power Plant, Kingdom of Saudi Arabia

Environmental and Social Impact Assessment

16/04/2015

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Acronyms

Acronym	Definition
ASL	Arabian Super Light
AQS	Air Quality Standard
BAT	Best Available Techniques
BOO	Build , Own and Operate
CEMP	Construction Environmental Management Plan
CGT	Combustion Gas Turbine
CO	Carbon Monoxide
CO_2	Carbon Dioxide
dB	Decibel
ECD	European Council Directives
ECP	Environmental Control Plans
EHS	Environment, Health And Safety
EIA	Environmental Impact Assessment
ESIA	Environmental and Social Impact Assessment
EMSP	Environmental Management System Procedures
EPFIs	Equator Principle Financial Institutions
ESF	Electrical substation Facility
FGD	Flue Gas Desulfurization
GDP	Gross Domestic Product
GER	General Environment Regulations
GHG	Greenhouse Gases
GT	Gas Turbine
HDI	Human Development Index
HFO	Heavy Fuel Oil
HGV	Heavy Goods Vehicle
HRSG	Heat Recovery Steam Generator
IFC	the International Finance Corporation
IUCN	World Conservation Union
IPP	Independent Power Plant
kV	Kilo Volts
KSA	Kingdom of Saudi Arabia
MAW	Ministry of Agriculture and Water
MBD	Million Barrels per Day
MEED	Middle East Business Intelligence
m	Meter

Acronym	Definition
MSL	Meter Above Sea Level
MW	Mega Watts
NO_2	Nitrogen dioxide
OECD	Organization for Economic Cooperation and Development
OEMP	Operation Environmental Management Plan
OP	Operating point
PCOD	Project Commercial Operation Date
PEA	Preliminary Environmental Assessment
PME	Presidency Of Meteorology and Environmental
PM	Particulate Matter
PP13	Power Project 13
RFP	Request For Proposal
SCR	Selective Catalytic Reduction
SEC	Saudi Electricity Company
SO_2	Sulphur Dioxide
STG	Steam Turbine Generator
ToR	Terms of Reference (as in, Environmental Impact Assessment Terms of Reference)
U.S EPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds
WB	World Bank
WHO	World Health Organization
WWF	World Wildlife Fund

Executive Summary

WSP Middle East (WSP) has been commissioned by the Saudi Electricity Company (SEC, the project proponent) to provide an Environmental and Social Impact Assessment (ESIA) for the proposed Power Project 13 Combined Cycle Power Plant 13 (PP-13), located approximately 110km to the west of Riyadh, the capital of the Kingdom of Saudi Arabia (KSA).

The PP-13 facility will be a combined cycle power plant consisting of F-Class gas turbines with a nominal capacity of 140 to 170 MW each (at rated site conditions), and capable of operating in both simple cycle, and combined cycle modes, utilising Heat Recovery Steam Generators (HRSG) and steam turbine generators (STG) together with auxiliary plant equipment. The range of nominal plant output is to be 1800 MW at +/- 10% at reference site conditions.

This report is primarily concerned with the identification and assessment of the social and environmental impacts associated with PP-13. However, in addition, it considers the cumulative impacts associated with the adjacent operational IPP-11 facility, and the PP-12 facility, which is currently under construction; both of which are combined cycle plants adjacent to the Project site. Where significant social and environmental effects have been identified, appropriate mitigation measures have been developed for implementation during both the construction and operational phases of the Project. The results of the assessment have also been used to identify a detailed monitoring programme, which is summarised below.

The key findings and conclusions of the ESIA are provided in the sections below:

Air Quality

The impact of Riyadh PP-13 Combined Cycle Power Plant on local air quality has been assessed. A complex dispersion model (Aermod) was used to predict ground level concentrations of NO_2, SO_2 and PM_{10} over a 15 km by 15 km area and at various discrete receptor locations, including residential locations, within this area.

Concentrations of SO_2, NO_2 and PM_{10} were predicted for the baseline conditions at the time the PP-13 would come into operation, with dispersion modelling used to predict concentrations for PP-13 operating in isolation, as well as operating with all the existing sources in the power plant complex (i.e. PP-11 and PP-12).

GHG emissions from PP-13 have been estimated using emission factors for CO_2 and methane published by the IPCC for GHG emissions.

The results of the dispersion modelling for PP-13 process contributions only shows that under normal operating conditions for the power plant (combined cycle on Sales Gas) and simple cycle operating conditions (on Sales Gas) the plant would have a minor residual impact on local air quality at the point of maximum impact for NO_2. No exceedances of the PME AQSs for pollutants were identified at sensitive receptor locations.

The modelling showed that in emergency or abnormal operating conditions, exceedances of NO_2 and SO_2

are likely to be significant at the point of maximum impact and that exceedances of the PME AQS and IFC Guideline for 1-hour NO_2 and IFC Guideline for 10-minute mean SO_2 concentrations could potentially occur in off-site locations. Regardless of the low probability of occurrence, the exceedances are predicted to occur in an area with no sensitive receptors present.

However, the concentrations are predicted to decrease rapidly with distance from the source and no exceedances are predicted to occur at off-site sensitive receptors even under these worst-case conditions. It is therefore considered that areas where potential exceedances are predicted to occur under emergency or abnormal conditions would be considered a dispersion zone in accordance with the provisions of the PME National Environmental Standard. However, health and safety impacts upon operational workers are a concern in this regard and therefore continuous ambient air quality monitoring throughout the operational phase has been recommended.

Modelling of the Riyadh PP-13 Power Plant emissions in conjunction with the two power plants (IPP-11 and PP-12) showed that under normal operating conditions, no exceedances of the respective PME AQSs or IFC Guidelines were predicted for the pollutants considered and all concentrations were well below the standards.

The maximum predicted pollutant concentrations for PP-13 operating under emergency or abnormal conditions (i.e. on ASL) were not exacerbated by the emissions from the existing two plants.

Whilst the assessment showed that exceedances of the PME AQS and IFC Guideline for 1-hour mean NO_2 concentrations and the IFC Guideline for 10-minute mean SO_2 concentrations were likely to occur over a larger area under emergency/abnormal operating conditions, no exceedances were predicted to occur at any off-site sensitive receptor locations.

Due to limited availability of detailed design information, it was necessary to apply a number of assumptions to the dispersion modelling methodology. Once further detailed design information becomes available, it is recommended that this data is compared against the input data used to determine the requirement, or otherwise, for re-modelling of emissions and identify any further mitigation or abatement measures required.

Noise and Vibration

An assessment of the potential noise and vibration effects of the PP-13 during both construction and operation has been undertaken, including an estimation of baseline noise levels. Assessments of the suitability of the site for industrial development were also conducted.

During all construction activities the overall noise effect is unlikely to be significant beyond 110 m from the main work site. Impacts at the existing workers accommodation are therefore likely and a mitigation measure specifying the requirement to relocate the accommodation premises has been provided. Construction traffic has the potential to give rise to a moderate impact in the town of Dhurma if construction HGV movements are significant. Compliance with construction noise guidelines according to the KSA standard is however predicted. Measures to minimise construction noise and vibration levels from the development have been proposed, if deemed necessary.

Noise and vibration effects from the operation and traffic associated with the operation will be negligible. During the detailed design and construction phase of the project, regard will be given to the necessity of

mitigation measures and where appropriate such measures will be adopted. This will ensure satisfactory internal and external noise levels at accommodation proposed north of the application site.

Waste and Hazardous Materials

An assessment of waste management issues has been undertaken as part of the ESIA, which has identified the management and disposal of hazardous wastes as the key issue.

Appropriate control measures for waste storage, handling and transport during the construction and operational phases have been provided following a consideration of waste generation estimates and waste management protocol and facilities in the KSA.

Overall, it is considered that the Project should be able to limit pressures on the existing waste management infrastructure in the surrounding region and reduce the potential for contamination occurring by following good practices, which should be implemented through the EHS document and a site specific Operational Environmental Management Plan.

Soils, Geology and Contamination

A Phase II investigation is not considered necessary for the proposed project at this stage as no localised contamination was identified during the site reconnaissance, undertaken in February 2013 and December 2014. However, it is highly recommended that any contaminated materials, including soils, are considered as hazardous waste if encountered during excavation activities and disposed of in a licensed landfill site by an appropriately licensed contractor. Notwithstanding the above, intrusive investigations will need to be enacted if additional significant pollutant sources or contaminations through accidental releases are identified prior to or during the site preparation works.

During the construction and operational phases of the project, there is a potential for workers and visitors to come into contact with contaminated land and hazardous or semi-hazardous wastes, as well as the potential for leaks and spills to adversely affect the wider environment. Control measures have been recommended to minimise the potential for these negative environmental and social impacts.

Water Resources and Wastewater

During construction and operation, the potential exists for impacts to occur to the soils and groundwater and site workers as a result of the generation of different streams of waste water from the Project. However, the construction and operational impacts that have been identified are those that, with good on site and off site environmental management practices, can be relatively easily avoided or mitigated.

Recommendations and mitigation detailed within this assessment, including monitoring and testing of all discharges to the evaporation/holding ponds are designed to ensure compliance with EPA and IFC effluent discharge guidelines, in addition to guidance set out within the IFC Environmental Health and Safety Guidelines for Water and Sanitation (2007).

Terrestrial Ecology

An assessment of the potential impacts upon terrestrial ecology of the Project site and surrounding area has been undertaken based on the site reconnaissance undertaken in February 2013 and December 2014. An assessment has been made of the status of the existing terrestrial ecology on the proposed Riyadh PP-13 site and applicable approaches to mitigate or minimise any potential negative impacts of this development have been provided.

The existing site was found to be of very low ecological 'value'. The overall construction impacts on the terrestrial ecology are therefore thought to be negligible, whilst, the operational impacts (e.g. landscaping) will be of a minor positive significance.

Socio Economic Issues

An assessment of the potential social effects of the Project has been undertaken. The key aspects highlighted relate to the health and safety and welfare of construction workers and the health and safety of operational staff and nearby mobile camel farmers. With the adoption of suitable control measures, including health and safety plans and in the case of construction workers measures to ensure their social wellbeing, it is predicted that the potential impacts will be reduced to acceptable levels.

It is generally thought that the development of the PP-13 facility will have a positive impact on the local economy, particularly in terms of local job creation. In addition, it will be the responsibility of the EPC contractor to develop a comprehensive Environmental Management Plan specific to the construction and operation of the PP-13 facility.

One risk item was identified in relation to the potential exposure of operational workers to elevated levels of NOx during operation under abnormal conditions when utilising back-up fuels. A programme of monitoring and mitigation (if required) should be developed to ensure that during such periods, workers are not exposed to dangerous NOx levels.

No significant impacts identified at sensitive noise receptor locations.

The positive impact on the local economy is particularly pertinent to Dhurma since it is recognised that there has been a significant migration of the local community to Riyadh where there are more job opportunities. The proposed facility would, therefore, represent a positive employment option which may draw prospective residents back to the region.

Cultural, Heritage and Archaeology

The assessment has identified that there are no sites of cultural or heritage significance in the local area. It is also considered that there is a low risk of buried archaeological remains. However, an archaeological watching brief is recommended during excavations and other site preparation works. Should any potential artefacts and/or resources be discovered at any time, all responsible parties will to ensure that works are curtailed immediately within that area and experts consulted.

Landscape and Visual

The proposed PP-13 site is located in a remote and isolated desert landscape, which represents little or no visual amenity. In addition, no sensitive receptors with the exception of the residential units associated with the IPP_11 located within the footprint area of this facility, have been identified and the landscape and visual impacts have therefore been considered low throughout both construction and operational phases.

Traffic and Transportation

Due to the isolated nature of the Project Site, and in the absence of traffic data, a review of potential traffic impacts has been made and best practice mitigation measures presented. With a relatively low increase in traffic due to the construction and operation of the Project, combined with the existing capacity of Highway 505, the impact of traffic and transportation is considered to be low.

1 Introduction

1.1 Background

WSP Middle East (WSP) has been commissioned by the Saudi Electricity Company (SEC, the project proponent) to provide an Environmental and Social Impact Assessment (ESIA) for the proposed Combined Cycle Power Plant 13 (PP-13), located approximately 110km to the west of Riyadh, the capital of the Kingdom of Saudi Arabia (KSA).

The PP-13 facility will be a combined cycle power plant consisting of F-Class gas turbines with a nominal capacity of 140 to 170 MW each (at rated site conditions), and capable of operating in both simple cycle, and combined cycle modes, utilising Heat Recovery Steam Generators (HRSG) and steam turbine generators (STG) together with auxiliary plant equipment. The range of nominal plant output is to be 1800 MW at +/- 10% at reference site conditions.

This ESIA has been prepared for the PP-13 facility by WSP as part of the Presidency for Meteorology (PME) approval process. As the first step in this permitting process, a Preliminary Environmental Assessment (PEA) was issued to the PME setting out a clear terms of reference (ToR) for this ESIA.

At this stage the Engineering, Procurement and Construction Management (EPCM) includes SEC and Worley Parsons, while the Site Construction Contract is currently under Tender. This ESIA has therefore been developed on the basis of the Request for Proposal developed by SEC. This identifies the key characteristics of the power plant, which has been used as the basis for the assessment. The ESIA has also therefore been designed to provide information to SEC on any requirements for changes in design to mitigate potentially significant environmental impacts and to determine the environmental management requirements during the construction and operational phases of the project. In this regard, the ESIA has assessed compliance against the following requirements:

- The Presidency of Meteorology and the Environment's 'General Environmental Regulations' (GER 2001), the principal environmental legislation in Saudi Arabia, including any pertinent revised standards released by the PME in 2014; and
- The Equator Principles and the International Finance Corporation (IFC) Performance Standards, General EHS Guidelines and Sector Specific EHS Guidelines should the project require international funding.

It should however be noted that there may be an additional requirement for the Contractor, once appointed, to undertaken additional environmental studies and assessments to ensure that the actual equipment and technologies proposed to be utilised meet the requirements of the above.

1.2 Overview of the Project

SEC intends to develop the PP-13 combined cycle power plant within a greenfield site situated adjacent to the operational Independent Power Plant 11 (IPP-11), and the Power Project 12 (PP-12), which is scheduled to become operational and is located approximately 800 metres west from the Project site. Both of these

plants are gas fired combined cycle facilities. The Project site is located in a wide valley known as Al-Batin, approximately 110 kilometres (km) west from the capital city of Riyadh, within the Kingdom of Saudi Arabia. The site road is about 31km from the nearest town: Dhurma. with the Project site itself located about 25km west from Route 505. Dhurma has a population of approximately 15,000 residents; whilst the larger town of Muzahmiyya located approximately 75km southeast of the Project site supports a population of approximately 25,000 inhabitants.

As discussed above, SEC is currently in the process of appointing a contractor for the project. This contract requires that the Riyadh PP-13 is designed, constructed and operated in accordance with the environmental and social requirements of the PME.

1.3 Project Justification

The demand for electricity in Saudi Arabia has increased dramatically over the past decade. Power consumption is set to continue to increase with SEC forecasts indicating that power usage will increase to 50,074 MW by 2012 and to 75,155 MW by 2020 (MEED, 2010). The power industry is a strategic industry in Saudi Arabia and has ensured the continued economic development and industrial diversification in the Kingdom.

Faced with a fast-growing population and an expanding industrial base, SEC has begun a phased programme for bringing new power stations online through private sector investment. There are four projects in the first phase of the programme, whose total required investment is expected to reach over SR 25 billion, including: Riyadh IPP-11 and PP-12, Qurayyah IPP1, Riyadh PP-10, and Riyadh PP-13 which is the subject of this ESIA.

The power and water project programme also includes the following projects: the Dheba IPP 1800 MW steam plant, the Dheba CGT / renewable project and additional planned projects currently under finalisation by SEC.

1.4 Scope of Work for the ESIA

1.4.1 Introduction

The approach adopted for compiling the ESIA is consistent with the approach set out within the Preliminary Environmental Assessment and Terms of Reference (PEA and ToR) completed by WSP in October 2014 (1). The approach follows guidance set out within the GER (2001/2006), the Equator Principles, and the relevant International Finance Corporation guidance.

1.4.2 Scoping Phase

ESIAs typically consist of two main phases, namely the Scoping and Impact Assessment Phase. WSP completed the Scoping Phase as part of the pre-bid work on the Project, which comprised of the completion of the PEA and ToR as described above.

The Scoping Phase identifies the social and environmental issues that are likely to be of most importance, and eliminates ('scopes out') those that are of relatively little concern. In this way, the Impact Assessment Phase can focus on the more significant issues, thus optimising the use of time and resources.

The PEA and ToR identified a number of primary and secondary environmental issues relating to the construction and operation of the PP-13 facility. Primary issues are those that are of crucial importance to the project and are typically where a sensitive receptor (or receptors) has been identified and the potential impact is of a significant magnitude. Secondary issues include impacts of a lesser magnitude, where a sensitive receptor is absent or unlikely to be significantly affected and / or the potential impact can be easily mitigated.

The primary identified issues are:

- Air quality; and
- Environmental noise.

The secondary issues are considered to be:

- Waste management;
- Soil and groundwater;
- Water and wastewater;
- Socio-economic issues;
- Terrestrial ecology;
- Archaeology and cultural heritage;
- Landscape and visual; and
- Traffic and transportation.

Further, as the project is located in an area which already contains one operational power facility : IPP-11 in addition to PP-12, which is under construction, establishing the cumulative impacts of all facilities will be of crucial importance in order to properly understand the current and future pressures upon the environment. This is specifically relevant to primary environmental issues such as in relation to the modelling of air quality impacts. The key Findings of the PEA and ToR were as follows:

- Air Quality Impacts: a detailed cumulative assessment of air quality impacts resulting from the construction and operation of PP-13 taking into account both the existing IPP-11 and proposed PP-12 is required. This assessment is to include stack-height analysis to determine the optimum stack height for the PP-13 facility, together with detailed air quality modelling; and
- Noise: a detailed noise assessment is required to predict the impacts of both construction and operation of the PP-13 facility in cumulation with IPP-11 and PP-12.

Other impacts identified within the PEA and EIA ToR include:

- Waste Management: Determination of waste volumes and types during construction and operation; and the development of appropriate management measures including waste reduction, re-use and recycling

and the measures required as part of waste management legislation and requirements in the KSA;

- Socio-economic: A desktop socio-economic assessment is required with the key information incorporated into the social and economic assessment;
- Soil and Groundwater: the undertaking of a Phase I (non-intrusive) Assessment to identify the presence of existing surface contamination on site;
- Terrestrial Ecology: a survey of the site and the surrounding area in order to characterise any extant terrestrial habitat in terms of flora and fauna and to determine any ecological value.
- Cultural Heritage and Archaeology: a survey and review of existing information to determine any features of potential archaeological or cultural heritage significance within the site or the surrounding area/s;
- Landscape and Visual: a baseline survey of the project site and the surrounding areas to establish the existing landscape character areas; and,
- Traffic and Transportation: an assessment based upon the anticipated traffic volumes associated with the construction and operational phases of the project.

1.5 Structure of the Report

As noted above, the ESIA report has been prepared in accordance with the specific requirements of PME, and also references IFC Performance Standards and other international best practice where appropriate. The ESIA specifically addresses the issues determined within the PEA and ToR.

PME guidelines for compiling EIAs are stated in Appendix 2.4 of the GER (2001/2006). In relation to PP-13, the regulations specify that the ESIA will be structured as follows:

- Justification and presentation of the project;
- Description of the project and its objectives;
- Baseline status of the surrounding environment including the following:
  - Air quality;
  - Soil and topography;
  - Surface and ground water;
  - Land environment (fauna/flora);
  - Land use of selected site and its surroundings; and,
  - Land ownership.
- Identification of the general, potential impacts of the project and suggested alternatives;
- Identification and analysis of key effects of the project on air quality, surface-and-groundwater, flora and fauna, land use and urban development, residential clusters and general scenic view.
- Assessment of significant impacts, which will:

- Quantify and rate the significant impacts on natural resources;
- Estimate the relative damage to the area and the extent of potential damage;
- Estimate the lifespan of the facilities;
  - Study the possible mitigation of anticipated impacts; and
  - Provide a summary of the significant (residual) impacts after mitigation.

It has been determined that the following IFC Performance Standards may also apply to the Project:

- Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts;
- Performance Standard 2: Labour and Working Conditions;
- Performance Standard 3: Resource Efficiency and Pollution Prevention;
- Performance Standard 4: Community Health, Safety and Security;
- Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources; and
- Performance Standard 8: Cultural Heritage.

The exact structure of the ESIA report is as follows:

- Executive Summary;
- Chapter 1 - Introduction;
- Chapter 2 - Project Description;
- Chapter 3 - Legislative Framework and Standards;
- Chapter 4 - Project Site Overview;
- Chapter 5 - Impact Assessment Methodology;
- Chapter 6 - Air Quality;
- Chapter 7 - Noise and Vibration;
- Chapter 8 - Water Resources and Wastewater;
- Chapter 9 - Soil and Geology;
- Chapter 10 - Waste Management;
- Chapter 11 - Terrestrial Ecology;
- Chapter 12 - Socio-Economic Analysis;
- Chapter 13 - Traffic and Transportation;
- Chapter 14 - Landscape and Visual Amenity;
- Chapter 15 - Cultural Heritage and Archaeology;

- Chapter 16 - Impact Assessment and Analysis Summary;
- Chapter 17 - Framework Environmental Management Plan;
- Chapter 18 - Framework Operational Environmental Management Plan;
- Chapter 19 - Conclusions and Recommendations; and
- Appendices.

Chapters 2 - 4 provide a description of Project Site, detail the legislative and policy framework and provide a detailed description of the Project, which has formed the basis for the assessment of environmental impacts.

Chapter 5 provides the methodology for the assessment of impacts which has been undertaken in the following technical chapters.

Chapters 6 - 15 then present the results of the impact assessment for each of the technical areas considered.

Following the assessment of impacts, Chapter 16 provides a summary of all impacts identified as part of the assessment process, a summary of mitigation measures and the residual impacts which will result following the implementation of mitigation measures.

All mitigation measures which have been identified as part of the technical assessments (Chapters 6 - 15) as being required in order to offset any potentially significant environmental effects are then set out in full in Chapters 17 and 18. Chapter 17 provides a framework for the development of a Construction Environmental Management Plan (CEMP) through the provision of appropriate environmental controls to be implemented during the construction phase of the project. Chapter 18 provides a framework for the development of an Environmental Management System (EMS) once the Project becomes operational.

Chapter 19 provides the conclusions and recommendations of the study.

1.6 The Project Team

Table 1-1 below, notes the main project team members and their respective contribution associated with the compilation of this report:

Table 1-1: The project team

Name	Responsibility	Area of Expertise
Edward Crowley	Project Director	ESIA and Environmental Management
Anna Blackwell	Technical Delivery	ESIA
Janos Tsakiris	Specialist	Acoustics and Vibration
Morgan Perret	Specialist	Environmental Management
Hassan Ktaech	Specialist	Waste Management
Paul Day	Specialist	Atmospheric Emissions and Modelling

2 Project Description

2.1 Introduction

The Saudi Electricity Company (SEC) intends to develop the Riyadh PP-13 combined cycle plant within a 'greenfield' site situated adjacent to the existing operational IPP-11 plant and approximately 800m metres east from the PP-12 plant which is currently under construction, as illustrated by **Figure 2-1** below:

The PP-13 facility will be a combined cycle power plant consisting of F-Class gas turbines with a nominal capacity of 140 to 170 MW each (at rated site conditions), and capable of operating in both simple cycle, and combined cycle modes, utilising Heat Recovery Steam Generators (HRSG) steam turbine generators (STG) together with auxiliary plant equipment to provide a combined cycle (CC) power plant.

PP-13 is to be designed to have a net plant output of 18,00MW (megawatts) +/- 10% at reference conditions.

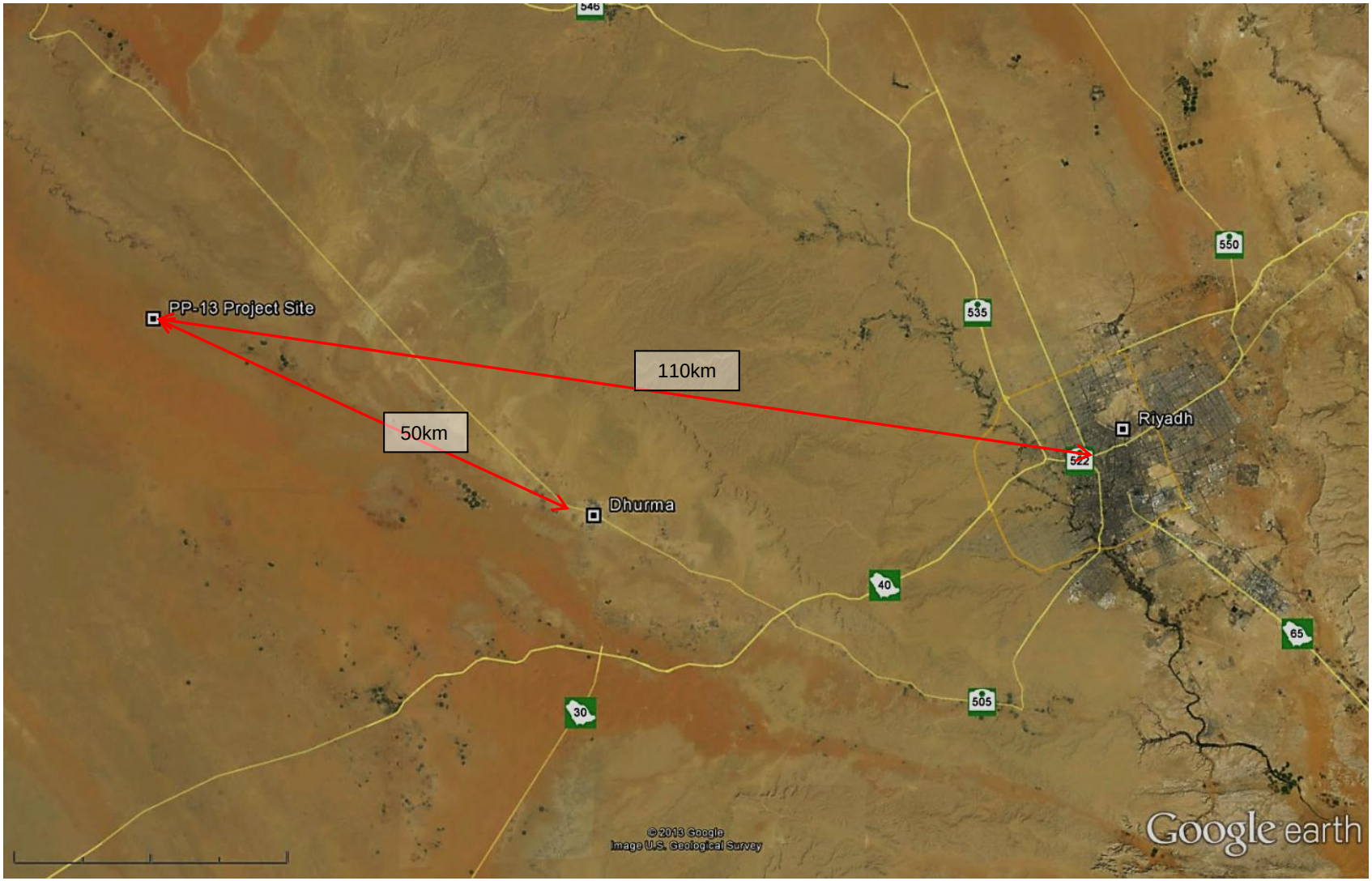


Figure 2-1: Project site location

2.2 Project Scheduling

The anticipated start date for construction of the PP-13 Project would be around April – May 2015, while site preparation works have started in June 2014. It is anticipated that the commissioning period would be completed by December 2016.

2.3 Basic Design Requirements for Riyadh PP-13

The basic design requirements for the PP-13 facility are detailed within '*Saudi Electricity Company: PP-13 Riyadh Combined Cycle Power Plant – Schedule B, Attachment III'*. The electrical capacity of the plant will be based on gas and steam turbine technology, with corresponding heat recovery steam generators (HRSGs).

The plant will consist of two (2) independent combined cycle gas turbine (CCGT) groups with individual air cooled condensers (ACC), individual closed cooling water system and wet surface air coolers, and common plant auxiliary systems including water treatment plant, fuel special facilities (FSF), electrical special facilities (ESF) and common plant ancillary systems. All plant equipment will be adequately designed to ensure efficient operation between a range of -5°C and + 50°C.

The Gas turbines (GT), HRSGs, and Steam Turbine Generator Units (STG) and all ancillary equipment will be constructed as a combined cycle (CC) power plant, whilst the GT will retain the ability to operate as simple cycle units in the event there are operating problems with the combined cycle portion of the plant. Each GT shall exhaust into its own HRSG.

The power plant will consist of six GTs and two STG units and the plant output is to be 1,600-1,900MW.

In accordance with the requirements of the RFP[1], the following elements are required for inclusion within the plant design:

- Indoor Class (F) Gas Turbine Generator Units and their associated auxiliaries.
- Exhausts system including ducting, by-pass and exhaust stacks diverter damper, etc.
- Vertical/horizontal heat recovery steam generating (HRSG) units with natural circulation and associated auxiliaries, including main exhaust stack.
- Boiler feed water pump system and their associated auxiliaries.
- Indoor Steam turbine and generator units and their associated auxiliaries.
- Air Cooled Condensers and their associated auxiliaries.
- Closed Circuit Cooling Water Systems and their associated auxiliaries.

[1] Saudi Electricity Company: PP-13 Riyadh Combined Cycle Power Plant – Schedule B, Attachment III

- Continuous emission monitoring system and their associated auxiliaries.
- Raw water system and its associated auxiliaries and storage including supply pipeline.
- Water Treatment Plant inclusive of Two Pass Reverse Osmosis (RO) plant and resin based mixed bed Demineralization Plant.
- Bulk Chemical Storage System.
- Water wash system for Gas Turbine, HRSG & Air Condensers and disposal system.
- Laboratory with all necessary devices and equipment, apparatus, etc.
- Local sampling racks at each block.
- Fire pump station and associated auxiliaries.
- Fire water storage tanks.
- Service water storage tank.
- Potable storage tank.
- Demineralised water storage tanks.
- Water supply and make-up system.
- Emergency start diesel generators and associated switchgear.
- Main control room, local rooms, fuel gas control room.
- Liquid Fuel oil (Arabian Super Light “ASL” and diesel oil) storage tanks.
- Fuel oil treatment and forwarding system.
- Fuel additive storage and forwarding system.
- H_2 plant and storage (if applicable).
- Nitrogen storage.
- CO_2 storage (if applicable).
- Gas heating system.
- Gas filtration system.
- Gas pressure control (reduction) skid.
- Gas compression station.
- 380KV, MV, LV, control, fiber optic cables.
- Cathodic Protection System.
- Trenches (cables & pipes), duct banks & cable trays and cable tunnels.
- MV/LV Bus Ducts (IPBS & Segregated).

- Generators circuit breaker (52G) and accessory compartments.
- System circuit breakers (52S) and accessory compartment
- Earthing and lightning protection system.
- Protective relaying and metering system.
- Fire Protection and Detection System.
- Compressed Air System (instrument air & service air).
- Heating Ventilation and Air Conditioning (HVAC) System
- Cranes and Hoists.
- HRSG elevator.
- Bulk lubrication oil purification & storage system for steam turbines.
- Generator Step-Up Transformers 18 kv /380 kv and on line condition monitoring system.
- Unit AC auxiliary power supply systems (transformers, switchgear, MCC) and on line condition monitoring system.
- Plant AC auxiliary power supply systems (transformers, switchgear, MCC) and on line condition monitoring system.
- DC power supply including batteries and UPS (Plant & Unit).
- Instrumentation & Controls works as described and specified including DCS, CCR and LCR facilities including Large Screen Display and Operator Engineering Workstations, Fire and gas detection and protection system interface with DCS, HVAC monitoring system, Site security and CCTV system, Cyber protection system, alarm management system, DCS interface with third party I&C and PLCs,.
- All local and field instrumentation suitable for the specified process, including associated pipe work, tapings, thermo wells, control, isolation valves and dampers, local equipment housings, gauges, cabling (including special cables, fiber optic cables) etc.
- Complete monitoring, control and protection for GTs, HRSGs, STGs and auxiliaries from Central Control Room (CCR) & Local Control Room (LCR), including steam and water systems, demineralized water plant, service and potable water systems, chemical dosing systems, instrument and service air systems, hydrogen generation and storage plant, waste water and effluent systems, common services and all auxiliary equipment. Plant performance monitoring equipment for the gas turbines, combined cycle block and overall plant.
- Gas turbine starting system.
- Emergency Shutdown system for each unit power block
- Fuels and electrical metering systems

- Condition monitoring system and Vibration monitoring equipment.
- Fuel System and Tank Inventory Monitoring System
- IP Telephone system.
- Control and monitoring of electrical systems
- UPS for Plant Control System
- Communication system (Public address and inter-com system, mobile radio system, IT LAN network).
- Master clock and GPS synchronization system
- Continuous Emissions Monitoring System (CEMS)
- Weather station
- Training Simulator
- Process Information (PI) Centralized Historian System
- Plant Maintenance Nebras SAP-PM system
- Project Management Information System
- All Instrumentation and process Control for Gas Pipeline to power plant.
- SCADA & AGC system.
- Security fencing, lighting, surveillance cameras, patrol roads, crash walls.
- Lighting interior, exterior and yard.
- Civil works such as road, access roads concrete pavement.
- Evaporation ponds.
- Storm water system.
- Landscaping.
- Irrigation system.
- Sewage treatment system.
- Plant oily water and sludge drainage system, collection, treatment & disposal system.
- Plant waste water drainage system collection, treatment neutralization & disposal system.
- Gas Turbine Building.
- Steam Turbine Building.
- Air compressor building.
- Fire pump house.

- Emergency Diesel Generator building.
- Water treatment & demineralizer building.
- Central Control (Operations) Building.
- Local Control Building.
- Gas compression building.
- Fuel (sales) gas control room / building.
- Electrical buildings.
- Central & local sampling laboratory buildings.
- H_2 plant building.
- Annex buildings.
- Ware-house & outdoor storage area.
- Workshop (including machineries, Cranes and Hoist tools, benches & cabinets etc.) and all required services.
- Sun shades -unloading, forwarding, chemical dosing, H2 storage, N storage, CO2 storage, Gas heater, gas filtration, gas pressure reduction station, HP BFP, inside and outside power plant covered parking, water make-up & injection, covered storage area, chemical bulk storage, bulk lubrication oil.
- Owner/engineer offices.
- Plant Administration Building & Auditorium.
- First class furniture for plant offices & Auditorium with all necessary appliances, etc.
- Irrigation system.
- Gas fuel delivery system
- All other necessary component, systems, equipment and bulk material required to complete the project.

2.3.1 Gas Turbines

The GT units and associated equipment shall be designed to operate efficiently and in a satisfactory manner within an ambient temperature range of -5°C and 50°C. The turbine buildings are to be ventilated and designed to maintain a minimum temperature of +10°C (i.e. in the winter), and +5°C above ambient when ventilated (in the summer months).

The GT units are to be supplied with a complete multi-fuel supply system (sales gas and ASL), together with such items as high-pressure liquid fuel pumps, liquid fuel heating system, fuel drain system, sump tank, lubricating oil system pumps, tanks, filters, and coolers.

The primary fuel shall be sales gas, with ASL as secondary (back-up) fuel.

The GT and compressor section water wash system shall be supplied with the GT unit, and the system shall be supplemented with other systems such as, but not limited to, demineralised water supply, wash-water and overflow drains, a detergent loading points, electrical supply, and control interconnection, amongst others.

The generators will be a hydrogen cooled, direct-drive, 18kV, 3 phase, 3600 rpm, 2-pole, 60 Hz synchronous machines.

2.3.2 Heat Recovery Steam Generators and Steam Turbines

Each GT will exhaust to a designated HRSG unit, which will match the characteristics of operation to enable optimum performance for the entire plant power cycle.

The HRSG units will be fully integrated within the combined cycle system and designed in accordance with the requirements of ASME Boiler and Pressure Vessel Code (BP&PVC). Three pressure levels from GT waste heat will be generated by the HRSGs which will be located outside. The design life of each HRSG unit will be in excess of 30 years and each will be capable of 250 cold starts per year.

2.3.3 Operation Modes

The following operational modes are to be incorporated within the plant design:

- Full Load Case
  - 100% of total capacity under all site conditions.
- Partial Load Case
  - 60% - 100% of total capacity for combined cycle operation.
- Start-Up Case
  - A description is required for each individual GT, HRSG and STG start-up and shut-down scenario. Start-up fuel will be sales gas and distillate fuel.

Grid Failure Case

An island operation shall be maintained in anticipation of grid failure. It is required that the plant can be shut down safely within normal time frames specified by equipment manufacturers if necessary.

Operational Criteria

The plant will be required to operate continuously for the following operating scenarios set out in **Table 2-1**.

Table 2-1: Plant operational criteria

Item	Scenario A	Scenario B	Scenario C
Unit Operation	8,000hrs/year	5,500 hrs/year	4,000hrs/year
No. of normal starts/year required	10	100	250

2.3.4 Stack Height

From an environmental perspective, the following are of particular relevance:

- Exhaust gases shall exit each HRSG via a stack for each unit. The stack height shall be determined as per the Presidency of Meteorology and the Environment (PME) requirements, but shall be a minimum of 60m above the finished floor of the turbine building; and
- Stacks to be provided with separate ports for the provision of in-situ type Continuous Emissions Monitoring (CEMs) and for air emissions testing.

Note that a stack height analysis has been undertaken within **Chapter 6 – Air Quality** to confirm the height of the stack to ensure compliance with PME requirements, as per the RFP.

2.3.5 Bypass Stack

The by-pass stack for each GT's exhaust system is to meet the following requirements:

- Stack height: to be determined in line with the requirements of the Presidency of Meteorology and the Environment (PME) but shall be a minimum of 40m above the finished level floor of the turbine building; and
- Bypass stacks to be provided with separate ports for the provision of in-situ type CEMs and for air emissions testing.

2.3.6 Fuel Use and Storage

The Riyadh PP-13 must be designed to fire primarily on sales gas with Arabian Super Light (ASL) to be used as the secondary (back-up) fuel. The GT units are to be capable of starting on either sales gas, or via distillate oil as the starting fuel for ASL.

Each GT should be capable of operating continuously from the minimum to base load rating.

Gas Fuel Delivery System

The primary fuel, sales gas, will be delivered from the Saudi Aramco east-west high pressure gas transmission pipeline.

The installation of this system will include such required items as check metering and pressure regulation and will be housed in a fenced-in gas house, located at the south-east corner of the site.

ASL will be pumped from PP12 treated ASL tanks to PP13 ASL storage tanks. A fuel handling system will be installed to deliver fuel to the gas turbines at the required pressure. The ASL storage tanks at PP13 will have sufficient capacity to allow 72 hours operation of the plant

Typical fuel specifications for sales gas and ASL for back up fuel are provided below in **Table 2-2**.

Table 2-2: Sales gas (primary fuel) specifications

Component		Unit	Current (RFP Reference Gas	Low	High
CH_4 Methane		mole-%	83	80.85	80.7
C_2H_6 Ethane		mole-%	6.6	2.28	16
C_3H_8 Propane		mole-%	0.07	0.47	2.8
C_4H_{10} Butane		mole-%	0.5	0.14	-
C_5H_{12} Pentane		mole-%	0.5	0.04	-
C_6H_{14} Hexane		mole-%	0.5	-	-
N_2 Nitrogen		mole-%	6.4	13.77	0.5
CO_2 Carbon dioxide		mole-%	2.5	2.41	-
H_2S		--			
Specific Gravity @ 60°F, Air = 1		--	0.6098	0.55	0.65
Water Dew point		°C	--	-75	-55
Hydro Carbon Dew Point @ 39.2 bar(a)		°C	--	--	-5
HHV	Higher Heating Value	MJ/m³	40.215	34.529	46.217
		MJ/kg	46.445	40.841	53.843
		BTU/SCF	1080	930	1240
LHV	Lower Heating Value	MJ/m³	36.367	31.154	41.865
		MJ/kg	42.001	36.85	48.772
		BTU/SCF	976	836	1124
PGas	Gas Pressure	bar (g)	35	21	66
TGas	Gas Temperature	°C	50	15	65

Table 2-3: Diesel oil specification (back-up fuel)

Aramco Specification AL-18/Diesel Oil for Local Use		
Test	**Guarantee**	**Method**
Acid No. mg KOH/gm		ASTM D974
Strong	Nil	
Total	0.25 max	
Ash wt. %	0.005 Max.	ASTM D482
Carbon residue 10% bottoms wt %	0.2 Max	ASTM D524
Cloud Point °F	(-1.1 c) + 3r Max	ASTM D2500
Colour	3 Max	ASTM D1500
Composition	100% virgin distillate	
Corrosion, on strip 3 hours @ 212°F	# 2 strip of better	ASTM D130
Diesel index	55 min	IP-21
		ASTM D86
Distillation (% recovered)	(357.2°C) 675 Max	
90% point °F	(385°C) 725 Max	
End point °F		
Flash P.M. Closed, °F	(60°C) 140 Min.	ASTM D93
		ASTM D287
Gravity		
°API	34.0-42.0	
Specific 60/60 °F	0.8155 – 0.8550	
Pour point °F	(-666°C) + 20 Max	ASTM D97
Sulphur wt%	1.0 Max	ASTM D2622
		ASTM D1522
Viscosity S.U.S @ 100°F seconds	33-45	ASTM D88
Water: sediment by centrifuge %	Trace Max.	ASTM D1796
Water by distillation, vol %	0.05	ASTM D95
MHV (mj/KG)	45.57	

Table 2-4: Liquid fuel oil (ASL) specification (back-up fuel)

Property	Limit
Heating value, gross, BTU/lb	19145
Kin. Viscosity, cSt (20°C) Kin. Viscosity, cSt (37.8°C) Kin. Viscosity, cSt (40°C) Kin. Viscosity, cSt (50°C)	2.09 1.8 1.58 1.5
Gravity, API	49.1
Specific gravity 60°F (15.6°C)	0.7835
Flash point (°C)	< 0°C
Distillate temp. 90% point °F(°C)	N/A
Pour point °F(°C)	-31°F
Cold filter plugging point	20°F
Ash ppm	3
Sodium plus potassium ppm	2.1
Lead ppm	1
Vanadium ppm	0.5
Calcium, max	10
Nitrogen ppm	62
Carbon residue (wt %)	0.8
Nickel ppm	0.1
Reid vapour pressure psi	7.8
Salt as NaCl, PPTB	< 1
Hydrogen wt % min	0.8
Carbon residue wt % (100% sample) max air automixation, low pressure	
Sulphur wt %	0.1
Wax (%) Max	1.43

2.3.7 Emergency Diesel Generator (EDG)

Two up to diesel-engine-driven generator sets will be installed which include fire protection and detection system with all required facilities and auxiliaries in a controlled temperature environment.

The EDGs will be capable of starting and operating without AC power and can be synchronized automatically and manually, locally and remotely from the CCR although the generators will be housed in a purpose built building.

Fuel tanks for diesel supplies will be provided and situated outdoors, sunshade protected, adjacent to the EDG building to allow gravity flow of fuel to the day tank(s). The main fuel tank(s) shall have a minimum capacity of one (1) day of fuel, be installed in a moat and will be double walled with leak detection between wall sections.

2.3.8 Fire Protection System

A fire detection and protection system will be designed and installed in compliance with the requirements of Safety and Fire Protection Directive for Industrial Facilities and/or National Fire Protection Association (NFPA) 850. This will be supplemented by company 'Fire Protection and Prevention Requirements for Company Facilities' which will be considered as primary in terms of recommendations but not in terms of requirements. The fire detection system will include:

- Heat detectors;
- Flame detectors;
- Local alarms and strobes;
- Remote alarm panel in CCR and Fire Station/Centre and interfaced to DCS; and
- Additional alarm panels within LCRs.

The fire protection system will an indoor fire station with all necessary equipment and devices to cater for the largest possible fire for the plant. The specifications shall include:

- Fire pump houses
- Firewater storage tanks of appropriate reserve volume in accordance with NFPA;
- Tank to be supplied from service water tank with emergency back-up interconnection with underground raw water tank;
- Minimum of two foam generating units and foam storage tanks;
- Two electric firewater pumps;
- Two diesel firewater pumps each with fuel day tank to connect to distillate supply lines (to be located outside, with sunshades and adjacent to fire pump houses;
- Two jockey firewater pumps;
- Piping network system to provide capacity to deal with the largest single fire for the entire plant;

- Yard hydrants;
- Water based sprinklers in administrative areas, offices, warehouses, maintenance workshops and general building areas; and
- Fire water pipes installed above ground on pipe sleepers.

PP13 will utilise the fire station from PP12.

2.3.9 Heating, Ventilation and Air Condition (HVAC) System

The HVAC system will include heating, building ventilation for fresh air makeup and cooling, and air-conditioning, as required, for various buildings equipment rooms and areas. Smoke extraction and isolation considerations will also be made. The main specifications shall include:

- Multiple HVAC units shall be used for the electrical and electronics rooms;
- Ventilation fans for the turbine enclosure;
- Turbine Building ventilation shall be designed to ventilate the building to +5 degrees C above ambient conditions (shaded location);
- The effect of units operations (GT, STG and other equipment) shall be accounted for in building ventilation requirements. The effect of GT and STG outages shall be accounted for in building heating requirements to prevent local cold spots from occurring;
- Building louvers shall be adjusted by ventilation/heating control systems and fire protection system;
- Where used for life safety purposes HVAC systems shall be 2 x100%; and
- Where used for equipment ventilating, cooling or heating the loss of a HVAC system shall not cause any reduction or limitation on plant/unit capacity.

2.3.10 Water Supply System

The source of raw water for PP-13 will be a branch take-off from the grey water pipeline which supplies raw water to the adjacent IPP-11. Groundwater will not be extracted for use as process water. The tap location will contain isolation valves, check valves and instantaneous and flow metering station. All metering data shall be transferred to PP-13 DCS and to pumping station; communication shall be linked with the IIPP-11 communication system.

Raw water will be stored in an underground concrete tank which has been sized for a volume of two days to provide capacity for plant water usage. Biological disinfectant and/or UV sterilization will be dosed to the raw water used as service water (wash down stations, etc.). The service water will be treated water and stored in a storage steel tank. All steel storage tanks shall be internally epoxy coated as per international standards and codes.

Raw water taken from the storage tanks shall be by a means that is suitable for the various usages. If by pumping this shall always be by 2 x 100% pumps (one installed spare) for each of the usages.

A new piping system will be installed to transfer the feed raw water from the new underground water tank to the new water treatment plant and for water distribution to plant various locations. The pipe shall be UPVC pipe.

2.3.11 Service and Potable Water

Potable water is to be supplied by road tankers and stored in a potable water steel tank. Following this, water reserves will be pumped to a pressurised system. This system shall also supply safety eyewash and shower stations. The service and potable water system will provide backup supply to the fire water system via interconnecting piping which will limit the flow direction only from the potable water to the fire.

The service and potable water system will provide a backup supply to the firewater system via interconnecting piping which shall limit flow direction only from potable water to fire water.

Water storage tanks will be provided for:

- Raw water;
- Service water;
- Potable water; and
- Chemical water.

The service water and potable water bulk storage tanks shall be designed based on a minimum of 3 days storage of the plant consumption plus a 20% margin.

The demand for service water by the demineralised water production system shall be based on a future makeup rate corresponding to 3% blow down plus a margin of 20%.

2.3.12 Wastewater Storage and Treatment

Industrial wastewater that results from the turbine washing, including wash-water skid drains, detergent tank overflow etc., shall be connected to a separate common underground tank. The wash water will be removed by means of a mobile vacuum truck.

Oily water and waste drainage from the GT building, fuel forwarding pump house, gaseous fuel, and any other areas where oils, fuels, and greases may have the potential to be spilled or leaked and will therefore be collected via local collection sumps and then forwarded by gravity or force main via two 100% pumps to the plant's oil-water separator. The oil-water separator separated oil shall be batch pumped to an independent 1000m^3 storage tank for temporary storage until it is removed from the site.

Wastewater from the waste neutralisation system and chemically contaminated water and clean water from the oil/water separator shall be discharged to an evaporation pond after treatment.

2.3.13 Demineralised Water

A demineraliser plant will be installed to provide capacity for the entire project. The plant will provide all required infrastructure including:

- Reverse osmosis and ion exchange;
- Power supplies;
- Redundant control interfaces;
- Chemical systems;
- Water supply connections; and
- Wastewater discharge lines.

The plant shall be designed to operate for approximately 16 hours daily and provide all water requirements for the steam turbine, HRSG, ACC and steam circuit requirements. Two storage tanks will be provided made of carbon steel with an internal epoxy coating. Sizing of the tanks will be to accommodate base load of daily continuous operation for five days of consumption of the plant, plus 20%. The storage tanks will include controls, power, grounding and all other necessary equipment.

All discharges from the water treatment plant will be neutralised before discharge to the agreed location. There shall be water sampling/steam sampling/condensate sampling racks within each block.

It is proposed that all waste water discharges from the various water treatment systems will be directed to a process/equipment drain evaporation pond located within the Project site.

2.3.14 Sanitary Waste Treatment

All sanitary waste streams generated by the plant will be directed via a contractor to a sanitary waste treatment plant for stream separation of solids, disinfection, and biological and chemical treatment.

It is proposed that the potable water produced by the sanitary waste treatment can be provided to supplement grey water for raw water sources. Solids will be stored and held in a holding sump to be later trucked off-site.

The waste treatment plant will include a PLC based control system including instrumentation to measure flow, liquids and solids levels, and potability of the outflow. All data and operating information shall be delivered to the DCS.

The waste treatment plant will contain detection methods to identify if and when outflows are not suitable for use as raw water. A diversion holding tank will be utilised in these instances until the adverse conditions are rectified and the tanked outflow can be retreated. Flow quantities exceeding the capacity of the holding tank will be diverted to the wastewater drainage pond for evaporation. Disinfection will be undertaken manually.

2.3.15 Security

Construction Security

During construction, temporary security fencing will be installed around the perimeter of the construction area to prevent unauthorised entrance. The construction area will be well illuminated and temporary construction gates of appropriate width installed to control entrance to the construction site. All construction gates shall be manned by security provided by the main appointed contractor. All construction gates shall be locked closed when not in use.

Operational Security

A security fence will be erected around the perimeter of the Project site, with security lights and surveillance cameras required to distinguish the site as a Class 1 Facility and Category 1 Fencing System as per security directive requirements for industrial facilities of HCIS.

The security fence will be surrounded by internal and external security patrol roads used for security vehicles only with periodic widening of the road for U-turn provisions.

Two security gates will be provided (entrance and exit) to the main plant gate and fuel unloading truck gate. These gates will be required to comply with security directive requirements for industrial facilities of HCIS.

Access to the PP13 site will be via the existing PP12 security gate.

2.3.16 Civil Works

It is required that all works are undertaken in accordance with the requirements and standards of ACI, IBC, KSA, DIN, ASTM and BS codes and standards and ‘General Specifications for Building Construction handbook issued by the Ministry of Public Works and Housing, Kingdom of Saudi Arabia.

Waste utilised for construction purposes e.g. in concrete production will adhere to the requirements of BS-3148 Standards, ASTM C 94 and C 1602.

2.3.17 380/132kV PP-13 Substation

A new substation is proposed, which will be constructed immediately adjacent to the south of the proposed PP-13 and will comprise an indoor 380/132 kV GIS substation.

2.3.18 Laboratory

Each power block will contain an automatic analyser containing sampling and analytical instruments for locally analysing water/steam grab samples from within the block and will be connected to the main control room.

The laboratory equipment will enable analysing of liquid fuels, gaseous fuels, lubricating oil, RO water treatment and demineralised plant product, steam and condensate systems, feed water and coolant systems.

The laboratory shall include, but not be limited to the following:

- pH meter;
- TDS/Conductivity metre;
- Gravity meter (digital);
- Density meter (digital);
- Cal. Fisher apparatus (digital – directly showing readings for PPM concentration);
- X-Ray – 2000 (for detection of sulphur, vanadium. etc.);
- Thermometers (mercury type):
  - 0-100 deg. C
  - 0 – 230 deg. F. – 2 Nos.
  - 700 – 2000 deg. F - 2 Nos.
  - Digital Thermometer (Fisher) :-
  - -35 to 2200 deg. F – 2 Nos.
  - -212 to 1200 deg. F – 2 Nos.
- Barometer;
- Thermometer for room temperature;
- Boiling point apparatus (England – make);
- Kinematic viscosity bath (Koehler instrument company);
- Flash tester – close cup (Pensky – Martens – U.K.);
- Hydrometer (Fisher brand) – CAT-# 11-583-B, USA-make;
- Saybolt Chromometer (for color of petroleum products); and
- One spectrometer for fuel.

2.4 Removal of Existing Facilities

The project area is understood to have been previously used as an equipment storage and staging area, together with offices for the construction of IPP-11. Whilst all above-ground facilities are understood to have been removed, it is thought that underground facilities may have been abandoned in-situ, including a groundwater well which was identified during the visit undertaken on the 22nd

December 2014. The Construction Contractor would to be fully responsible for the safe removal of such abandoned facilities, if encountered during the construction phase.

2.5 Site Development

Following site clearance, the following activities are anticipated as part of the Project development:

- Site grading;
- Excavation & backfilling;
- Construction;
- Roads & accesses;
- Pavements;
- Drainage;
- Landscaping including water sprinklers/irrigation;
- Hardscaping;
- Aggregate mulching;
- Underground utilities;
- Construction and permanent fencing;
- Security, and
- All other related works shall form the Site development works.

2.6 Decommissioning

The Project Company will assume responsibility for dismantling the facility following the end of its useful life. The facility lifetime is predicted to be in excess of 30 years following the PCOD.

2.7 Environmental Criteria and Considerations

Specifically, the Project will be required to conform to PME standards, as set out within the GER (2001/2006) and revised Environmental Protection Standards (2012).

The following standards, in particular, in addition to other general compliance requirements and recommendations, will need to be considered:

- Emissions standards relating to pollutants discharged to the air;
- Ambient air quality standards;
- Environmental and occupational noise standards; and

- Wastewater discharge standards.

Given that the Project could attract private sector finance, it is also possible that additional requirements could apply, as set out within the IFC General EHS Guidelines (2007) and IFC EHS Guidelines for Thermal Power Plants (2008).

Further details on these requirements are presented in **Chapter** 3 **– Environmental Legislation and Standards,** and the relevant technical chapters of this ESIA.

3 Environmental Legislation and Standards

3.1 Regulatory Environmental Framework in KSA

3.1.1 The General Environmental Regulations, 2001

The protection of the environment in Saudi Arabia is controlled and operated under the jurisdiction of the PME. The regulatory requirements and enforcement regime for pollution control in the KSA has been significantly strengthened in recent years by the introduction of the General Environmental Regulations (GER, 2001). These have placed specific requirements and duties on PME to apply environmental law across the whole Kingdom and develop a system of regulation and enforcement. The GER is subdivided into the following three sections:

- General Environmental Law;
- Rules for Implementation; and
- Environmental Protection Standards.

Table 3-1 below provides a list of relevant environmental legislation in KSA. Further detail will be provided in the following sections where required.

Table 3-1: Relevant content of the general environmental regulations

Regulation Title	Sub Title (if applicable)	Regulator
General Environmental Regulation (GER 2001)	The 'Act' in 24 Articles	PME
Rules for Implementation (GER 2001)	The regulations in 22 Articles	PME
Environmental Protection Standards (Rules for Implementation) 2001	Environmental standards for issue areas	PME
GER (2001) Art 3, 4 & 10, 11, Duties and obligations	Regarding the implementation of these regulations	PME
GER (2001) Art 5 Requirement for EIA	-	PME
GER (2001) Art 6 Requirement for BAT	-	
GER (2001) Art 7 Education and communication	-	PME
GER (2001) Art 8 Conservation of Natural Resources	-	PME
GER (2001) Art 9 Environmental Disaster Planning	-	PME
GER (2001) Art 12 Waste management and disposal	-	PME/Municipalities
GER (2001) Art 13 Prevention of pollution	-	PME
GER (2001) Art 14 Hazardous waste management	-	PME/Municipalities
GER (2001) Art 15 Implementation and timescales	-	PME
GER (2001) Art 16 Project financing and development	-	PME
GER (2001) Art 17, 18, 19, 20 Violations and penalties	Includes grievances and appeals.	PME
Doc 1409-01 GER (2001) Air quality 1982	Ambient air and source standards	PME
Doc 1409-01 GER (2001) Water quality 1982	Ambient and discharge standards to environment and wastewater treatment works.	PME
Doc 1409-01 GER (2001) Appendix 2 1982	EIA regulations	PME
Doc 1423-01 GER (2001) Appendix 4 1992	Waste management regulations	PME

3.1.2 Revised Environmental Protection Standards

In 2014, PME issued a revised set of Environmental Protection Standards to replace those previously referred to within the GER (2001). These new standards are listed below.. The results of this assessment have therefore been compared against the provisions set out within these updated set of legislative requirements.

- *PME (2014), National Material Recovery and Recycling of Waste Guidance Document for KSA;*
- *PME (2014), Standard for Control of Emissions from Mobile Sources;*
- *PME (2014), General Environmental Standard for Noise;*
- *PME (2014), Standards for the Control of Emissions to Air from Stationary Sources;*
- *PME (2014), Protection of Major Accidents;*
- *PME (2014), National Storage and Material Reclamation Facilities – Design and Operation Standard for KSA;*
- *PME (2014), National Thermal Treatment and Incineration Design and Operation Standard for KSA;*
- *PME (2014), Waste Acceptance Criteria Standard for KSA;*
- *PME (2014), Waste Classification Standard for KSA;*
- *PME (2014), Drinking Water Quality;*
- *PME (2014), National Biological Treatment Design and Operations Standards for KSA;*
- *PME (2014), Waste RCC Standard for KSA;*
- *PME (2014), National Waste Storage Standard for KSA;*
- *PME (2014), National Waste Training and Assessment of Technical Competence of Operators Standard for KSA;*
- *PME (2014), National Waste Transport Standard for KSA;*
- *PME (2014), National Landfill Design and Operations Standards for KSA;*
- *PME (2014), Wastewater Discharge Standards for KSA;*
- *PME (2014), National Best Practicable Environmental Option for Waste Disposal Guidance Note for KSA;*
- *PME (2014), Ambient Air Quality Standard; and*
- *PME (2014), National Ambient Water Quality Standard for KSA.*

3.2 Environmental Impact Assessment

3.2.1 KSA Requirements

An EIA is required in the KSA on the basis of the General Environmental Regulations (GER) 2001 for specific projects.

In accordance with the industrial and development project classification guide, Appendix No. 2.1 of the GER 2001: *"Guidelines for Classification of Industrial and Development Projects"*, issued by PME, projects are classified into three categories taking into consideration their environmental impacts. For projects within the first and second categories, an initial environmental assessment report, in addition to the forms included within the regulations themselves, is usually sufficient although an EIA may potentially be required by the PME.

Larger power plants, with capacities in excess of 30 MW, are classified as Category III projects. Projects falling within this category, in the absence of full mitigation, could be expected to have negative effects on human health and the environment and thus require a comprehensive EIA.

Guidelines for compiling the EIA are stated in Appendix 2.4 of the GER 2001. The regulations specify that the EIA should include, but not be limited, to:

- Justification and presentation of the project;
- Description of the project and its objectives;
- Baseline status of the surrounding environment including the following:
  - Air quality;
  - Soil and topography;
  - Oceanography;
  - Surface and ground water;
  - Land environment (fauna/flora);
  - Marine environment (fauna/flora);
  - Land use of selected site and its surroundings; and
  - Land ownership (original owner).
- The GER 2001 further states that an EIA should include the following:
  - Identification of the general potential impacts of the project and suggested alternatives; and
  - Identification and analysis of key effects of the project on air quality, the marine and coastal environment, surface-and-groundwater, flora and fauna, land use and urban development, residential clusters and general scenic view.
- Assessment of significant impacts, which should:

- Quantify and rate the significant impacts on natural resources;
- Estimate the relative damage to the area and the extent of potential damage;
- Estimate the lifespan of the facilities;
- Study the possible mitigation of anticipated impacts; and
- Provide a summary of the significant (residual) impacts after mitigation.

3.2.2 International Finance Corporation Performance Standards

Given that the project is likely to attract private sector finance, it is assumed that an EIA would need to assess the environmental impacts in accordance with the International Finance Corporation (IFC) Performance Standards. For projects located in non-OECD countries (as is the case for KSA), the EIA should refer to The IFC Performance Standards and IFC Environmental Health and Safety Guidelines, which provide general and sector specific guidance.

All IFC projects or projects where IFC Performance Standards[2] (updated 2012) are adhered to must meet with the following Performance Standards on Environmental and Social Sustainability:

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

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

The IFC has prepared a series of Environmental Health and Safety Guidelines, which provide general and sector specific guidance. These documents provide details of the required levels and considerations when undertaking an EIA for a project. The following would specifically be referred to as part of the preparation of an EIA for the project:

- IFC General EHS Guidelines (April 2007);

[2] International Finance Corporation (January 2012) Performance Standards on Environmental and Social Sustainability

- IFC EHS Guidelines for Thermal Power Plants (December 2008).

3.2.3 Equator Principles

In October 2002, the IFC convened a meeting of banks in London to discuss environmental and social issues in project finance. It was decided to try to develop a banking industry framework for addressing environmental and social risks in project financing. This led to the drafting of the Equator Principles. On June 4th, 2003, 10 banks from seven countries signed up to the Equator Principles, a voluntary set of guidelines for assessing and managing environmental and social risks in project financing. To date, in excess of 60 financial institutions operating in more than 100 countries worldwide have adopted the Equator Principles. As a result, the Equator Principles have become the industry standard for addressing environmental and social issues. During March to May 2006, the Equator Principles Financial Institutions (EPFIs) engaged in a substantive review of the Equator Principles. The revised principles became effective from July 6th, 2006, although have recently been superceded by a third revision on 4th June 2013. This revision is referred to as 'Equator Principles III' (EP III). EP III ensures a strengthened framework for both social and environmental aspects and will result in benefits for Equator Principles Financial Institutions e.g. improved transparency in reporting, and focus on emerging social and environmental concerns. The key changes to these revised principles relate to project related corporate loans and bridge loans. The revised EP III will not be mandatory for application to Projects until January 2014.

The key points to note are as follows:

- The Equator Principles apply to all new project financing that has a total capital cost of $10 million or more across all industry sectors (the previous threshold was $50 million);
- For projects with potentially significant social and environmental impacts (Category A and B), the borrower must complete and disclose a Social and Environmental Assessment (EIA) (previously called an Environmental and Social Impact Assessment). The EIA must now comprise a detailed assessment of social and environmental impacts including labour, health and safety; and
- In the context of the project, the EIA report must address the relevant potential impacts and risks.

3.3 Environmental Standards Applicable to the Project

This section details applicable environmental standards which have been specified by SEC (2). In the absence of any specific information and/or requirements set by SEC, the relevant IFC/PME environmental requirements that must be adhered to during the design, construction and operational phases of the facility are presented.

3.3.1 Ambient Air Quality

Table 3-2 below provides the relevant values for each important air quality parameter for PME (and the World Health Organisation, as adopted by the IFC).

The PME ambient air quality standards are straightforward and apply to all circumstances. However, the IFC standards require a certain level of interpretation due to various 'interim' and 'guideline' values being specified rather than fixed limits. The WHO guidelines provide interim targets for countries that still have very high levels of air pollution to encourage the gradual cutting down of emissions.

Guidelines values have the objective of minimising the health effects associated with each pollutant.

The PME and IFC air quality standards (AQSs) and emission limits for the pollutants considered are also shown in **Table 6-1** and **Table 6-2**, respectively.

Table 3-2: PME and IFC ambient air quality standards for SO_2, NO_2, PM_{10} and $PM_{2.5}$

Pollutant	Averaging period	PME (µg/m^3)[3]	IFC EHS Guidelines (µg/m^3)[4]
NO_2	1-hour	660[(a)]	200
	Annual	100	40
SO_2	10-min	--[(b)]	500
	1-hour	730[(a)]	--
	24-hour	365[(c)]	125 (interim target 1)
			50 (interim target 2)
			20
	Annual	80	--
PM_{10}	24-hour	340[(c)]	150 (interim target 1)
			100 (interim target 2)
			75 (interim target 3
			50
	Annual	80	70 (interim target 1)
			50 (interim target 2)
			30 (interim target 3)
			20
$PM_{2.5}$	24-hour	35[(c)]	75 (interim target 1)
			50 (interim target 2)
			37.5 (interim target 3
			25
	Annual	15	35 (interim target 1)
			25 (interim target 2)
			15 (interim target 3)
			10

(a) Not to be exceeded more than twice per month (30 day period).
(b) No 10-min standard has been set by PME.
(c) 90th percentile of 24-hour means.

[3] *PME (2014), Ambient Air Quality Standard*

[4] IFC (April 2007) General EHS Guidelines

3.3.2 Stack Emissions Limits

The RfP[5] does not explicitly prescribe stack emission limits for the proposed facility. From an engineering point of view, the RfP[6] notes the following:

- That the exhaust gases shall exit each HRSG via a stack for each unit. The stack height shall be determined as per the Presidency of Meteorology and the Environment (PME) requirements, but shall be a minimum of 60m above the finished floor of the turbine building; and,
- That stacks to be provided with separate ports for the provision of *in-situ* type Continuous Emissions Monitoring (CEMs) and for air emissions testing to include NO_x, SO_x, CO and O_2.

Whilst the bypass stack(s) for each of the exhaust systems of the turbines are to meet the following requirements:

- That the stack height is to be determined in line with the requirements of the Presidency of Meteorology and the Environment (PME) but shall be a minimum of 40m above the finished level floor of the turbine building; and,
- That the bypass stacks to be provided with separate ports for the provision of *in-situ* type CEMs and for air emissions testing.

The Technical Specification and Scope of Work document[7] prescribes that flue gas emission limits provided by Contractor for the plant shall be in accordance with PME and the requirements of SECO-10-24-0-SP-RPG2-RA (Gas Turbine and Accessories) in addition to IFC EHS Guidelines.

The specified emissions limits should be adhered to throughout all operation modes from the minimum emissions compliant load (MECL) to the full continuous (base) load capability for the specified fuels.

Demonstration of emissions compliance shall be in accordance with PME guidelines and will be conducted during steady state conditions. During performance testing, NOx, SOx, CO and oxygen concentration values and opacity will be measured by a CEMS system, one of which will be installed on each main and bypass stack.

We have determined the air emissions requirements in line with international best practice in the form of the IFC EHS Guidelines for Thermal Power Plants together with additional information in respect to PME's requirements with regards air pollution source standards as shown in **Table 3-3**.

[5] Saudi Electricity Company: PP-13 Riyadh Combined Cycle Power Plant – Schedule "B" Attachment III.

[6] Ibid.

[7] Saudi Electricity Company: Riyadh PP- Project Construction of Riyadh Combined Cycle Power Plant No. 13 (PP-13) – Technical Specification and Scope of Work.

Table 3-3: PME/IFC Emission Standards for SO_2, NO_2, PM_{10} and $PM_{2.5}$

Pollutant	PME[8]	IFC EHS Guidelines (Combustion Turbines >50MWth)
		Non-degraded Airshed/Degraded Airshed
NO_x	500 mg/Nm^3 in non-degraded airshed 350 mg/Nm^3 in degraded airshed Threshold: 1000g/hr	Natural Gas fired - 51 mg/Nm$^{3(a)}$ (25ppm) – NDA/DA Oil-fired 152 mg/Nm^3 (74ppm) – NDA/DA
SO_2	600 mg/Nm^3 in non-degraded airshed 400 mg/Nm^3 in degraded airshed Threshold: 1000g/hr	No limit for Natural Gas fired power plants Use of 1% or less sulphur fuel in non-degraded air sheds (Oil-fired power plants) Use of 0.5% or less sulphur fuel in degraded air sheds (Oil-fired power plants)
Particulate Matter (PM_{10})	150 mg/Nm^3 in non-degraded airshed$^{(b)}$ 100 mg/Nm^3 in degraded airshed$^{(b)}$	No limit for Natural Gas fired power plants 50 mg/Nm^3 in non-degraded airshed (Oil-fired power plants) 30 mg/Nm^3 in degraded airshed (Oil-fired power plants)
Particulate Matter ($PM_{2.5}$)	50 mg/Nm^3 in non-degraded airshed$^{(b)}$ 25 mg/Nm^3 in degraded airshed$^{(b)}$	No limit specified for this pollutant
Nm^3 – Normalised cubic metre, reference conditions 273K, 101.3 kPa, dry gas, 15% oxygen. (a) Above background conditions.		

It should be noted that there is some confusion with the revised PME emissions standards as the units presented within Appendix A of Control of Emissions to Air from Stationary Sources are µg/Nm^3, whereas within the standard itself (Article II – General Provisions, 1 Units of Measurement) state that "Milligrams per normal metre cubed (mg/Nm^3) shall be used to indicate the concentration of gaseous, particulate and toxic pollutants". It is therefore assumed that mg/Nm^3 is the correct unit.

Detailed exhaust gas plume dispersion and air quality modelling has been undertaken to determine the necessary heights of the stacks for adequate dispersion of the stack gases to meet the air quality requirements. The conclusions of this study are presented in **Chapter 6 – Air Quality**.

3.3.3 Environmental Noise Standards

The Technical Specifications for HRSGs[9] and STs[10] indicates the maximum near and far field requirements in terms of overall sound pressure levels. These requirements are based on individual

[8] *PME (2014), Standards for the Control of Emissions to Air from Stationary Sources*

[9] Saudi Electricity Company: Heat Recovery Steam Generator Engineering Specification (Ref: SECO-10-024-9-SP-MBX0).

[10] Saudi Electricity Company: Steam Turbine and Accessories Engineering Specification (Ref: SECO-10-024-9-SP-RPG1).

units operating under normal conditions with no emergency blow-offs. These requirements are set out below:

Near Field Requirements

With regard to HRSGs:

'Sound levels generated by each HRSG unit must not exceed 85 dB (A) in terms of overall sound pressure level, reference 20 micropascals, at a distance of 1 metre from noise generating surfaces when measured with a sound level meter meeting Type II requirements of ASA Standard S1.4'[11]*; and*

With regard to ST units:

'Noise emissions……including the drive motors shall not exceed 85 dB(A) when measured with a standard sound level meter at slow response at 1 meter (3 feet) from the equipment and 1.5 meters (5 feet) above grade. Measurement and measurement equipment shall comply with applicable portions of ASA S1.4 and S1.13'[12]*.*

Far Field Requirements

'All HRSG equipment with intermittent and emergency sound emissions e.g. safety and relief valves or vents, a sound limit of 85 dB(A) will apply three feet from the outlet of the silencer'[13].However, emissions from the Riyadh PP-13 facility will also need to comply with the operational noise criteria as laid out within the PME General Environmental Standard for Noise, together with the IFC General EHS Guidelines (2007) as illustrated in **Table 3-5** below. For reference purposes, it is worth noting the IFC Guidelines criteria for noise emissions from industrial premises stipulate that:

*'Noise impacts should not exceed the levels presented in… **Table 3-4**…or result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site'.*

The General Environmental Standard for Noise issued by PME, provide maximum permissible façade noise limits for general construction, in addition to ambient noise standards during operation; these are detailed below in **Table 3-4** and will be applicable during the construction phase of the project.

Table 3-4: PME general construction – maximum permissible façade noise limits[18]

Daytime LAeq,12h (dB)	**Evening LAeq,12h (dB)**	**Night-time LAeq,12h (dB)**
5m	5m	5m
80	80	80

[11] Saudi Electricity Company: Heat Recovery Steam Generator Engineering Specification (Ref: SECO-10-024-9-SP-MBX0).

[12] Saudi Electricity Company: Steam Turbine and Accessories Engineering Specification (Ref: SECO-10-024-9-SP-RPG1).

[13] Saudi Electricity Company: Heat Recovery Steam Generator Engineering Specification (Ref: SECO-10-024-9-SP-MBX0).

Article V – Noise from industrial units in areas set aside primarily for industrial facilities sets out a range of permitted noise limits, classifying land uses types for which different noise limits apply. On the basis of the descriptions provided for each category, it can be concluded that Riyadh PP-13 can be classified as *A5 - Heavy Density Industrial and* is therefore required to adhere to the standards provided within **Table 3-5** below.

Table 3-5: PME & IFC EHS noise guidelines limit values

	PME[14]			IFC[15]	
Receptor	**LAeq,T (dB)**			**Leq,1hr (dBA)**	
	Day-time	Evening	Night-time	Daytime 07:00 – 22:00	Night-time 22:00 – 07:00
Residential; Institutional; Educational.	55	50	45	55	45
Industrial; Commercial	75	65	55	70	70

3.3.4 Wastewater Quality Standards

Standards for Direct Discharge

The IFC Guidelines for Thermal Power provide environmental guidance for effluents from power plants, including thermal discharges, wastewater effluents and sanitary wastewater. Recommended water treatment and wastewater conservation methods are discussed in Sections 1.3, Wastewater and Ambient Water Quality, and 1.4, Water Conservation, of the IFC General EHS Guidelines. Further specific measures are also provided with the IFC EHS Guidelines for Thermal Power Plants. **Table 3-6** below, provides the updated 2014 PME standards for direct discharge. These standards apply to water bodies and municipal collection systems. However, whilst these standards apply for disposal but they do not specifically address water reuse.

[14] PME (2014) General Environmental Standard for Noise

[15] IFC (April 2007) General EHS Guidelines

Table 3-6: Discharge limits for effluents prior to discharge into water bodies (and municipal collection systems)[16]

Constituents	Unit	Allowable effluent level
Physical chemistry		
Temperature	Δ°C	45
pH	-	5-10
Total dissolved solids	mg/l	3000*
Turbidity	NTU	-
Total suspended solids	mg/l	600
Indicators		
BOD	mg/l	500
COD	mg/l	1000
Total oil and grease	mg/l	100
TKN (organic N)	mg/l	120
TOC	mg/l	1000
Phosphorous (total)	mg/l	50
Phosphate $(PO_4)^3$-	mg/l	n/a
Ammonia (as NH_3)	mg/l	40
Chloride (as Cl)	mg/l	n/a
Total inorganic nitrogen (as NO_2 and NO_3)	mg/l	n/a
Sodium	mg/l	1000
Sulphate	mg/l	500
Sulphide	mg/l	10
Heavy Metals		
Aluminium	mg/l	30
Arsenic	mg/l	1
Barium	mg/l	2
Cadmium	mg/l	1.0
Chromium (total)	mg/l	1
Chromium (hexavalent)	mg/l	0.5
Cobalt	mg/l	2
Copper	mg/l	1
Iron	mg/l	30
Lead	mg/l	1
Manganese	mg/l	2
Mercury	mg/l	0.5
Nickel	mg/l	1.5
Silver	mg/l	1
Zinc	mg/l	10

[16] PME (2014), Wastewater Discharge Standards for KSA

3.3.5 Wastewater Reuse Standards

The IFC Performance Standards for wastewater reuse are dependent upon the intended reuse application and vice-versa.

Table 3-7 below shows the required effluent quality for restricted and unrestricted irrigation established by the Ministry of Water and Electricity in 2006 (3). The updated PME Standards (2014) for 'Industrial and Wastewater Discharges' states that wastewater destined for regulated or unregulated reuse must adhere to the criteria specified by the relevant designated agency, which is therefore the MOWE. It should however, be noted that WSP have concerns with these prescribed standards as these standards are intended for agricultural reuse they may not necessarily be applicable to landscaping.

An alternative approach could be to reference the WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater or recognised standards such as the US Environmental Protection Agency (US EPA) Guidelines for Water Reuse (2004).

Table 3-7: Wastewater re-use standards (MOWE, 2006)

Parameter	Unit	Unrestricted Irrigation	Restricted Irrigation
Floatable materials		Absent	Absent
Biochemical Oxygen Demand – Monthly average – Weekly average	 mg/l mg/l	 10 15	 - 40
Total suspended solids (TSS)	mg/l	10	40
Aluminium (Al)	mg/l	5	5
Arsenic (As)	mg/l	0.1	0.1
Beryllium (Be)	mg/l	0.1	0.01
Boron (B)	mg/l	0.75	0.75
Cadmium (Cd)	mg/l	0.01	0.01
Chromium (Cr)	mg/l	0.1	0.1
Cobalt (Co)	mg/l	0.05	0.05
Copper (Cu)	mg/l	0.4	0.4
Cyanide	mg/l	-	-
Fluoride (F)	mg/l	1	1
Iron (Fe)	mg/l	5	5
Lead (Pb)	mg/l	0.1	0.1
Lithium (Li) for citrus fruits	mg/l	2.5	2.5
Manganese (Mn)	mg/l	0.2	0.2
Mercury (Hg)	mg/l	0.001	0.001
Molybdenum (Mo)	mg/l	0.01	0.01
Nitrate as N	mg/l	10	10
Nickel (Ni)	mg/l	0.2	0.2
Selenium (Se)	mg/l	0.02	0.02
Vanadium (V)	mg/l	0.1	0.1
Zinc (Zn)	mg/l	4	4
Phenol	mg/l	0.002	0.002
Oil and grease	mg/l	Absent	Absent
pH		6 – 8.4	6 – 8.4
Faecal coliforms per 100 ml – Average of last seven days – Maximum of any one sample		 2.2 MPN 23 MPN	 - 1000 colonies
Intestinal nematodes per litre		1	1
Turbidity	NTU	5	5

3.3.6 Solid and Hazardous Waste

KSA Requirements

The GER (2001), updated in 2012, provides a suite of Environmental Protection Standards relating to waste which may be relevant to the Project. These are as follows:

- Waste Acceptance Criteria Standards for KSA;
- Waste Classification Standard for KSA;
- Waste RCC Standards for KSA;
- National Waste Storage Standard for KSA;
- National Waste Transport Standard for KSA; and
- National Best Practicable Environmental Option for Waste Disposal Guidance Note for KSA.

In particular, the Waste RCC Standards for KSA makes specific reference to the control of solid waste materials and in particular waste materials which are classified as hazardous in terms of their impacts on the environment:

> *Article 4 (Purpose) identifies that PME is charged with protecting the natural environment and is therefore obliged to issue controls over waste activities in KSA'.*

The Waste Classification Standard for KSA provides the following:

"A national classification system that may be employed within KSA by all waste generators, transporters, facility operators and the relevant competent agencies and other interested parties. The standard provides classification, coding and defining of all waste types so they can be handled treated or disposed of accordingly".

IFC Guidelines

Section 1.6 of the IFC General Environmental, Health, Safety (EHS) Guidelines is entitled Waste Management and is applicable to all projects that generate, store or handle any quantity of waste; whilst Section 1.5 of the IFC EHS Guidelines covers Hazardous Materials Management.

The waste management guidelines state that facilities that generate and store wastes should practice the following:

- Establish waste management priorities at the outset of activities based on an understanding of potential requirements;
- Identify Environmental, Health, and Safety (EHS) risks and impacts and consider waste generation and its consequences;
- Establish a waste management hierarchy that considers prevention, reduction, reuse, recovery, recycling, removal and finally disposal of wastes;
- Avoid or minimise the generation waste materials, as far as practicable;

- Identify where waste generation cannot be avoided but can be minimized or where opportunities exist for, recovering and reusing waste; and
- Where waste is not able to be recovered or reused, identify means of treating, destroying, and disposing of it in an environmentally sound manner.

This section also provides guidelines for the segregation of waste into hazardous and non-hazardous and how to manage these waste streams. The project should seek to demonstrate compliance with these principles and the guidelines set out within this document.

International Conventions

The Kingdom of Saudi Arabia signed and ratified 'The Basel Convention on the Control of Trans-boundary Movement of Hazardous Wastes and their Disposal' in 1989 and confirmed it in 1990. This convention aims to introduce a system for controlling the export, import and disposal of hazardous wastes, and to reduce the volume of such exchanges so as to protect human health and the environment.

The convention defines a trans-boundary movement as 'any movement of hazardous wastes or other wastes from an area under the national jurisdiction of one State to or through an area under the national jurisdiction of another State, or to or through an area not under the national jurisdiction of any State, provided at least two States are involved in the movement'.

General obligations include the following:

- It is prohibited to export or import hazardous wastes or other wastes to or from a non-party State;
- No wastes may be exported if the State of import has not given its consent in writing to the specific import;
- Information about proposed trans-boundary movements must be communicated to the States concerned, by means of a notification form, so that they may evaluate the effects of the proposed movements on human health and the environment;
- Trans-boundary movements of wastes must only be authorised where there is no danger attaching to their movement and disposal;
- Wastes which are to be the subject of a trans-boundary movement must be packaged, labelled and transported in conformity with international rules, and must be accompanied by a movement document from the point at which a movement commences to the point of disposal; and
- Any party may impose additional requirements that are consistent with the provisions of the Convention.

3.3.7 Requirements for Best Available Technologies

Article 6 of the General Environmental Regulations (GER, 2001) outlines the requirement for the party implementing a new project or making major modifications to existing projects to utilize the best and most suitable technologies available for the local environment and use materials that cause the least contamination to the environment. In order to apply further clarity to this requirement reference shall be made to international best practice, such as the approach of the US EPA in the Clean Air Act which requires the use of the Best Available Technology which is economically achievable or the European approach of requiring best available techniques not entailing excessive costs (BATNEEC).

4 Project Site Overview

4.1 Introduction

4.1.1 The Kingdom of Saudi Arabia

The Kingdom of Saudi Arabia (KSA) is a large country with a land area estimated to be approximately 2,150,000km^2, supporting an estimated population of 26.54 million (July 2012[17]). KSA shares geographic boundaries with Iraq, Jordan, Kuwait, Oman, Qatar, the United Arab Emirates, and Yemen.

The country has a varied geography ranging from the south-western Asir region, which includes mountains as high as 3000m and is known for having the most moderate climate in the country, to the harsh environment of the c. 647,500 km^2 Rub Al-Khali or 'Empty Quarter', the world's largest contiguous sand desert. Much of the country's land mass consists of deserts and semi-deserts which are largely uninhabited. With the exception of the capital city Riyadh, population centres are predominantly on the eastern (e.g. Dammam) and western (e.g. Jeddah) coasts and at densely populated interior oases.

KSA is an extremely hot and arid country with summer temperatures frequently exceeding 50°C. The average winter temperatures range from 8 to 20°C, but can drop to as low as 2°C in some central areas. The climate of the region is dry with large seasonal and daily variations in temperature; rainfall is irregular with large variations between years.

Administratively, the Kingdom is divided into 13 provinces, which are further divided into 118 governorates. The Riyadh PP-13 site is situated within the Riyadh (or Arriyadh) Province of Saudi Arabia. Riyadh Province has an area of 412,000 km^2 and a population of 5,455,363 (2004). Riyadh contains more than 75% of the population of the province (4,622,421).

4.1.2 The Project Site

The area allocated for the Riyadh PP-13 facility is located some 110km to the west of the city of Riyadh in a wide valley known as Al Batin as illustrated by **Figure 2-1**. Access to PP-13 is by travelling south-west on Highway 40 from Riyadh, before progressing along Route 505, and heading north-west towards the nearest town of Dhurma, which is situated approximately 50km from the site. Dhruma has a population of approximately 15,000 residents, whilst the larger town of Muzahmiyya, located approximately 75km southeast from the Project site supports a population of 24,000 inhabitants.

[17] US Central Intelligence Agency: www.cia.gov/library/publications/the-world-factbook/geos/sa.html

The site is located approximately 30km from Route 505. PP-13 is proposed to be located adjacent the operational IPP-11 facility, and 800 metres east from the PP-12 facility, which is currently under construction. The PP-13 is a new facility and not an extension of, or upgrade to, an existing power facility, the proposed layout of the PP-13 facility is illustrated by **Figure 4-1**.Further imagery is included in Appendix 1, including a record of the GPS waypoints taken during the site visits, undertaken in 2013 and in the December 2014.

The overall area currently supports the operational IPP-11 facility, together with allocated areas for the PP-12 facility, and an area that has been proposed for the construction of the PP-13 facility.

Prior to the development of power facilities at the site, the land is thought to have been formerly used in part for agriculture; and otherwise undeveloped.

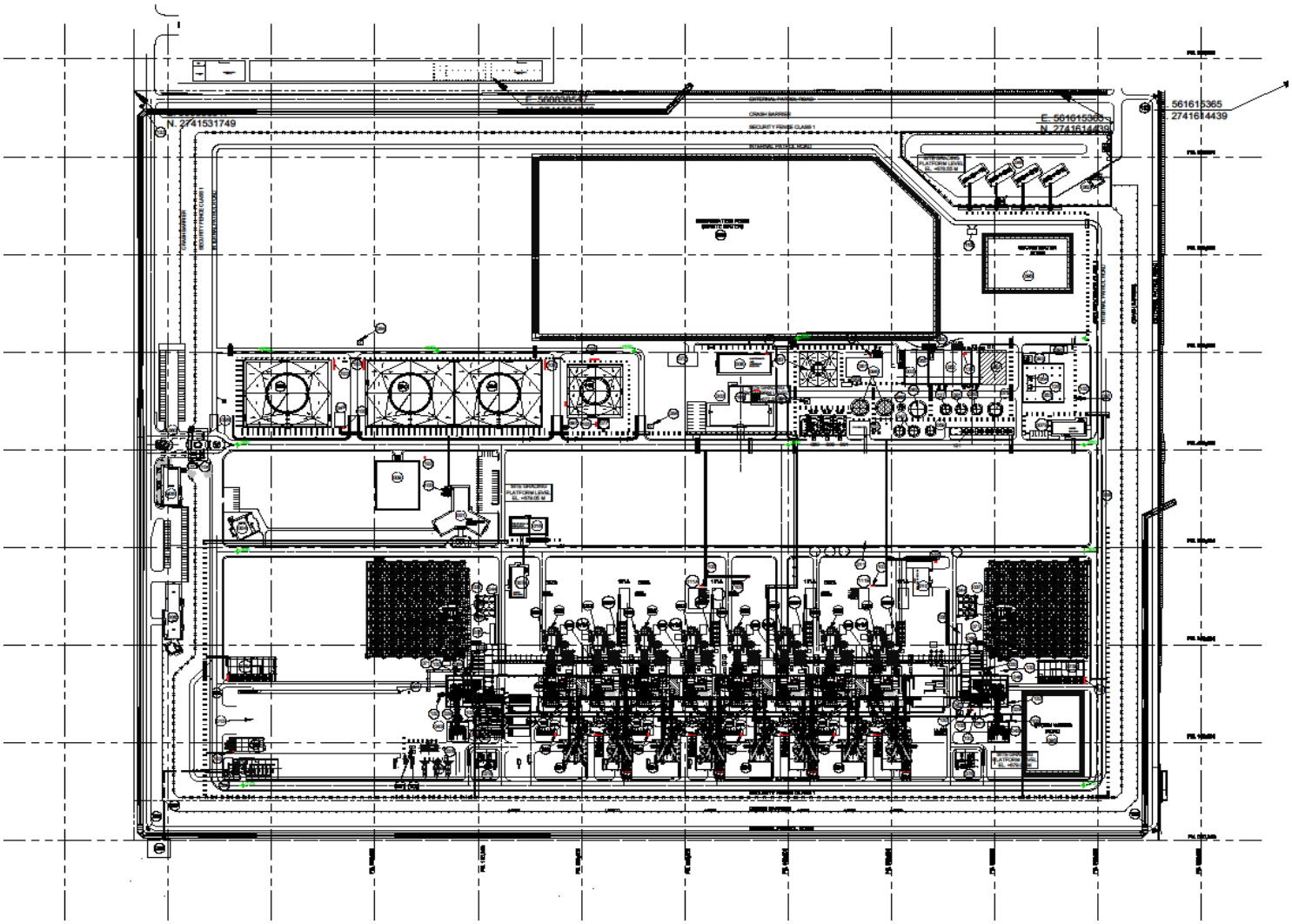


Figure 4-1: PP-13 proposed site layout

As per correspondence received from the Saudi Electricity Company[18], the allocated site is approximately 70 ha, as detailed within **Figure 4-2**, **Figure 4-3** and **Figure 4-4 below**. The Project site is characterised by a flat topography at an elevation estimated to be 600m above sea level, and mainly includes compact disturbed land due to the previous construction grading activities.

To the north of the Project site, are located construction lay-down areas, either for the PP-12, IPP-11 or PP-13 facilities, which include engineering and associated equipment. As aforementioned, the Project site is located within close proximity to the various existing contractor yards. From the access afforded to these contractor yards, it would seem that each yard support laydown areas, office units, and temporary accommodation blocks, including aboveground storage tanks and generators.

4.2 Site Features

The following descriptions and photographs are from a site reconnaissance undertaken by WSP in in 22nd December 2014. Where relevant, observations are supported by available background information.

In order to inform on the condition of the PP-13 footprint area and its vicinity, photographs were taken at each of the way waypoints identified within **Figure 4-4.**

WSP notes that the satellite images sourced from Google Earth Pro were captured prior to the site reconnaissance and show that the project site supported laydown areas in 2014 which are likely to have been associated with the earlier construction phases of the PP-12 facility.

[18] Saudi Electricity Company – Generation Projects Development Department (March 4th 2013)



Figure 4-2: Layout sketch with coordinates

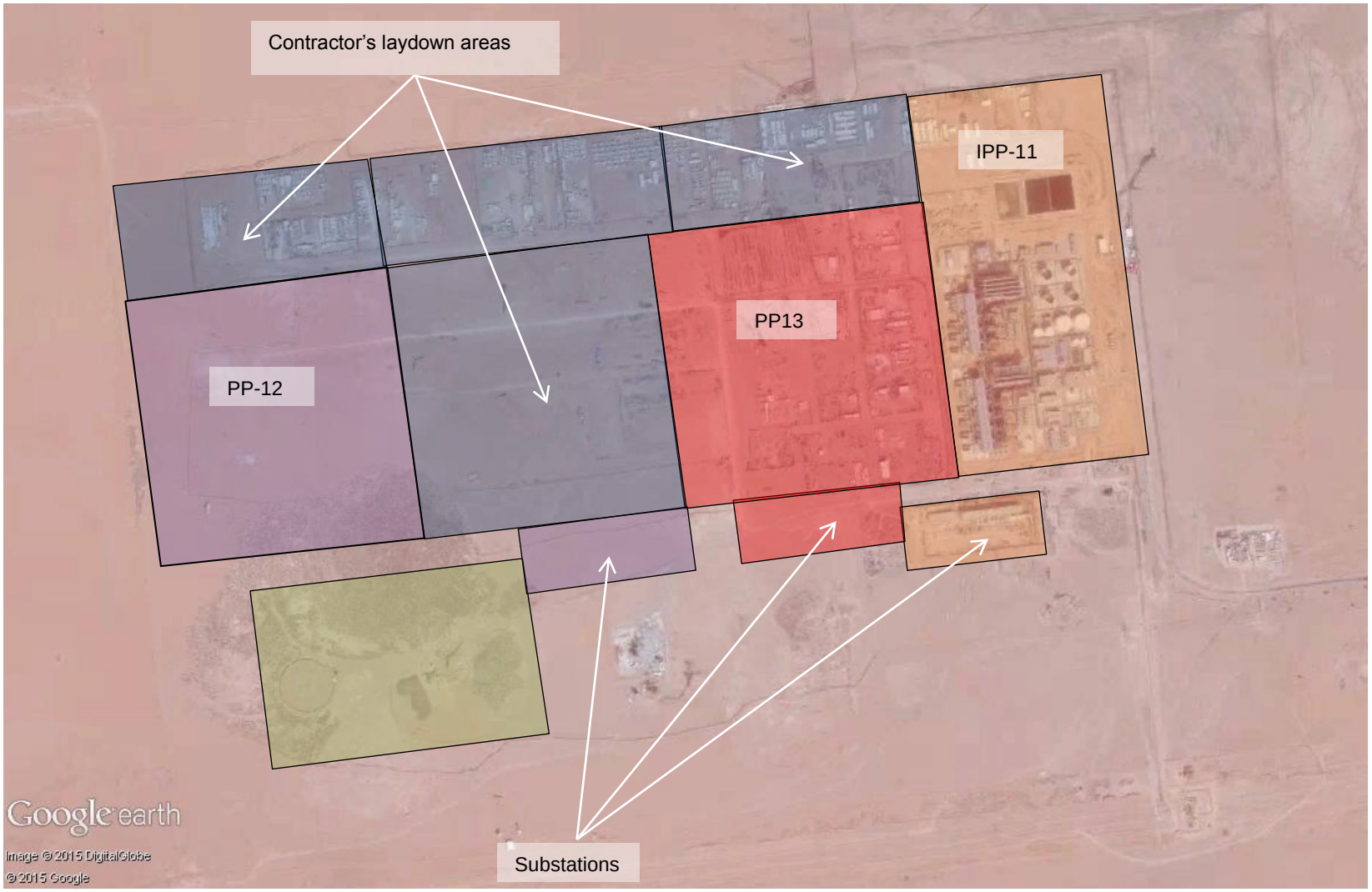


Figure 4-3: PP-13 proposed location in the context of adjacent site allocations

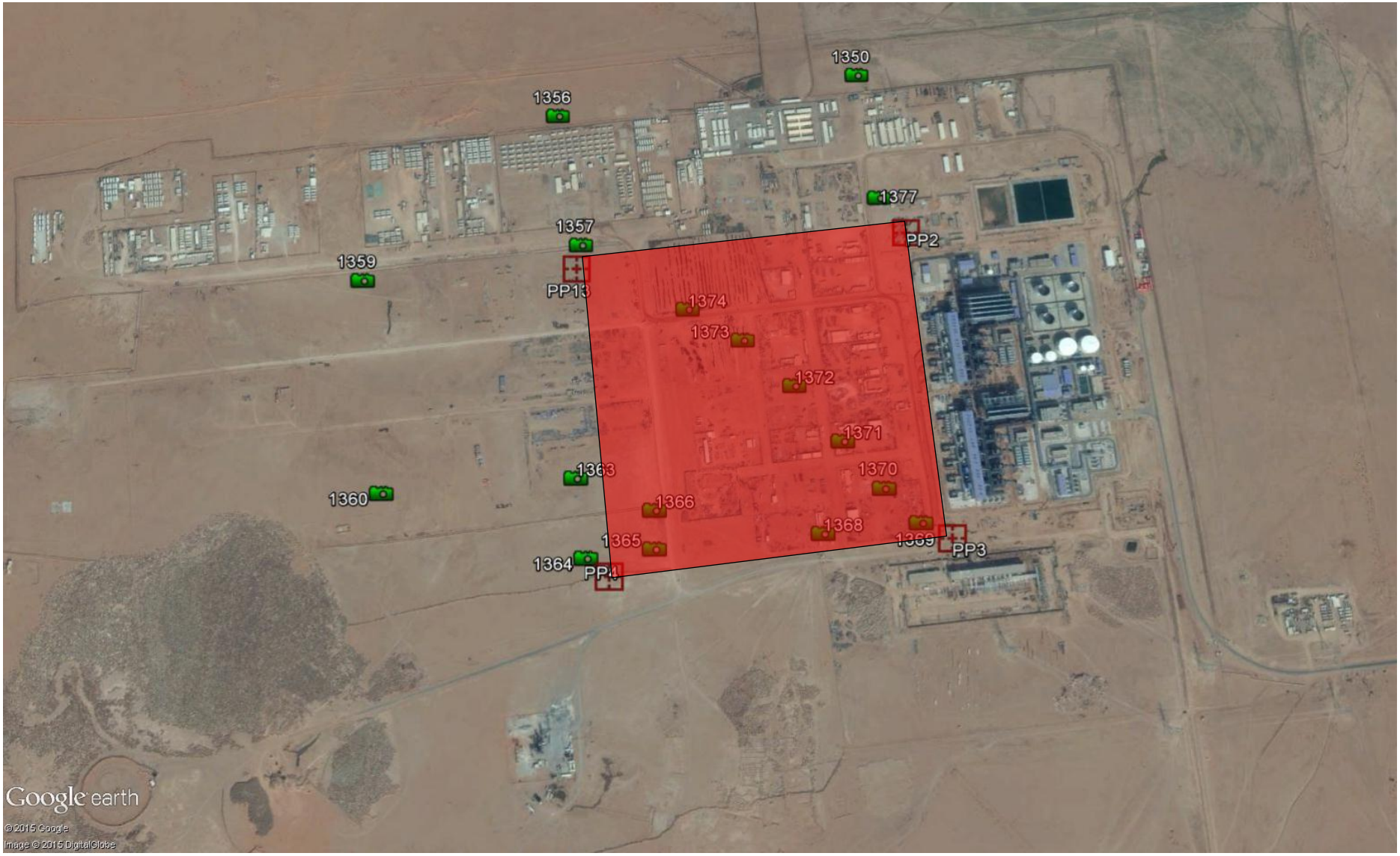


Figure 4-4: Waypoint (WP) referencing



Figure 4-5: WP 1357, towards PP-11



Figure 4-6: WP 1357, towards southeast



Figure 4-7: WP 1357, towards PP-12



Figure 4-8: WP 1357, towards PP-12 laydown areas



Figure 4-9: WP 1359, towards PP-11



Figure 4-10: WP 1359, towards South



Figure 4-11: WP 1359, towards PP-12



Figure 4-12: WP 1359, towards PP-12 temporary accommodation units



Figure 4-13: WP 1360, towards East



Figure 4-14: WP 1360, towards PP-12 substation



Figure 4-15: WP 1366, groundwater extraction



Figure 4-16: WP 1366, groundwater extraction



Figure 4-17: WP 1369, towards PP-11



Figure 4-18, WP 1369, towards Northeast



Figure 4-19: WP 1370, towards PP-12



Figure 4-20: WP 1370, towards Northeast



Figure 4-21: WP 1371, excavation area



Figure 4-22: WP 1372, towards PP-12



Figure 4-23: WP 1373, towards PP-11 accommodation units



Figure 4-24: WP 1373, towards South



Figure 4-25: WP 1374, ASTs within PP-13 laydown areas



Figure 4-26: WP 1374, generators within PP-13 laydown areas



Figure 4-27: WP 1375, PP-11 accommodation units



Figure 4-28: WP 1375, PP-11 accommodation units

4.2.1 Climatic Conditions

There are no meteorological stations near the proposed Riyadh PP-13 site. Data recorded at the Riyadh meteorological station (24°42'N/46°44'E; Elevation: 608m) has been used as this falls within the same climatic zone as the project site (see **Table 4-1** below).

The following climatic conditions are considered to be quite severe and the design of the Riyadh PP-13 will need to take these into account:

- Protection against dust and sand for outdoor equipment;
- Rainfall is very erratic but attention must be paid to the fact that sudden heavy downpours can, and do occur; and
- Strong winds are common and sand-and-dust storms are frequent.

Table 4-1: Average climatic conditions

Category	Design Data – SI Units (Riyadh)
Approximate elevation above mean sea level (m	+/- 600 to 700
Station coordinates: Latitude North	24° 74' to 24° 79'
Latitude East	45° 60' to 45° 61'
Ambient air & soil temperatures (°C):	
Average annual temperature	27
Average daily (maximum) temperature (hottest month)	37
Monthly normal (maximum) temperature (hottest month)	43
Average daily soil temperature. (1m below grade)	33
Monthly normal maximum soil temp. (1m below grade)	34
Lowest one-day mean temperature	5
Highest one-day mean temperature	40
Lowest recorded temperature	-4
Highest recorded temperature	49
Summer design dry bulb temp. @ 1%	44
Mean Coincident wet bulb temp. @ 1%	21
Summer design dry bulb temp. @ 2.5%	43
Mean Coincident wet bulb temp. @ 2.5%	20
Summer design wet bulb temp. @ 1%	22
Mean Coincident dry bulb temp. @ 1%	34
Summer design wet bulb temp. @ 2.5%	20
Mean Coincident dry bulb temp. @ 2.5%	34
Summer design dry bulb temp. @ 5%	42
Main daily range	16
Winter design dry bulb temp. @ 99%	3
Wind:	

Category	Design Data – SI Units (Riyadh)
Basic wind speed, 3-sec gust, km/hr	165
Basic wind speed, fastest-mile, (km/hr) 50 yr	140
Prevailing direction	N
Precipitation, mm:	
Rainfall, average annual	116
Rainfall, maximum 24 hours	70
Isokeraunic levels (days/lightning/year)	10

4.2.2 Landscape and Geology

The site is on gravel/sand plains at an altitude of approximately 680 metres above sea level.

The site itself and immediately adjacent lands are entirely flat and largely devoid of any landscape character or visual amenity (**Figure 4-22** and **Figure 4-5**). A ridge can be seen approximately 7km to the north and northeast of the site and dunes are present to the southwest.

The site lies within the area known as the Arab Formation limestone which is underlain by the Jubaila formation; both are carbonate rock of marine origin and of upper Jurassic age. The Arab formation is brown to tan in colour, composed of massive layers of fractures limestone, with some marly and dolomitic intercalation.

The residual soil varies from silty sand to silty clay sand with limestone gravel of various sizes. The Arab Formation extends down to about 20 to 40 meters which is then underlain by a more compact Jubaila Formation limestone rock. This is generally composed of strong, horizontally bedded, light brown to creamy pale or grey dolomite limestone with dark grey inclusions.

4.2.3 Land Use and Socio-Economic Environment

The Project site is undeveloped with no vegetation identified during the site reconnaissance undertaken in December 2014, and would seem to have been levelled in recent history. As aforementioned, WSP notes that the most recent digitised images provided by Google Earth Pro were antecedent to the site reconnaissance and reveal that the project site was supporting laydown areas in 2014, certainly associated with the construction of the PP-12 facility. Since, the overall footprint area of the proposed PP-13 site has been graded and no extensive laydown areas were identified in December 2014.

Adjacent sites include laydown areas to the north for the PP12, IP-11 and PP-13 facilities and various contractor yards that form a large part of the eastern spine of the site. From the access afforded to these contractor yards, it would seem that each yard comprises a laydown area, office space, and temporary accommodation blocks.

Prior to the development of power facilities at the site, the land was formerly used for agriculture as illustrated by **Figure 4-29** (digitised images dated 2006 provided by Google Earth Pro) which was

subsequently abandoned prior the commencement of the construction phase associated with the IPP-11 facility. The closest formal land use appears to be a small, active farm comprising of a number of fields and silos approximately 13 km away from the site and a mining operation approximately 16 km away.

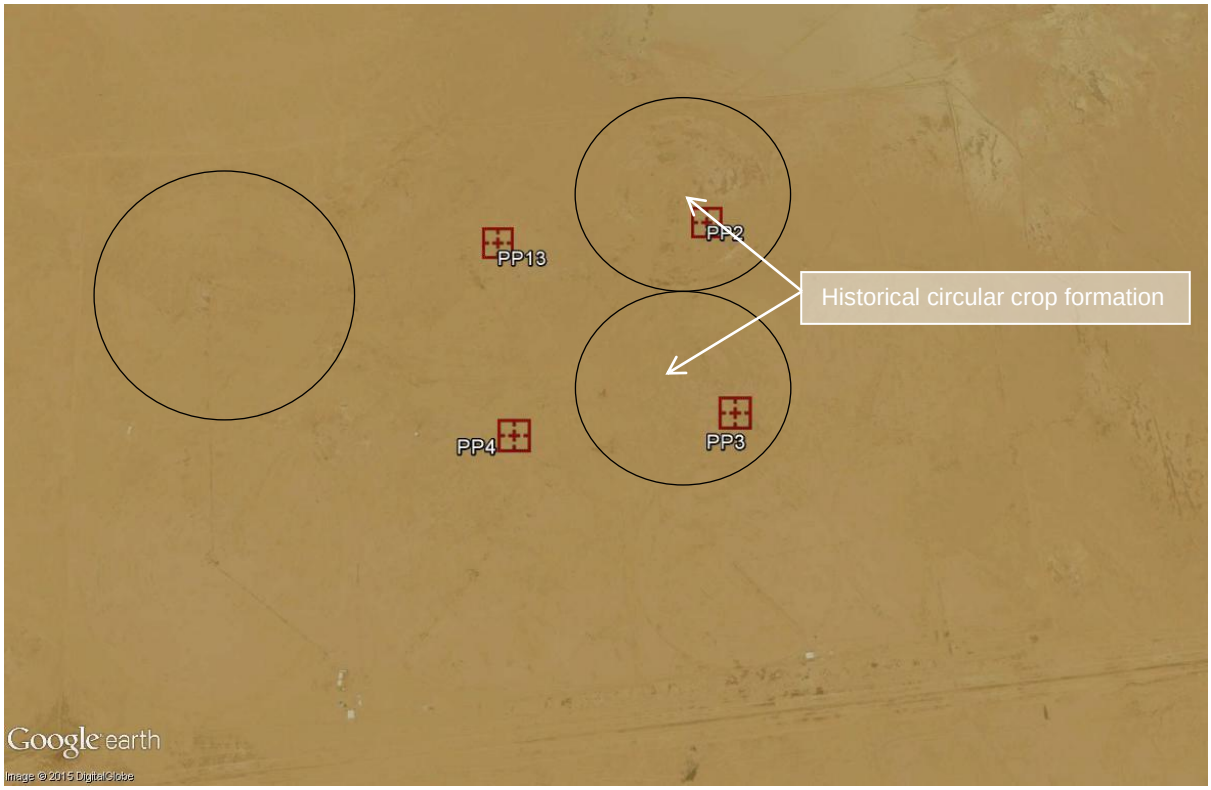


Figure 4-29: Google earth images dated 2006 showing historical circular crop formation.

4.2.4 Terrestrial Ecology (Flora and Fauna)

The site is situated within the WWF eco-region called 'Arabian Desert and East Sahero-Arabian xeric shrublands"[19]. This is a desert eco-region which holds relatively little biodiversity. The primary biomes in this region are deserts and xeric shrublands. Many species, such as the striped hyena, jackal and honey badger have become extinct in this area due to hunting, human encroachment and habitat destruction. Other species have been successfully re-introduced, such as the endangered Arabian oryx and the sand gazelle, and are protected at a number of reserves. Overgrazing by livestock, off-road driving, and human destruction of habitat are the main threats to this desert ecoregion.

The nearest protected area is thought to be the Jabal Tuwayq Nature Reserve, the south-western boundary of which is situated approximately 19km to the east of the Project site, and lies on the opposite side of Route 505.

[19] World Wildlife Fund (WWF), n.d. *Southwestern Asia: M Most of Saudi Arabia, extending into Oman, United Arab Emirates, Yemen, Egypt, Iraq, Jordan, and Syria* [Online] Available at: worldwildlife.org/ecoregions/pa1303 [Accessed 20 05 2013]

The site itself is on the western side of the Tuwaiq Escarpment, an 800km long narrow limestone plateau upon which Riyadh sits. Comprised entirely of a flat sand and gravel plain, the ecology observed on the site was unremarkable, with no vegetation identified during the site reconnaissance undertaken in December 2014.

4.2.5 Water Features and Water Supply

There are no surface water features present on site, and due to the flat topography of the Project site, no obvious drainage channels were identified during the site reconnaissance. However, it has been reported that a small groundwater facility is being currently operating at waypoint 1366 (**Figure 4-15**), located towards the south of the PP-13 footprint area, in order to provide water for dust suppression system, and excavation works associated with PP-13.

In addition, a number of former deep wells are located within the local area, which was previously used for agricultural purposes. None of these are currently active.

The local area is defined as an aquifer outcrop area by the Ministry of Agriculture (MoA) within their Aquifer Maps for the region.

4.2.6 Waste Management and Potential for Contaminated Land

No visible sources of waste and/or potential contamination were identified on the PP-13 footprint area. However, the main issue for the PP-13 project will relate to the potential use of sections of the site area as contractor laydown and temporary storage areas, which may generate waste materials within the Project site. It is however assumed that the site area has been cleared of any waste materials as no solid waste streams on the existing Project footprint area were identified during the site reconnaissance undertaken in December 2014. Although there may be a low risk of historical ground contamination.

4.2.7 Air Quality

Air pollution in KSA, as in other Middle Eastern countries, is generally considered to be a major issue with emissions of Sulphur Dioxide (SO_2) and Oxides of Nitrogen (NO_x) being very high by international standards, and urban populations often experiencing air pollution levels that exceed the WHO guidelines.

Population growth and the development of the oil industry have led to the increased use of heavy fuels for power generation, cement production, oil refining and water desalination. The use of heavy fuels in the operations of the above industrial sectors, poses significant ambient air quality issues as it contributes to the release of various air pollutants, particularly SO_2.

The PP-13 project is to be located between other power facilities in the area: IPP-11 currently operational, and the PP-12 currently under construction.

The site of the proposed facility is relatively remote. There are no major roads or urban centres in the vicinity of the site that could influence the local air quality. The main influences on local air quality are

therefore emissions from existing combustion sources at IPP-11 and those at PP-12 when the facility comes on stream. In addition, natural sources are also likely to influence local air quality to varying extents including natural particle emissions from the surrounding desert landscape.

A short term baseline air quality monitoring programme has been undertaken at the IPP-11 site in 2010 as part of an EIA conducted by WSP. This survey was undertaken over a period of 2 months to measure ambient NO_x, NO_2 and SO_2 concentrations.

The monitoring data shows that the ambient concentrations for NO_2 and SO_2 were all very low relative to the annual AQS for each pollutant. As might be expected, the highest concentrations were predicted to occur in the northern outskirts of Dhurma. This monitoring location is near a road, which would account for the higher concentrations relative to the other monitoring locations.

The impact of IPP-11 on ambient air quality levels was assessed as part of the EIA for the facility in 2010. The predictions within this ESIA showed that a very limited impact at sensitive receptor locations and the potential for exceedances of any of the relevant AQSs was determined to be negligible.

4.2.8 Environmental Noise

A baseline noise survey was undertaken at the IPP-11 site in 2010 as part of an EIA conducted by WSP. This survey found that, prior to the development of the IPP-11 facility; the local area was affected by few sources of noise, which is reflected in extremely low background noise levels recorded during daytime and night time periods.

The impact of IPP-11 on local noise levels was assessed as part of the EIA for the facility in 2010. The predictions within this ESIA showed that with the inclusion of appropriate noise barriers the noise levels at the IPP-11 boundary would not exceed 60 dB(A). At this stage however the impact of PP-12 is not known.

4.2.9 Transport and Infrastructure

The site itself is accessed by a purpose built sealed road which branches off Highway 505. The distance from Highway 505 to the site is approximately 20 km. An existing gas pipeline and telephone cable runs adjacent to this road.

4.2.10 Cultural and Archaeological

No features of cultural or archaeological significance were noted during the site visits (for IPP-11 and PP-13).

4.3 Key Sensitive Receptors

Based on the descriptions provided in this chapter, it is evident that the Riyadh PP-13 site is very remote and isolated from any permanent human settlements, with the exception of the permanent accommodation units located adjacent north to the existing IPP-11 facility, and temporary worker accommodation units associated with the PP-12 facility.



Figure 4-30: Temporary worker accommodation units associated with PP-12



Figure 4-31: Permanent residential units associated with IPP-11

Other sensitive receptors include soil and groundwater, which are potentially at risk of contamination, terrestrial ecology, waste management facilities, and human receptors (largely limited to those temporarily or permanently present on the wider SEC site).

A summary of potential sensitive receptors and possible impacts is provided in **Table 4-2** below:

Table 4-2: Key Identified sensitive receptors

Receptor	Potential Construction Impacts	Potential Operational Impacts
IPP-11 Permanent Accommodation Units	■ Exposure to dust and construction related emissions to air during PP-13 construction works. ■ Exposure to noise emissions during PP-13 construction works.	■ Health and safety ■ Exposure to air emissions from IPP-11, PP-12 and PP-13 ■ Exposure to noise emissions from IPP-11, PP-12 and PP-13
PP-13 Construction workers	■ Health and safety ■ Working conditions and welfare ■ Exposure to air emissions from IPP-11 & PP-12	-
Operational staff at IPP-11, PP-12 and PP-13	■ Exposure to dust and construction related emissions to air during PP-13 construction works (operational staff from IPP-11 and PP-12 only) ■ Exposure to noise emissions during PP-13 construction works (operational staff from IPP-11 and PP-12 only)	■ Health and safety ■ Working conditions ■ Exposure to air emissions from IPP-11, PP-12 and PP-13 ■ Exposure to noise emissions from IPP-11, PP-12 and PP-13
Terrestrial ecology	■ Loss of native habitats ■ Loss of native species	
Soil & groundwater	■ Contamination events associated with construction works	■ Contamination events associated with operations.

5 Impact Assessment Methodology

5.1 Methodology for the Assessment of Impacts

The assessment of the potential impacts of both the construction and operational phases associated with the project is based on a number of criteria, which are used to determine whether or not such effects are 'significant'. These significance criteria comprise:

- Local, national and international legislation, regulations and standards;
- Relationship with national planning policy;
- The sensitivity of the local environment;
- The reversibility/irreversibility and duration of effects;
- The inter-relationship, if any, between the effects – i.e. an assessment of cumulative impacts; and
- The results of consultations with the environmental regulator.

The significance of effects reflects judgements as to the importance or sensitivity of the affected receptor(s) and the nature, magnitude and duration of the predicted changes. For example, a large adverse impact on a feature or site of low importance will be of less significance than the same impact on a feature or site of high importance.

5.2 Sensitivity (Importance) of Receptors

Receptors are defined as the physical resource or user group that would be affected by a proposed development. The baseline studies identify potential environmental receptors for each topic. Certain receptors may be more sensitive to environmental effects than others, whilst the importance of a receptor may depend, for example, on its frequency or extent of occurrence at a local, national, regional or international scale.

5.3 Description of Effect

Effects (otherwise referred to as 'impacts') are defined as the physical changes to the environment as attributed to a project. For each topic, the likely environmental effects are identified and taken into consideration, including their magnitude, comparing the effects with and without the project in place.

Effects are defined as either 'adverse' or 'beneficial' and, depending on the discipline, either 'direct' (effects directly attributable to a project action/activity), or 'indirect' (effects that are not directly attributed to a project action/activity).

Effects are also divided into those occurring during the construction phase of a project, and those that occur during the operational phase. Again, dependent on the discipline, this SEA may refer to such effects as 'temporary' (generally during the construction phase), and 'permanent' (generally during the operational phase).

5.4 Significance of Effects

Prediction of impacts is essentially an objective exercise to determine what could potentially happen to the environment as a consequence of the project and its associated activities. Impacts have been categorised according to their various characteristics (e.g. are they detrimental or beneficial, direct or indirect, etc.). The various types of impacts that arise, and the terms used in this assessment are shown and discussed in the following tables and associated text.

5.5 Evaluation of Impacts

In evaluating the significance (i.e. importance) of impacts, the following factors were taken into consideration:

- *Impact severity:* The severity of an impact is a function of a range of considerations including impact magnitude, impact duration, impact extent, and legal and guideline compliance; and

Nature and sensitivity of the receiving environment: The characteristics of the receptor / resource will be taken into consideration with respect to its vulnerability / sensitivity to an impact / change. In evaluating the severity of the impacts, the following factors were taken into consideration:

- *Impact Magnitude*: The magnitude of the change that is induced (i.e. the percentage of a resource that is lost)
- *Impact Duration*: The time period over which the impact is intended to last;
- *Impact Extent*: The geographical extent of the induced change; and
- *Regulations, Standards and Guidelines*: The status of the impact in relation to regulations (e.g. discharge limits), standards (e.g. environmental quality criteria) and guidelines.

The tables below outlines the impact criteria used within the assessment of the Riyadh PP-13.

Table 5-1: Definition of impact type

Impact Type	Definition
Direct Impact	Impacts that result from a direct interaction between a planned project activity and the receiving environment (e.g. between occupation of a plot of land and the habitats which are lost).
Secondary Impact	Impacts that follow on from the primary interactions between the project and its environment as a result of subsequent interactions within the environment. (e.g. loss of part of a habitat affects the viability of a species population over a wider area).
Indirect Impacts	Impacts that result from other activities that are encouraged to happen as a consequence of the project (e.g. presence of project promotes service industries in the region).
Cumulative impact	Impacts that act together with other impacts to affect the same environmental resource or receptor.
Residual Impact	Impacts that remain after mitigation measures have been designed into the intended activity.

Table 5-2: Impact assessment terminology

Term	Definition
Impact magnitude	
Magnitude	Estimate the size of the impact (e.g. the size of the area damaged or impacted, the % of a resource that is lost or affected etc.)
Impact Nature	
Negative impact	An impact that is considered to represent an adverse change from the baseline, or introduces a new undesirable factor.
Positive impact	An impact that is considered to represent an improvement on the baseline, or introduces a new desirable factor.
Neutral impact	An impact that is considered to represent neither an improvement nor deterioration in baseline conditions.
Impact Duration	
Temporary	Impacts are predicted to be of a short duration and intermittent / occasional in nature.
Short-term	Impacts that are predicted to last only for a limited period but will cease on completion of the activity, or as a result of mitigation / reinstatement measures and natural recovery.
Long-term	Impacts that will continue over an extended period but cease when the project stops operating. These will include impacts that may be intermittent or repeated rather than continuous of they occur over an extended period of time.
Permanent	Impacts that occur once on development of the project and cause a permanent change in the affected receptor or resources that endures substantially beyond the project lifetime.
Impact Extent	
Local	Impacts are on a local scale (e.g. restricted to the vicinity of the facility etc).
Regional	Impacts are on a national scale (effects well beyond the immediate vicinity of the project and affect an entire region).
Global	Impacts are on a global scale (e.g. global warming, depletion of the ozone layer).

Table 5-3: Impact severity criteria

Impact Severity	Definition
Slight	Effects are very small and difficult to distinguish from the baseline / within natural fluctuations.
Low	Affects a specific group of localised individuals within a population over a short time period (one generation or less), but does not affect other trophic levels or the population itself.
Medium	Affects a portion of a population and may bring about a change in abundance and/ or distribution over one or more generations, but does not threaten the integrity of that population or any population dependant on it.
High	Affects an entire population or species in sufficient magnitude to cause a decline in abundance and / or change in distribution beyond which natural recruitment (reproduction, immigration from unaffected areas) would not return that population or species, or any population or species dependant upon it, to its former level within several generations.

The likelihood (probability) of an event occurring has been ascribed using a qualitative scale of probability shown in the table below.

Table 5-4: Likelihood categories

Likelihood	Definition
Extremely unlikely	The event is very unlikely to occur under normal conditions but may occur in exceptional circumstances, e.g. emergency conditions.
Unlikely	The event is unlikely but may occur under normal conditions.
Low likelihood	The event is likely to occur during normal conditions.
Medium likelihood	The event is very likely to occur during normal conditions.
High likelihood / inevitable	The event will occur during normal conditions.

The significance of each impact is determined by comparing the impact severity against the sensitivity of the receptor in the impact significance matrix provided in **Table 5-5** below:

Table 5-5: Determining the significance of impacts

		Sensitivity of Receptor				
		Low	**Low-Medium**	**Medium**	**Medium-High**	**High**
Impact Severity	**No Change**	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight	Negligible	Negligible	Negligible	Minor	Minor
	Low	Negligible	Negligible	Minor	Minor	Moderate
	Medium	Negligible	Minor	Minor	Moderate	Moderate
	High	Minor	Moderate	Moderate	Major	Major

Lastly, impacts are defined according to the following criteria:

Table 5-6: Definition of impacts

Significance	Definition
Positive Impact	An Impact that is considered to represent an improvement on the baseline or introduces a new desirable factor.
Negligible Impact	Magnitude of change comparable to natural variation.
Minor Impact	Detectable but not significant.
Moderate Impact	Significant; amenable to mitigation; should be mitigated where practicable.
Major Impact	Significant; amenable to mitigation; must be mitigated.
Critical Impact	Intolerable; not amenable to mitigation; alternatives must be identified – Project Stopper.

5.6 Cumulative Effects

Where possible the cumulative effects of the Project are considered within the ESIA. Two types of cumulative effects have been considered:

- **Type 1 Cumulative Impact**: the combined effects of different environmental factors from a single development on a particular receptor, e.g. one residential property may experience a degradation in local air quality and an increase in noise levels as a result of construction activities; and
- **Type 2 Cumulative Impact**: the combined effects of all developments within the area, e.g. impacts on air quality from one development may not be significant when considered alone, but may be significant in combination with other proposed developments.

The ESIA has considered Type 1 cumulative effects largely in relation to construction; whereby there is the potential for noise impacts together with dust emissions upon sensitive residential receptors to the north and south of the Project Site.

A detailed assessment of Type 2 cumulative effects associated with the operational phase of the Project has also been undertaken in relation to those activities which are those most likely to give rise to significant environmental impacts as follows:

- Air quality which includes numerical modelling to determine the air quality impacts associated with air emissions from the Project together with existing emissions from the adjacent IPP-11; and
- Noise which includes numerical modelling to determine the noise impacts associated with the operation of the Project together with existing noise emissions from IPP-11.

6 Air Quality

6.1 Introduction

WSP carried out an assessment of the potential air quality impacts arising from the operation of the Riyadh PP-13 Combined Cycle Power Plant (PP-13) under a range of operating scenarios, both in isolation and within the context of the existing emission sources at the power plant complex.

This chapter of the ESIA considers the issues relating to stack emissions from the proposed PP-13, as well as emissions from the existing 1,729 MW Riyadh IPP-11 Combined Cycle Power Plant (IPP-11) and the soon to be operational) 1,800MW Riyadh PP-12 Combined Cycle Power Plant (PP-12), which will characterise the baseline air quality when PP-13 would come into operation.

PP-13 will be located adjacent to IPP-11 and approximately 800m eastwards from PP-12, adding a further 1,700 to 2,000MW capacity at the site; however, the design of the proposed facility has not yet been finalised. Therefore, for the purposes of the air quality impact assessment, it has been assumed that the facility will be a similar design to PP-12, which is a 1,800MW combined cycle power plant. The design of the plant will consist of a series of gas turbines with a nominal capacity of 140 to 170MW each, which are capable of operating in a simple cycle (SC) mode and also include Heat Recovery Steam Generators (HRSG) and steam turbine generators (STG), together with appropriate auxiliary equipment to provide a combined cycle (CC) power plant. It has been assumed the plant will comprise six gas turbine (GT) units and heat recovery steam generator (HRSG) units and two steam turbines (ST). The gas turbines and steam generators are assumed to be divided into two blocks of three GT/HRSGs, with each block having one ST.

The primary fuel is to be Sales Gas, with Arabian Super Light (ASL) and distillate fuel (diesel) to be used as the secondary (back-up) fuels. The GT units will be capable of starting on either sales gas, or via distillate oil as the starting fuel for ASL.

Oxides of nitrogen (NO_x), Sulphur dioxide (SO_2) and fine particles (PM_{10}) emissions from PP-13 (operating at 100% load and according to an estimated annual operating profile) have been assessed using dispersion modelling. Modelling of the power plant operating in both combined cycle and simple cycle modes and using both primary and secondary fuels has also been undertaken. Emissions from IPP-11, located to the immediate east of the PP-13 site and PP-12, approximately 1.2km to the west of the PP-13 site, have also been included in the baseline and the cumulative impacts assessments.

The following key issues are considered in this chapter:

- Ambient air quality conditions at the existing site and at sensitive receptor locations;
- Emission characteristics and concentrations for key pollutants provided by the EPC for IPP-11 and by SEC for PP-12;

- Dispersion modelling of the area to establish the baseline conditions (when PP-13 would become operational), including the two power plants IPP-11 and PP-12; and
- Dispersion modelling of emissions from the proposed PP-13 facility to ensure adequate stack heights, to assess the significance of impacts of PP-13 and to assess the cumulative impact on local air quality of the additional plant.

Where significant impacts are identified appropriate avoidance and mitigation measures are provided, which are summarised below and set out in full in **Chapter 17 – Framework Construction Environmental Management Plan** and **Chapter 18 – Framework Operational Environmental Management Plan**.

6.2 Relevant Air Quality Emission Standards

6.2.1 International Standards

International guidelines for air emissions and ambient air quality are provided by the International Finance Corporation (IFC) of the World Bank Group for use in environmental assessments (IFC, 2007). However, it is stipulated in the IFC document that these guidelines are only for use in the absence of local (national) ambient air quality standards; therefore, they have been included in their entirety, but have only been used where national standards do not exist, which, in this case relates only to 10-minute mean SO_2 concentrations because national air quality standard exists for this averaging period in Saudi Arabia. The IFC ambient air quality guidelines for SO_2, nitrogen dioxide (NO_2) and PM_{10} are shown in **Table 6-1**. Guidelines have also been developed by the IFC for thermal power plants (IFC, 2008). The IFC guidelines include emissions limits for NO_x, SO_2, and PM_{10}, which are shown in **Table 6-2.**

6.2.2 National Standards

National ambient air quality standards as well as air emissions limits for KSA are provided by the Presidency of Meteorology and Environment (PME) in the Ambient Air Quality Standard March 2014, which amends the previous GER Standards for the Environment (PME 2006). Previously the emissions limits were based on mass of pollutant discharged per thermal input to the plant, rather than the emissions concentration format of the IFC guidelines. However, the updated National Environmental Standard 4: Control of Emissions to Air from Stationary Sources (PME 2014) provides standards in terms of concentrations and at a mass emission loading threshold, which allows a more accurate and direct comparison of IFC and PME emissions standards. The PME air quality standards (AQSs) and emission limits for the pollutants considered are shown in **Table 6-1** and **Table 6-2**, respectively.

Table 6-1: PME and IFC ambient air quality standards for SO_2, NO_2, PM_{10} and $PM_{2.5}$

Pollutant	Averaging period	PME (µg/m^3)	IFC EHS Guidelines (µg/m^3)
NO_2	1-hour Annual	660[(a)] 100	200 40
SO_2	10-min 1-hour 24-hour Annual	--[(b)] 730[(a)] 365[(c)] 80	500 -- 125 (interim target 1) 50 (interim target 2) 20 --
PM_{10}	24-hour Annual	340[(c)] 80	150 (interim target 1) 100 (interim target 2) 75 (interim target 3 50 70 (interim target 1) 50 (interim target 2) 30 (interim target 3) 20
$PM_{2.5}$	24-hour Annual	35[(c)] 15	75 (interim target 1) 50 (interim target 2) 37.5 (interim target 3 25 35 (interim target 1) 25 (interim target 2) 15 (interim target 3) 10

(a) Not to be exceeded more than twice per month (30 day period).
(b) No 10-min standard has been set by PME.
(c) 90th percentile of 24-hour means.

Table 6-2: PME/IFC emissions standards for SO_2, NO_2, PM_{10} and $PM_{2.5}$

Pollutant	PME	IFC EHS Guidelines (Combustion Turbines >50MWth)
		Non-degraded Airshed/Degraded Airshed
NO_x	500 mg/Nm^3 in non-degraded airshed 350 mg/Nm^3 in degraded airshed Threshold: 1000g/hr	Natural Gas fired - 51 mg/$Nm^{3(a)}$ (25ppm) – NDA/DA Oil-fired 152 mg/Nm^3 (74ppm) – NDA/DA
SO_2	600 mg/Nm^3 in non-degraded airshed 400 mg/Nm^3 in degraded airshed Threshold: 1000g/hr	No limit for Natural Gas fired power plants Use of 1% or less sulphur fuel in non-degraded air sheds (Oil-fired power plants) Use of 0.5% or less sulphur fuel in degraded air sheds (Oil-fired power plants)
Particulate Matter (PM_{10})	150 mg/Nm^3 in non-degraded airshed(b) 100 mg/Nm^3 in degraded airshed(b)	No limit for Natural Gas fired power plants 50 mg/Nm^3 in non-degraded airshed (Oil-fired power plants) 30 mg/Nm^3 in degraded airshed (Oil-fired power plants)
Particulate Matter ($PM_{2.5}$)	50 mg/Nm^3 in non-degraded airshed(b) 25 mg/Nm^3 in degraded airshed(b)	No limit specified for this pollutant

Nm^3 – Normalised cubic metre, reference conditions 273K, 101.3 kPa, dry gas, 15% oxygen.
(b) Above background conditions.

6.3 Pollutant Emission Concentrations for PP13

The exhaust characteristics and pollutant emissions data for the proposed PP-13 have been based on data contained in the Air Emissions Study (Parsons Brinckerhoff 2013) for PP-12 supplied by SEC. Analysis of the Sales Gas that will be utilised as the primary fuel for the proposed PP-13 indicates that there is effectively no sulphur present in the fuel; therefore, SO_2 emissions will be negligible. In addition to this, the gaseous fuel will also give rise to negligible emissions of fine particulates (PM_{10} and $PM_{2.5}$). ASL and diesel will be used as the secondary and start-up fuel for the facility. The specification for these two fuels shows that they have sulphur contents of 0.1% and up to 1%, respectively.

The concentrations of NO_x, SO_2 and PM_{10} in the emissions from PP-13 for the different fuels that will be utilised at the plant are shown in **Table 6-3** for comparison with the emission limits presented in **Table 6-2**. Data on emissions of $PM_{2.5}$ from the plants were not provided.

Table 6-3: SO_2, NO_x and PM_{10} emissions concentrations for the Riyadh PP-13

Pollutant	Concentration (mg/Nm3)		
	Sales Gas	ASL	Distillate
NO_x	41.6	869.1	916.4
SO_2	--	93.7	96.6
PM_{10}	--	12.5	13.1

A comparison of the emissions limits and the calculated emission concentration for the primary fuel shows that predicted emissions of NO_x complies with PME emission standard and IFC guidelines. For operation on the secondary (back-up) fuels, emissions of SO_2 and PM_{10} would comply with the PME emissions standards and IFC guidelines, whereas NO_x, emission concentrations exceed both the PME emissions standard and the IFC guidelines. The key issue here is that the emissions associated with the primary fuel on which the plant would normally operate comply with the PME emission limits and IFC Guidelines and only under short-term abnormal or emergency conditions are NO_x emissions likely to exceed the emission standards and guidelines for NO_x.

The IFC pollutant emission limit guidelines for Non-degraded and Degraded Airsheds are shown in **Table 6-2**. Based on the results of modelling previously undertaken for the EIA for the Riyadh IPP-11 Combined Cycle Power Plant (WSP, 2010), it is considered that the air shed within which the PP-13 facility and the other two plants lie would be currently defined as Non-degraded for the pollutants considered in the assessment. It is important to note that exceedances of the PME AQSs for fine particles (PM_{10} and $PM_{2.5}$) are possible with no additional contribution from industrial sources, such as the Riyadh power plants emissions. This is due to high background concentrations arising from natural sources (e.g. dust storms) and would not constitute a failure of the standard; therefore, the air shed is not considered Degraded for PM_{10}.

6.3.1 Projects Located in Degraded Air Sheds

Where facilities or projects are located within an air shed of poor quality, the IFC General EHS Guidelines for air emissions and ambient air quality require an operator to minimise incremental impacts by achieving the emissions limits shown in **Table 6-2** and where these emissions nevertheless result in excessive ambient impacts relative to local regulatory standards, the project should identify and implement site-specific off-sets that result in no net increase in the total emissions of those pollutants that are responsible for the degradation of the air shed.

The IFC General EHS Guidelines (IFC, 2007) state that an air shed should be considered as having poor air quality if nationally legislated AQSs (in this case PME standards) or WHO Air Quality Guidelines are exceeded significantly; however, no criteria are included to determine a significant exceedance. The results of previous modelling of the air shed (WSP, 2010), indicate that the air shed would not currently be considered as Degraded with respect to the pollutants emitted from PP-13.

6.4 Methodology

6.4.1 Scope

The scope of this assessment has included the following:

- Review of emissions data for the Riyadh IPP-11 Power Plant contained within the EIA for the facility and undertaken by WSP (WSP 2010);
- Review of the emission data and operating characteristics for the Riyadh PP-12 Power Plant supplied by SEC and used in the previous modelling studies undertaken by Parsons Brinckerhoff (Parsons Brinckerhoff 2013);
- Review of data, information and site plans for PP-13 supplied by SEC;
- Consultation with SEC on operating characteristics of PP-13 once it becomes operational;
- A desk study to confirm the locations that may be sensitive to changes in local air quality, including proposed sensitive receptor locations associated with the operation of PP-12 and potential sensitive receptor locations associated with the construction and operation of PP-13; and
- Review of relevant international and national air quality regulations, standards and guidelines for emissions to air from thermal plants and ambient air quality.

6.4.2 Prediction of Construction Phase Impacts

During the construction phase, activities undertaken within the site may cause dust and particulate matter to be emitted to the atmosphere.

Dust comprises particles typically in the size range 1-75 micrometres (µm) in aerodynamic diameter and is created through the action of crushing and abrasive forces on materials. The larger dust particles fall out of the atmosphere quickly after initial release and therefore tend to be deposited in close proximity (10 to 20 metres) to the source of emission. Dust therefore, is unlikely to cause long-term or widespread changes to local air quality; however, its deposition on property and cars can cause 'soiling' and discolouration. The site is in an area where there is a significant natural source of particulate material that will be readily entrained by the wind, therefore, the potential dust impacts during the construction period must be considered within this context.

The smaller particles of dust (typically less than 10 µm in aerodynamic diameter) are known as PM_{10} and $PM_{2.5}$ and represent only a small proportion of total dust released. As these particles are at the smaller end of the size range of dust particles, they remain suspended in the atmosphere for a longer period of time than the larger dust particles, and can therefore be transported by wind over a wider area (although the majority are generally deposited within 100m of the source). PM_{10} and $PM_{2.5}$ are small enough to be drawn into the lungs during breathing, which for sensitive members of the public could cause an adverse reaction. As a result of this potential impact on health, standards and objectives for PM_{10} and $PM_{2.5}$ are defined by PME.

A qualitative assessment of the potential impacts due to the generation and dispersion of dust, PM_{10} and $PM_{2.5}$ during the construction phase has been undertaken. As there are no formal assessment criteria for dust and PM_{10} and $PM_{2.5}$ generation and fine particle dispersion during construction, the significance of impacts associated with this phase of the project has been determined qualitatively by:

- Identifying the construction activities associated with the project which could generate dust and PM_{10} and their likely duration;
- Identifying sensitive receptors within 200m of the construction site boundary; and
- The prevailing wind direction.

Exhaust emissions from construction vehicles will have an impact on local air quality both on-site and adjacent to the routes used by these vehicles to access the site. Information on exact numbers of vehicles associated with the construction phase is not available; however, it is considered that vehicle movements associated with the construction phase are not likely to be significant. Therefore, a qualitative assessment of their impact on local air quality has also been undertaken.

6.4.3 Prediction of Operational Phase Impacts

Dispersion Model Used

The operational phase of PP-13 has been assessed using detailed dispersion modelling. The atmospheric dispersion model Aermod (version 7.7) was used for quantifying the impact of emissions from the plant at sensitive receptors in the area. Aermod is an advanced dispersion model for calculating concentrations of pollutants emitted continuously from point, volume and area sources and is approved by the United States Environmental Protection Agency (USEPA) and the Environment Agency in the UK for regulatory applications. This dispersion model is also specified as appropriate for assessments of this nature in the IFC General EHS guidelines (IFC, 2007).

The model includes algorithms which are also able to take into account the following (where suitable input data is available):

- Effects of building downwash;
- Complex terrain;
- Time varying emission rates;
- Chemical reactions;
- Plume rise as a function of distance; and
- Averaging times ranging from short-term (e.g. 10-minute or 1-hour) to annual.

Buildings and Topography

Both nearby buildings and complex topography can have a significant effect on the dispersion characteristics of the plumes from the stacks being assessed. Buildings can cause the plume to

come to ground much closer to the stack than otherwise expected, causing higher pollutant concentrations close to the source. Plumes can also impact on hillsides under certain weather conditions, or within a basin or hollow which may result in emissions being trapped for low level emissions.

Buildings that are likely to be constructed as part of the PP-13 Power Plant (e.g. Turbine hall and HRSG enclosures) which may have an impact on the dispersion of emissions from the stacks of the proposed plant have been identified and included in the model. The dimensions of these building have been assumed based on the buildings constructed for IPP-11 and to be constructed for PP-12.

The topography of the surrounding area is essentially flat and at the same elevation across the entire study area. Therefore, terrain data has not been included in the model.

Meteorological Data

Meteorological records of wind speed, direction and atmospheric stability parameters are required to predict the pollutant concentrations which could occur under different weather conditions.

With respect to the dispersion of pollutants, the atmosphere is commonly referred to in terms of its 'stability'. When the atmosphere is said to be 'stable', there is little turbulence and vertical movement of air. These conditions are almost exclusively confined to the hours between sunset and sunrise, and require light winds. Such conditions in conjunction with wind speeds of less than 1 m/s often give rise to the highest pollutant concentrations from a stack release.

'Unstable' atmospheric conditions are confined to the daytime when, primarily due to surface heating, there is considerable turbulence and rapid vertical movement, thus dissipating the pollutant fairly rapidly. Hence pollutant concentrations will decrease rapidly away from the source. Unstable conditions also favour light winds and strong to moderate levels of sunshine.

'Neutral' stability occurs under cloudier weather conditions and is biased towards higher wind speeds. A neutral atmosphere can persist during the day or night.

Five years (2005-2009) of sequential hourly readings of wind speed, direction and atmospheric boundary layer conditions from the observing station at Riyadh International Airport were considered. This observing station is located approximately 100km to the east of the proposed power plant and the closest where data suitable for dispersion modelling is collected. The modelling previously undertaken by WSP for IPP-11 indicated that data for 2005 produced the highest ground level concentrations at sensitive receptor locations; therefore, data for this year has been used for this dispersion modelling study to ensure consistency and comparability with the previous study.

The wind rose for 2005 is shown in **Appendix 2.1**, which identifies that the predominant wind directions are from the north northwest, north and north northeast, with winds from the south southeast also relatively frequent. Concentrations of each pollutant have been predicted over the averaging period of the relevant standards (i.e. 1-hour, 24-hour and annual mean) within the context of the individual operating conditions.

Modelling Scenarios

A number of scenarios covering a range of operating conditions at the plant have been assessed. These operating conditions represent the plant operating at maximum output (primary and secondary fuel) across an entire year and operating according to a more representative annual profile (primary fuel) with respect to the number of GTs in operation for a given period of the year. The scenarios are aimed at determining the potential worst-case impact, as well as impact under more representative normal operating conditions across a year.

Scenarios have also been modelled for PP-13 that take into account the plant operating in both combined cycle and simple cycle modes. These scenarios represent the normal operational conditions (combined cycle mode) with emissions from the stacks serving the HRSGs (main stacks) and abnormal operating conditions (simple cycle mode) with emissions coming directly from the GT and discharged through by-pass stacks serving the GT. Within these scenarios, assessment of the plant operating at maximum load and to a more representative annual profile (gas-fired) with respect to the number of GTs in operation for a given period of the year has also been undertaken.

In addition to the modelling scenarios for PP-13, emissions from the plants that would exist within the air shed when PP-13 comes into operation (Riyadh IPP-11 and PP-12) have been modelled to assess the cumulative impact of the plant. Emissions from these sources, in the absence of PP-13, determine the baseline air quality conditions of the air shed with respect to SO_2, NO_2 and PM_{10}, because there are no other significant sources of these pollutants within the air shed.

The same approach of modelling representative annual operating profiles was used for the other sources. It should be noted that a more detailed annual operating profile was used for emissions from PP-11, as this was available from the previous modelling study undertaken for the EIA for this facility. The same level of information regarding the various operating points (OPs) throughout the year was not available for PP-12 or PP-13 and therefore the annual operating profile was not as detailed. The scenarios that have been modelled are described in **Table 6-4** below.

Table 6-4: Description of operational scenarios

Scenario	Description	Operating Condition Details
1	Baseline[(a)] – All sources (IPP-11 and PP-12 operating according to annual profile)	• IPP-11 operating according to annual operating profile used for previous modelling undertaken for the plants EIA (number of GTs operating and load varied across the year).. • PP-12 operating according to annual operating profile based on IPP-11 profile with only the number of operating GTs varied according to the time of year. • PP-12 GTs assumed to be operating at maximum load when operating. • Both plants operating in combined cycle and gas-fired.
2A	Riyadh PP-13 – Maximum Load (Combined cycle)	• 6 x gas-fired GTs operating at 100% load over entire year. • Combined Cycle operation. • Main Stack height = 60m • Fuel sulphur content negligible (Sales Gas).
2B	Riyadh PP-13 – Annual Operating Profile (Combined Cycle)	• 3 to 6 x gas-fired GTs operating at 100% load over seasonal range. • Combined Cycle operation. • Main Stack height = 60m • Fuel sulphur content negligible (Sales Gas).
2C	Riyadh PP-13 – Maximum Load on Secondary fuel (Combined cycle)	• 6 x ASL or Diesel-fired GTs operating at 100% load over entire year. • Combined Cycle operation. • Main Stack height = 60m • Fuel sulphur content 0.1% (ASL) or 1% (Diesel).
2D	Riyadh PP-13 – Maximum Load (Simple Cycle)	• 6 x gas-fired GTs operating at 100% load over entire year. • Simple Cycle operation. • By-pass Stack height = 40m • Fuel sulphur content negligible (Sales Gas).
2E	Riyadh PP-13 – Maximum Load on Secondary fuel (Simple Cycle)	• 6 x ASL or Diesel-fired GTs operating at 100% load over entire year. • Simple Cycle operation. • Main Stack height = 40m • Fuel sulphur content 0.1% (ASL) or 1% (Diesel).
3A	Cumulative Impacts – Annual Operating Profile (Combined Cycle)	• IPP-11 operating according to annual operating profile used for previous modelling undertaken for the plants EIA. • PP-12 and PP-13 operating according to annual operating profile based on IPP-11 profile with only the number of GTs varied according to the time of year. • PP-12 and PP-13 GTs assumed to be operating at maximum load when operating. • All plants operating in combined cycle and gas-fired.
3B	Cumulative Impacts – Maximum load on secondary fuel (Combined Cycle)	• PP-11 operating according to annual operating profile used for previous modelling undertaken for the plants EIA. • PP-12 operating according to annual operating profile based

Scenario	Description	Operating Condition Details
		on IPP-11 profile with only the number of GTs varied according to the time of year. • PP-12 GTs assumed to be operating at maximum load when operating. • PP-13 operating at maximum load in combined cycle over entire year. • PP-13 fired on ASL. • PP-11 and PP-12 plants operating in combined cycle and fired on gaseous fuel.
3C	Cumulative Impacts – All sources at maximum load on secondary fuel (Combined Cycle)	• IPP-11, PP-12 & PP-13 operating at maximum load. • GTs assumed to be operating at maximum load when operating. • PP-11, PP-12 & PP-13 operating in combined cycle and fired on ASL.
(a) The baseline is representative of the situation that would prevail at the time PP-13 is anticipated to come into operation.		

Modelling Assumptions

The model input parameters used for this study are summarised in **Appendix 2.3**. For the Baseline Scenario, an annual operating profile had been developed for previous modelling for the IPP-11 Power Plant using detailed operating information supplied by EPC based on the anticipated power demand at the plant and different ambient conditions. In consultation with the EPC, five average operating power output levels were established for IPP-11, along with the period during the year the plant would be operating at each of the levels, together with the number of GTs operating.

Detailed operational data for PP-12 was not available at the time of preparation of the present ESIA report; however, emission data for the operation of the plant on the primary and secondary fuels was supplied and this data has been used to develop a less detailed annual operating profile. The annual profile assumes the number of GTs in operation varies across the year in the same manner as the annual operating profile previously developed for PP-11 and assume those GTs in operation were at maximum load for a single ambient temperature (45ºC). The data supplied for PP-12 indicated that there would be no emissions of SO_2 or fine particulates when firing on Sales Gas. The sales gas specification indicates that low levels of sulphur are present in the fuel (706 Grains per $100m^3$). Therefore, to ensure a worst case approach, emission concentration data for SO_2 for PP-11 (for OP1) operating on gas were used to calculate an emissions rate for this pollutant for PP12 and PP13, taking into account the different flow rates for the plants. The same approach was taken for fine particulates, where emission concentration data for PM_{10} for PP11 is used to calculate an emission rate for PP12 and PP13.

An EPC has not been selected for PP-13 and, as a result, detailed design information and data was not available; therefore it was necessary to make assumptions regarding the plant configuration and emission data for the proposed power plant. It has been assumed that PP-13 will have a similar configuration and output as PP-12. This includes the same emission characteristics for the GT/HRSG

units, but with six GT/HRSG units rather than eight as assumed for PP-12 (as stated in Parsons Brinckerhoff report for PP-12), based on advice from SEC. The number and type of buildings (e.g. turbine halls) were assumed to be the same as IPP-11. PP-13 was assumed to be oriented in the same way (i.e. in an east-west fashion) as PP-12, based on drawings supplied by SEC. It has been assumed that PP-13 site will be located immediately adjacent to the IPP-11 site

To accommodate the varying number of GTs in operation (for IPP-11, PP-12 and PP-13) and operating at varying loads across the year (for IPP-11) in the dispersion model, hourly emission files were created. These files allow each source pollutant emission rate and characteristics (temperature and efflux velocity) to be varied separately on a daily basis for each scenario where sufficient data allows. The operating conditions and the annual operating profiles used to develop the different hourly emission files for input to each of the models are presented in **Appendix 2.2**, together with a breakdown of the individual combustion units operating.

Scenario 1A represents the baseline situation when PP-13 would come into operation. The emission rates for NO_x, SO_2 and PM_{10} are based on the data supplied by the EPC for PP-11 and SEC for PP-12. Both power plants are assumed to be operating on gaseous fuel according to the annual operating profiles referred to above.

Scenarios 2A, 2B, 2C, 2D and 2E all represent the operation of PP-13 in isolation. For Scenario 2A, all GTs were assumed to be operating 24 hours per day, seven days a week, at the maximum operating load. This would not occur in reality due to the daily and seasonal variation in power demand; however, this has been modelled to allow the meteorological conditions that would give rise to the highest ground level concentrations to be identified, should the entire plant be operating at maximum load.

For Scenario 2B, the annual operating profile developed for PP-13 (based on the profile previously developed for IPP-11) shown in **Appendix 2.2** was used, where the number of GTs operating varies from 3 to 6 depending on the period of the year. All GTs were assumed to be operating at maximum load when in operation.

Scenarios 2C, 2D and 2E all represent abnormal or emergency operating conditions. Operation of the plant under these conditions would only last for a relatively short period of time and therefore annual average concentrations have not been assessed; however, the scenarios were assessed using a full year of meteorological data to allow the worst-case weather conditions for each of the scenarios to be identified. For Scenario 2C, PP-13 is assumed to be operating on secondary fuel (ASL or Diesel) in combined cycle mode, with all GTs operating and all at full load all year. For Scenarios 2D and 2E, PP-13 is assumed to be operating in simple cycle model on sales gas and ASL/diesel, respectively. The entire plant is also assumed to be operating continuously at full load across the entire year for these scenarios.

Scenario 3A is essentially the same as the Baseline scenario, but with the addition of PP-13. The proposed plant is assumed to be operating according to the annual operating profile used in Scenario 2B, which provides a more representative assessment of the cumulative impacts of the existing

emissions sources and those associated with the PP-13 facility over both the short-term and a period of a year. Scenario 3B represents abnormal or emergency operation at PP-13 and provides an indication of the cumulative impacts on local air quality under these operating circumstances. It has been assumed that PP-13 is operating at maximum load on diesel for the entire year to determine the worst case impacts; however, because these operating conditions would only occur for a short period of time before operation on the primary fuel was reinstated, annual mean pollutant concentrations have not been predicted.

Scenario 3C assumes that there is an interruption to the gas supply upstream of all the three power plants leading to all of the plants having to operate on secondary fuel concurrently. It has been assumed that the three plants would be operating at maximum load (worst case)..

Stack Parameters

The atmospheric dispersion of pollutants is affected by the efflux velocity at the stack exit point (which determines the momentum of the plume) and the temperature of the gases (which determines the thermal buoyancy of the plume). Both momentum and buoyancy contribute to plume rise. The atmospheric conditions then govern the degree of turbulent mixing of the plume.

Engineering data (stack heights and diameters etc), exhaust flow data, pollutant concentrations and mass emissions rates for the emission sources at PP-11 were based on data supplied by the EPC for the plant and for PP-12 and PP-13, the parameter were based on data supplied by SEC (for PP-12). Each GT/HRSG unit will be served by two stacks: a main stack where the exhaust gases have passed through the HRSG (combined cycle mode) and a by-pass stack where the exhaust gases are discharged from the GT without passing through the HRSG (simple cycle mode). For the baseline and cumulative scenarios, PP11 and PP12 have been assumed to be operating in combined cycle. This means there will be a total of 7 x main stacks at the PP11 and 8 x main stacks at PP12. Both combined cycle and simple cycle operations has been modelled for PP13; therefore, it has been assumed that there will also be 6 x main stacks and 6 x by-pass stacks at PP13. The emissions data used for PP13 is based on the data supplied for PP12.

Modelling Grid

Pollutant concentrations have been predicted over a variable grid of discrete receptor locations. The grid covers an area of 15 km by 15 km, extending out to a distance of 7.5km in all directions from the approximately the centre of the power plant complex centre (562400, 2741100) . A grid spacing of 50m was selected for a distance of 1.5km from the centre of the grid; from 1.5km to 3km, a grid spacing of 100m was used and from 3km to 7.5km from the centre of the site, a grid spacing of 200m was selected. This gave a total of 9,324 (gridded) receptor locations in the model, along with 91 boundary receptor locations. In addition, 21 discrete receptor locations were also included in the model to represent specific existing and proposed receptors, both on and off the power plant complex site, identified as potentially sensitive to changes in air quality.

NO_x to NO_2 Conversion

NO_x emitted to the atmosphere as a result of combustion will consist largely of nitric oxide (NO), a relatively innocuous substance. Once released into the atmosphere, nitric oxide is oxidised to NO_2, which is of concern with respect to health and other impacts. The proportion of nitric oxide converted to NO_2 depends on a number of factors including wind speed, distance from the source, solar irradiation and the availability of oxidants, such as ozone (O_3).

A study published by Janssen *et al* (1988) made extensive measurements of the percentage oxidation of NO_x to NO_2 in power station plumes, and derived empirical relationships based on downwind distance, ozone concentration, wind speed and season of the year. The findings indicated that the occurrence of NO_x in the form of NO_2 within 2km of a stack will vary between 20% and 50%. An assumption that there will be 100% conversion of NO_x to NO_2 for annual mean concentrations would therefore be an overestimation, thereby providing worst case results.

In the absence of specific national guidance on detailed dispersion modelling, guidance provided by the Air Quality and Modelling Unit (AQMAU) of the Environmental Agency in the UK on conversion ratios for NO_x and NO_2 for large combustion sources has been used. The guidance sets out a phased approach to determining the magnitude of predicted NO_x concentrations. The initial phase of this approach is screening, where a worst-case assumption of 50% and 100% oxidation is made for short-term and long-term averaging periods (respectively).

For the purposes of this assessment, and to ensure a worst-case assessment, it has been assumed that there will be a 50% and 100% conversion of NO_x to NO_2, for predicted 1-hour mean and annual mean concentrations, respectively.

Predicted 10-Minute Mean Sulphur Dioxide Concentrations

It is not possible to predict 10-min mean pollutant concentrations directly with the EPA-approved modelling software that has been used, namely AERMOD. To address this, a methodology for conversion of 1-hour mean predicted concentrations to 10-minute averages published in Canada has been used. This methodology provides a factor of 1.65 for converting a 1-hour mean predicted concentration to a 10-minute mean, based on the following equation:

$$[SO_2]_{(10\text{-min mean})} = (60\text{min}/10\text{min})^{0.28} \times [SO_2]_{(1\text{-hr mean})}$$

The factor was applied to the predicted maximum 1-hour mean SO_2 concentrations. This provides an indicative concentration for this averaging period.

Significance Criteria

The significance of the predicted concentrations for the operation of PP-13 has been based on the magnitude of the maximum predicted off-site concentrations relative to the PME AQS for the pollutant and averaging period as well as concentrations predicted at sensitive receptor locations. The residual impact is based on the actual predicted concentration, with the significance being based on the

impact of PP-13 without any further mitigation measures beyond those already incorporated in the design of the plant.

For the predicted pollutant concentrations, the assessment was based on the levels presented in **Table 6-5** (which have been developed in the absence of any published national guidance taking into account the IFC guidelines on impact significance).

Table 6-5: Criteria for determination of significance

Process Contribution as Percentage of Relevant AQS	Significance
0 – 5%	Negligible
5 – 25%	Minor
25 – 70%	Moderate
70 – 100%	Major
>100%	Critical

Impacts on pollutant concentrations will be either positive (concentrations predicted to decrease) or negative (pollutant concentrations are predicted to increase).

Calculation of Annual Greenhouse Gas Emissions

Data on the CO_2 exhaust concentrations, fuel consumption and emissions factors published by the International Panel on Climate Change (IPCC) have been used to calculate the additional annual greenhouse gas (GHG) emissions once PP-13 is operational.

6.5 Existing Baseline Conditions

6.5.1 Local Emissions Sources

The proposed facility is located in an area where there will be two other operational combined cycle power plants once it commences operation (PP11 and PP12). There are no major roads, other industrial sources or urban centres in the vicinity of the site that could otherwise influence the local air quality. Therefore, the main influence on local air quality with respect to NO_x and SO_2 will be PP11 and PP12. With respect to fine particles, PP11 and PP12 will contribute to ambient levels, however, the main source is likely to be natural sources (e.g. natural particle emissions from the surrounding landscape). The power plant complex site location is shown in **Figure 2-1** in **Chapter 2 – Project Description**. According to site plans provided by SEC, the PP-13 site will be located immediately west of the PP-11 site, as shown in **Chapter 4 – Project Site Overview.**

The Aermod dispersion model only calculates the pollutant contribution from the stacks under consideration. It has the capacity to allow for the contribution of background concentrations to total

pollutant concentrations in addition to those arising from the proposed facility; however, this requires hourly sequential background monitoring files, which are not available. Nevertheless, there are no significant sources of the pollutants present in the area other than the existing power plants and therefore, emissions from these facilities will determine the baseline air quality in the area subject to this assessment (15km by 15km area).

6.5.2 Air Quality Monitoring Data

There is no long-term air quality monitoring data available for the area of the proposed PP-13 facility. However, a short-term air quality monitoring programme (2 months) was undertaken at the site in 2010 as part of the EIA for the IPP-11 facility.

The monitoring program utilised diffusion tubes, deployed at 6 locations, to measure ambient NO_x, NO_2 and SO_2 concentrations (diffusion tubes were deployed at each location in triplicate for each compound). These locations are illustrated in **Figure 6-1** and **Figure 6-2** below. Diffusion tubes were installed over two, one month periods (28/01/2010 – 03/03/2010 and 03/03/2010 – 13/04/2010), a summary of the results are shown below in

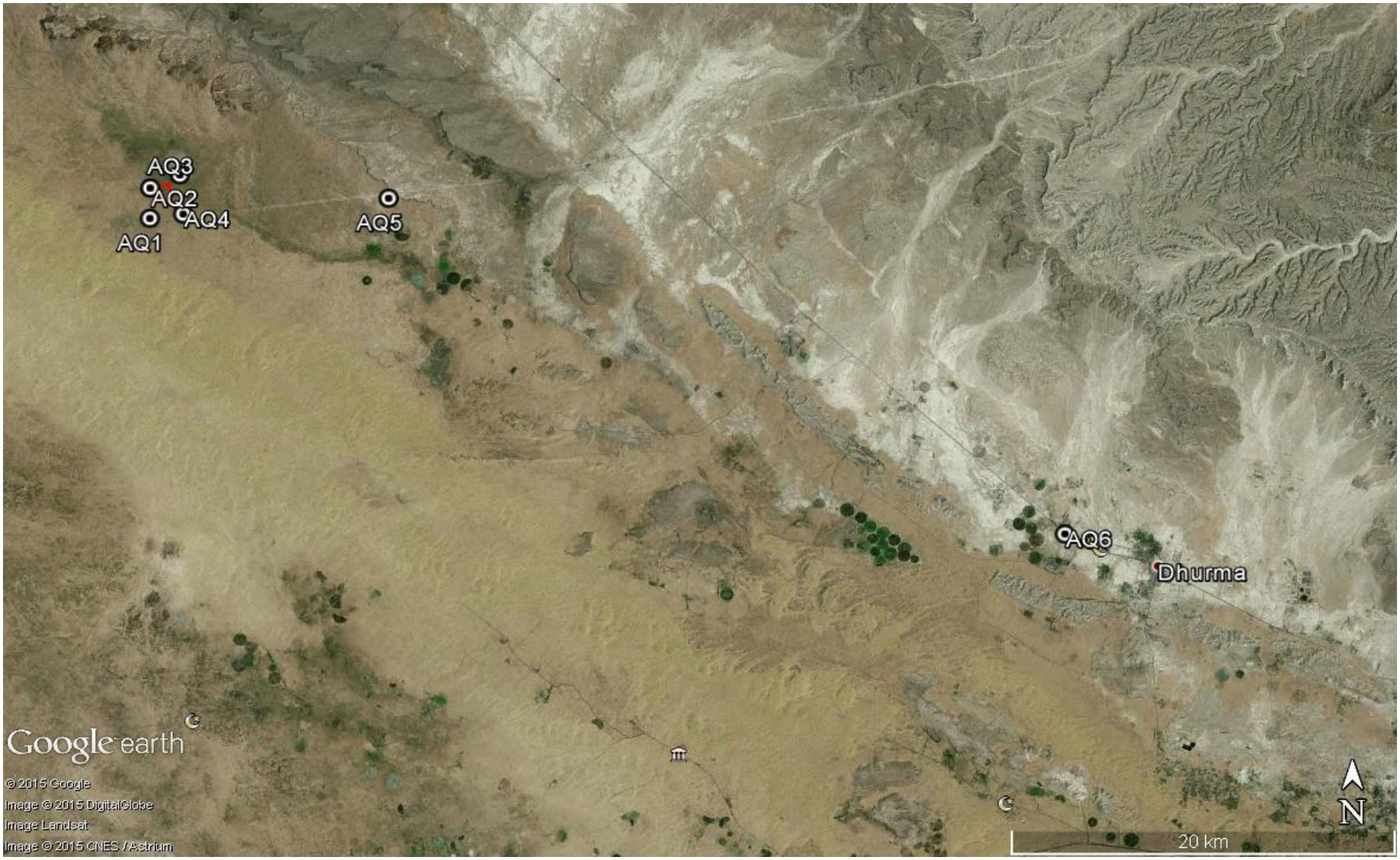


Figure 6-1 Diffusion tube monitoring locations: Wider area

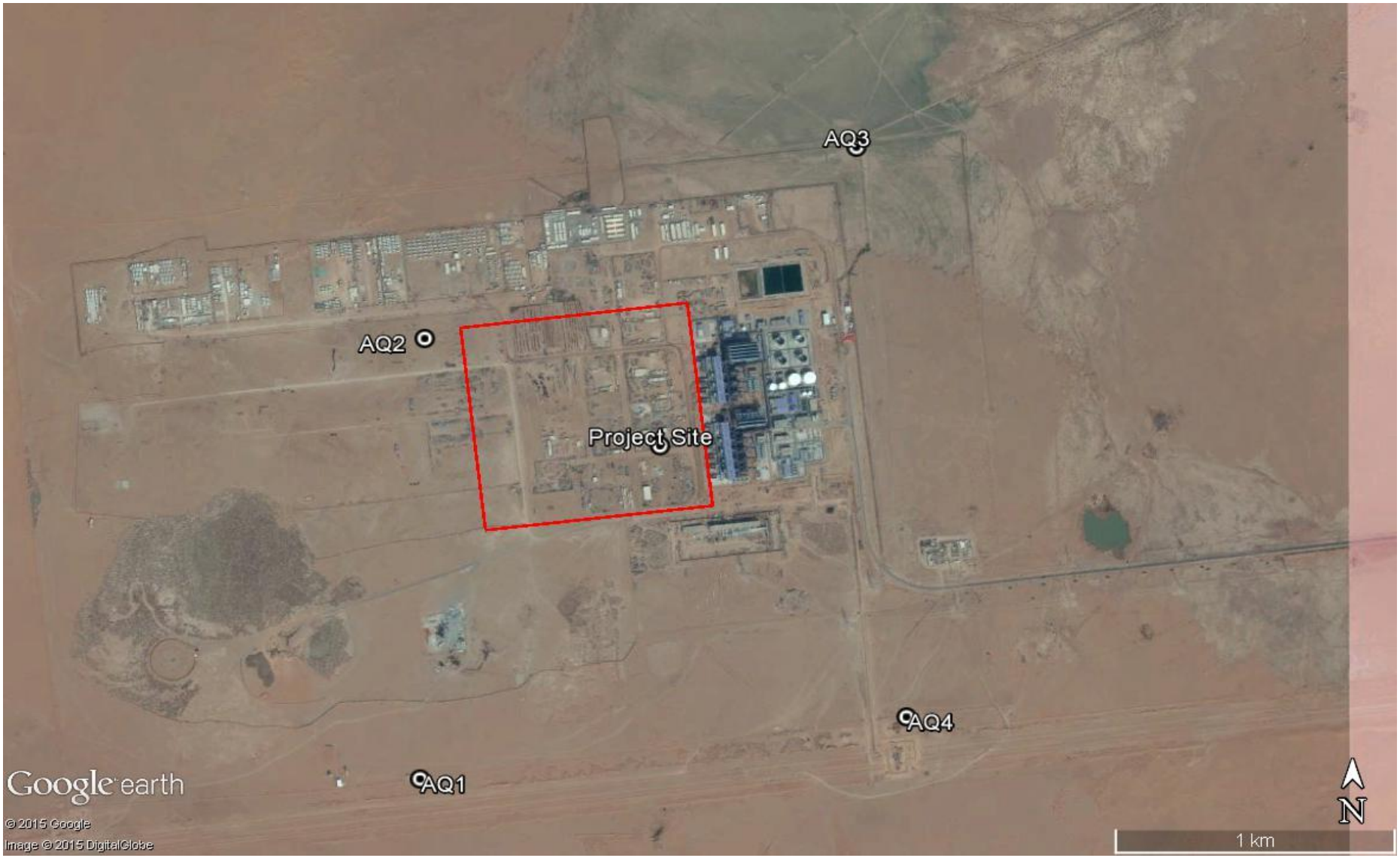


Figure 6-2 Diffusion tube monitoring locations: Project site

Table 6-6. The results from this programme provide a limited indication of the potential background concentrations for the key pollutants considered in the assessment (NO_2 and SO_2) in the absence of any power plant development. The average results for each site are shown in

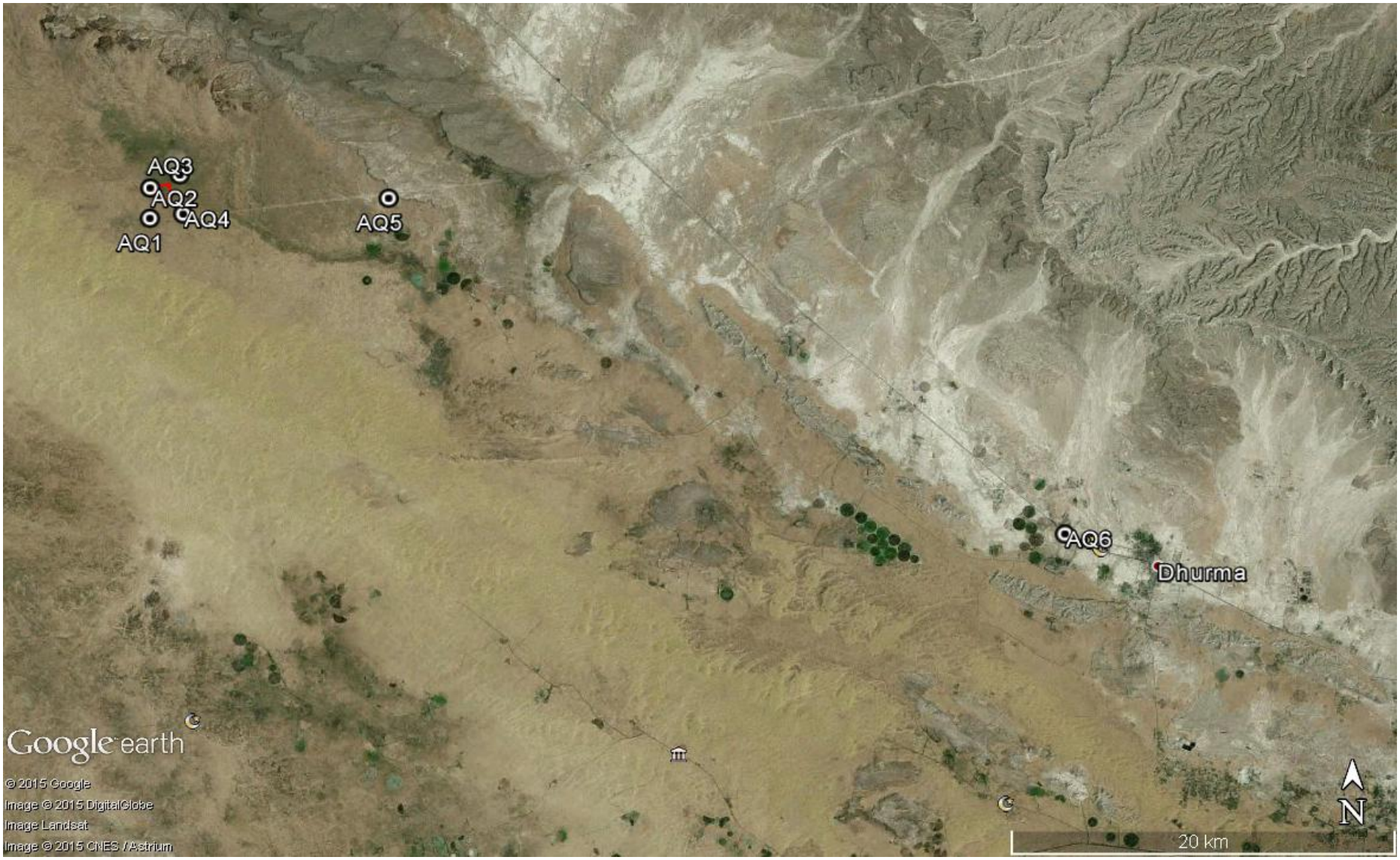


Figure 6-1 Diffusion tube monitoring locations: Wider area

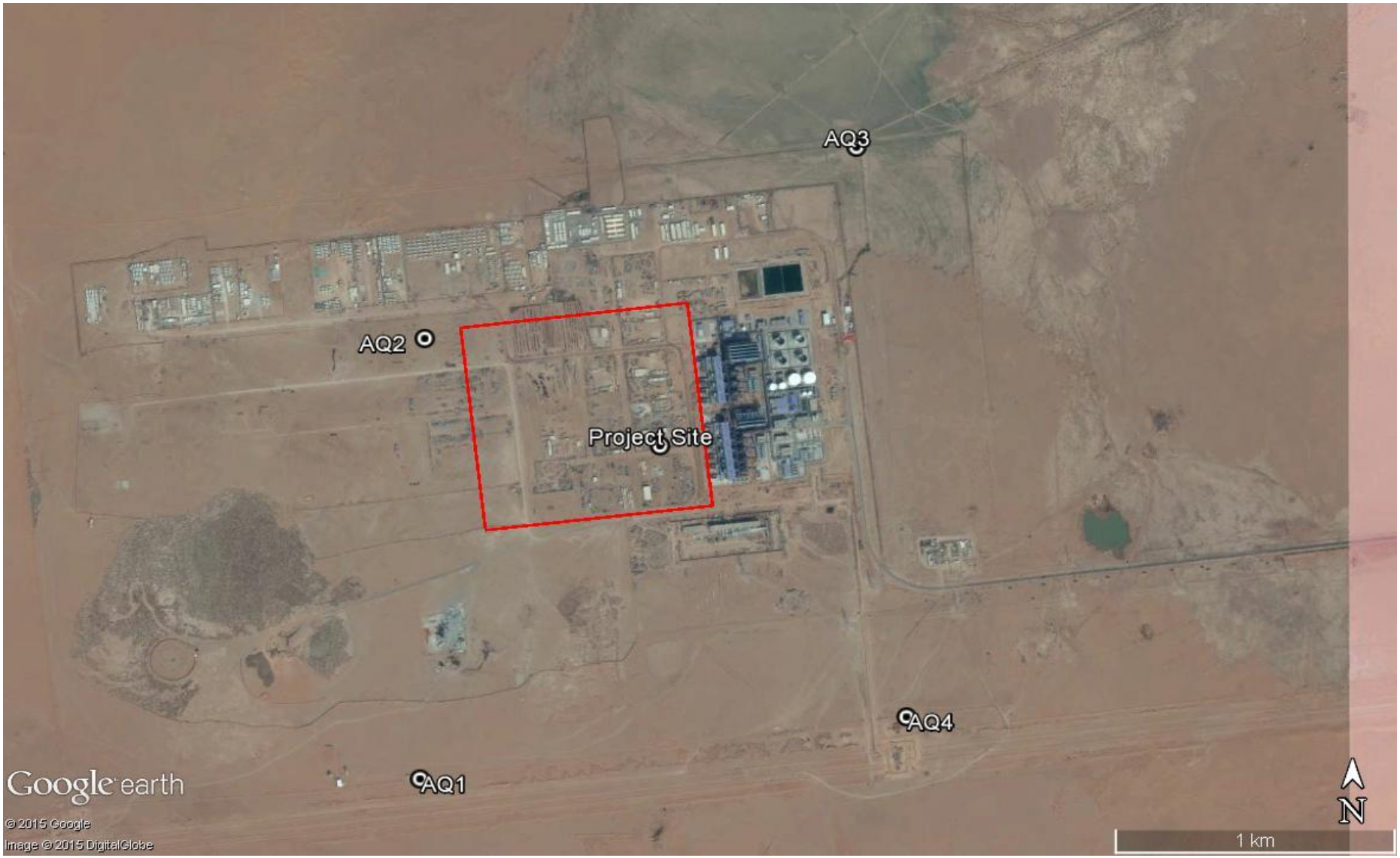


Figure 6-2 Diffusion tube monitoring locations: Project site

Table 6-6.

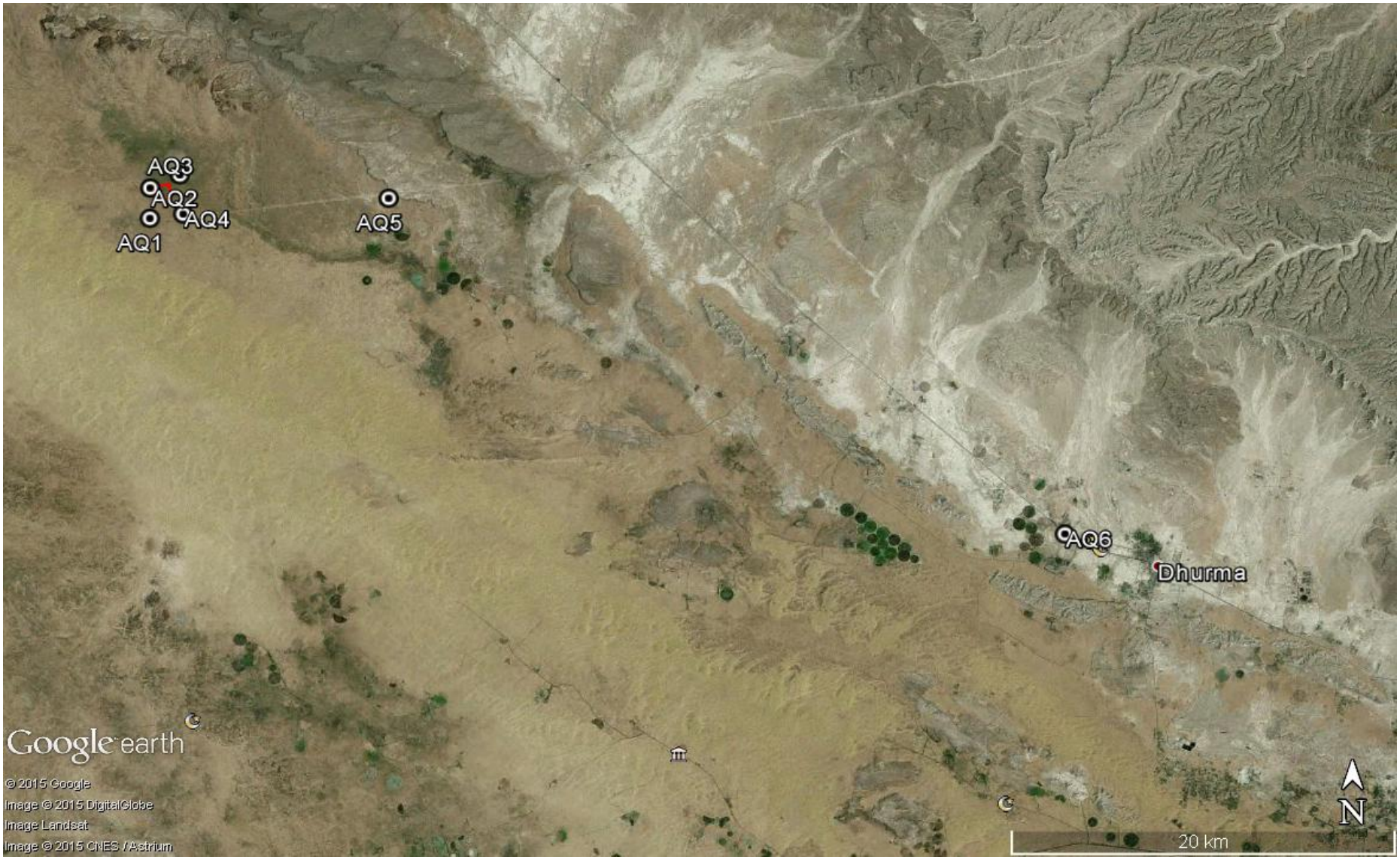


Figure 6-1 Diffusion tube monitoring locations: Wider area

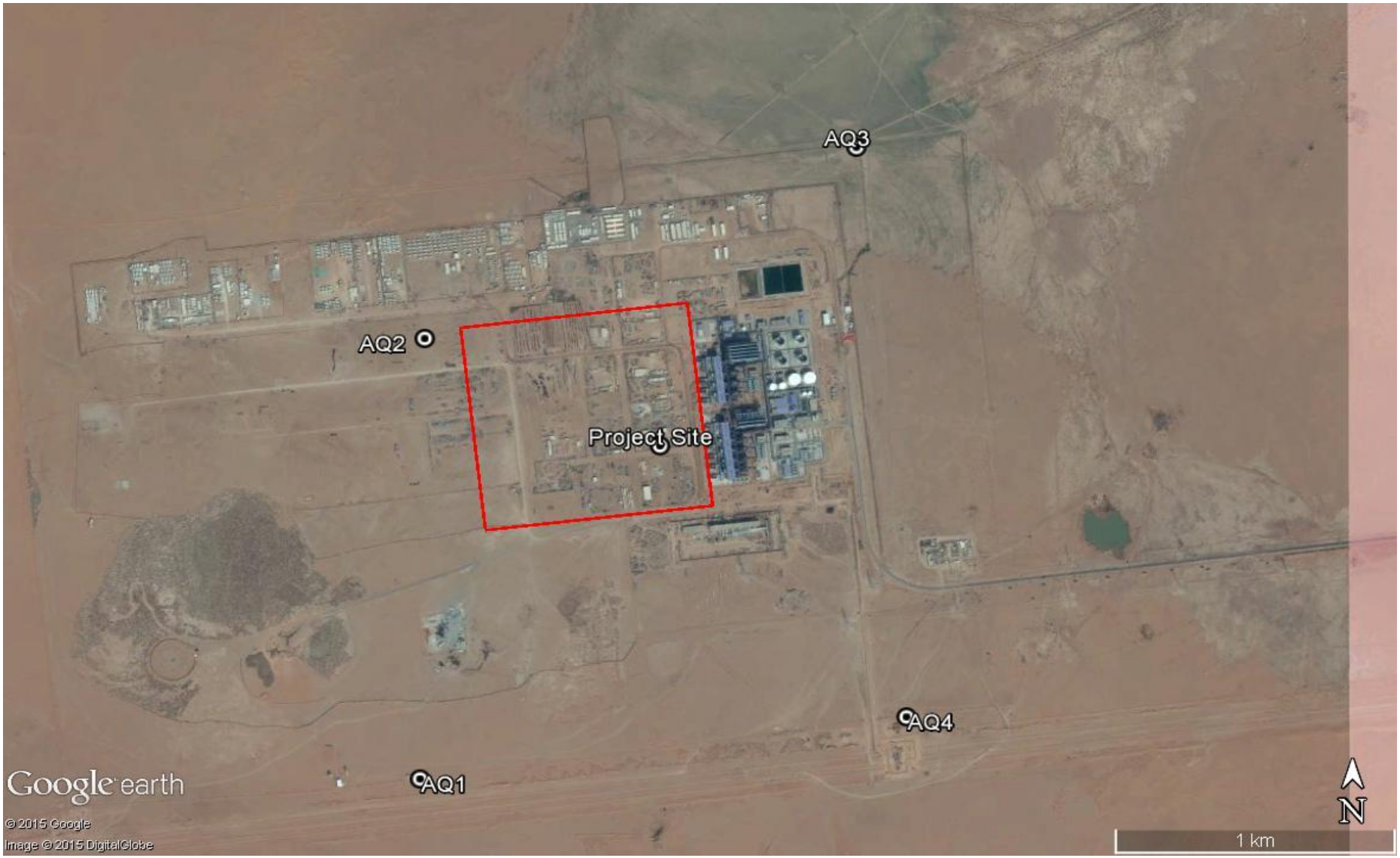


Figure 6-2 Diffusion tube monitoring locations: Project site

Table 6-6: Diffusion tube monitoring results

Location ID	Location Description	UTM Coordinates		NO_2 Concentration ($\mu g/m^3$)	NO_x Concentration ($\mu g/m^3$)	SO_2 Concentration ($\mu g/m^3$)
		Easting	Northing			
Month 1: 28/01/2010 to 03/03/2010						
1	SW corner of IPP site	562293	2740026	2.78	5.56	10.83
2	NW corner of IPP site	562302	2741687	3.07	3.34	9.67
3	NE corner of IPP site	563840	2742415	5.20	4.97	17.86
4	SE corner of IPP site	564029	2740268	4.59	4.80	14.45
5	Wheat/Fodder Fields and silos east of the IP site	574717	2741175	5.15	5.72	11.40
6	Northern outskirts of Dhurma	609950	2722935	14.33	7.18	39.27
Month 2: 03/03/2010 to 14/04/2010						
1	SW corner of IPP site	562293	2740026	3.64	3.76	3.57
2	NW corner of IPP site	562302	2741687	Sample Lost	Sample Lost	Sample Lost
3	NE corner of IPP site	563840	2742415	6.07	8.45	14.44
4	SE corner of IPP site	564029	2740268	4.67	4.15	13.44
5	Wheat/Fodder Fields and silos east of the IPP site	574717	2741175	4.21	6.39	4.77
6	Northern outskirts of Dhurma	609950	2722935	9.10	8.61	12.71
Average						
1	SW corner of IPP site	562293	2740026	3.21	4.66	7.20
2	NW corner of IPP site	562302	2741687	3.07	3.34	9.67
3	NE corner of IPP site	563840	2742415	5.64	6.71	16.15
4	SE corner of IPP site	564029	2740268	4.63	4.48	13.95
5	Wheat/Fodder Fields and silos east of the IPP site	574717	2741175	4.68	6.05	8.09
6	Northern outskirts of Dhurma	609950	2722935	11.72	7.90	25.99

The monitoring data indicate that the ambient concentrations for NO_2 and SO_2 were all very low relative to the annual AQS for each pollutant. As might be expected, the highest concentrations were predicted to occur in the northern outskirts of Dhurma. This monitoring location is near a road, which would also influence the concentrations relative to the other monitoring locations.

6.5.3 Local Meteorological Data

Site specific meteorological data is also not available for the study area. For the purposes of the modelling, hourly sequential meteorological data has been obtained for Riyadh International Airport, which is the nearest monitoring station to the site where meteorological data suitable for dispersion model input is collected.

Inter-annual Variation in Predicted Concentrations due to Meteorological Conditions

Screening modelling was undertaken previously for the preparation of the EIA for Riyadh IPP-11 Combined Cycle Power Plant (WSP, 2010), which assumed maximum operating conditions for each year of meteorological data (2005 to 2009) to determine the inter-annual variation in predicted concentrations (location of maximum impact) due to the effects of meteorological conditions alone. The results of the meteorological data screening showed that 2005 generally produces higher predicted ground level concentrations; therefore, to ensure consistency with the earlier study, dispersion modelling for the baseline, PP-13 and cumulative scenarios was undertaken using 2005 meteorological data.

6.6 Sensitive Receptors

The site is undeveloped apart from the operational IPP-11 and soon to be operational PP-12. The area immediately surrounding the site has been used in the past for camel farming and camps; however, these are transient activities and appear to have largely moved on from the area; as such, they are not considered permanently occupied residential areas. Therefore, these locations have not been specifically considered as discrete receptors; however, the areas where these activities may take place are covered by the modelling grid, so concentrations are predicted for the relevant areas. The locations that have been represented in the model by a number of discrete receptors in addition to the receptor grid are presented in **Table 6-7.**

Table 6-7: Sensitive receptor location included in the dispersion modelling

Receptor No.	Receptor Location	UTM Coordinates		Distance and Direction from Site Boundary
		Easting	Northing	
1.	IPP-11 Permanent Accommodation (SW corner)	563112.1	2741762.9	On SEC complex site
2.	IPP-11 Permanent Accommodation (SE corner)	562822.4	2741730.0	On SEC complex site
3.	IPP-11 Permanent Accommodation (NE corner)	562809.0	2741831.0	On SEC complex site
4.	IPP-11 Permanent Accommodation (NW corner)	563099.3	2741864.2	On SEC complex site
5.	IPP-11 Social Building (SW corner)	563641.5	2741327.0	On PP11 site
6.	IPP-11 Social Building (SE corner)	563657.9	2741331.1	On PP11 site
7.	IPP-11 Social Building (NE corner)	563655.8	2741351.5	On PP11 site
8.	IPP-11 Social Building (NW corner)	563639.5	2741349.4	On PP11 site
9.	IPP-11 Administration Building (SW corner)	563670.1	2741335.2	On PP11 site
10.	IPP-11 Administration Building (SE corner)	563715.0	2741339.2	On PP11 site
11.	IPP-11 Administration Building (NE corner)	563713.0	2741353.5	On PP11 site
12.	IPP-11 Administration Building (NW corner)	563670.1	2741349.4	On PP11 site
13.	Quarry	579650.0	2742930.0	15km East
14.	Goat Farming	583130.0	2742220.0	16km East
15.	Grain Silos	576290.0	2740520.0	12km East
16.	Aramco Pumping Station	584480.0	2742840.0	21km East
17.	Wheat/Fodder Fields	572955.0	2738800.0	9 – 21km Southeast
18.	PP-12 Administration Building	561030.9	2741154.6	On PP12 site
19.	PP-12 Musjid	561075.8	2741175.0	On PP12 site
20.	PP-13 Administration Building	562694.2	2741433.9	On PP13 site
21.	PP-13 Musjid	562739.1	2741454.3	On PP13 site

From the site plans for PP-12 supplied by SEC, it is not clear where permanent accommodation areas will be at that site, as there are for IPP-11. It is also not clear whether there will be any permanent

accommodation on the PP-13 site. As such, no specific discrete receptors have been included for such locations; however, the modelling grid covers the entire power plant complex area and provides a good indication of pollutant concentrations in any areas that may be used for permanent accommodation.

Receptors up to 20 km from the site have also been considered. These are all located to the east of the site and are located near the proposed natural gas pipeline corridor. The receptor locations/activities include a quarry, wheat/fodder fields, goat farming and an Aramco pumping station..

6.7 Assessment of Construction and Operational Impacts

6.7.1 Construction Phase Impacts

Construction Sources of Dust and Fine Particles

The main sources of dust and fine particles during construction activities include:

- Haulage routes, vehicles and construction traffic;
- Materials handling, storage, stockpiling, spillage and disposal;
- Exhaust emissions from site plant, especially when used at the extremes of their capacity and during mechanical breakdown;
- Site preparation and restoration after completion; and
- Construction and fabrication processes.

The construction phase has been estimated as being approximately 34 months in total, on the basis of other projects. During this time, the majority of the releases are likely to occur during the 'working week'. However, for some potential release sources, e.g. exposed soil produced from significant earthwork activities, in the absence of dust control mitigation measures, dust generation has the potential to occur 24 hours per day over the period during which such activities are to take place.

Distance from the Point of Generation to the Sensitive Receptor

Depending on wind speed and turbulence (not withstanding natural events such as dust storms), it is likely that the majority of dust will be deposited in the area immediately surrounding the source (up to 200m away). Because the proposed power plant site is within the existing power plant complex and in an area with little to no sensitive development, there are no permanent residential properties other than those associated with the IPP-11 and PP-12 workforce; however, there are large separation distances between the construction activities and these residential dwellings and there is unlikely to be a significant impact on air quality from construction activities. There may be camps occupied on a transitory basis and camel farming activities in the surrounding area; however, these activities would

occur outside the boundary of the site are likely to be located over 500m away from construction activities.

Prevailing Weather Conditions

The prevailing wind direction at the application site is from the north northwest, north and north northeast, with significant proportions of winds also coming from the south and the south southeast (refer to **Appendix 2.1**). With respect to dust emissions, moderate to strong wind speeds (e.g. above 5 m/s) tend to generate dust emissions through entrainment. On the basis of the 5 consecutive years of meteorological data for from Riyadh Airport (2005 – 2009), wind speeds of this magnitude occur for only around 15% of the time for all wind directions. Moderate to strong winds from the north northwest and south southeast occur most frequently at approximately 2.3% and 2.6% of the time in total for each direction (respectively), which represents approximately 8 days per year. For the majority of wind directions however, moderate to strong winds occur for less than 1% of the time (approximately 4 days per year).

The wind speed and direction data indicates that moderate to strong winds occur relatively infrequently and there are no sensitive receptors (residential, schools, hospitals etc.) located downwind near the application site boundary that could potentially be affected by dust emissions from the application site. In addition, any permanent accommodation block within the boundary of the power plant complex are also likely to be separated by distances of over 500m from the construction activities for PP-13 and not downwind of construction activities.

Despite the low potential for giving rise to off-site dust nuisance, it will be important to ensure that any releases of dust and other emissions to the atmosphere are controlled during the construction period. This would not be difficult to achieve with standard mitigation measures and good working practices. Dust control measures are presented below and in **Chapter 17 – Framework Construction Environmental Management Plan**.

By consideration of the factors described above the overall impact of dust nuisance would therefore be temporary, short-term, local in effect and of **minor negative** significance at worst in the absence of any mitigation measures. During construction, concentrations of PM_{10} in the locality will be elevated. As the magnitude of these releases is relatively small compared to total dust, any effects resulting from them are likely to be local, temporary, short-term and of **minor negative** to **negligible** significance.

Release of Emissions to Air from Construction Traffic

Construction traffic associated with the proposed PP-13 will increase traffic levels on the local access road for the site. The greatest potential for impacts on air quality from traffic associated with the construction phase of the proposed development will be in the areas immediately adjacent to the principal means of site access for construction traffic. However, there are few receptor locations in close proximity to the routes affected by construction traffic, and the level of construction tr traffic is

unlikely to be significant. Therefore, the impacts on local air quality of emissions associated with construction traffic would to be localised, temporary, and **negligible** significance.

6.7.2 Operational Baseline

Table 6-8 shows the maximum predicted ground level pollutant concentrations for the plants which would form the baseline (Scenario 1), i.e. IPP-11 and PP-12. The baseline represents the future situation when PP-13 would become operational. A full set of results for the Scenario 1 modelling is provided in **Appendix 2.4**.

The Baseline scenario assumes the existing IPP-11 and PP-12 plants are operating according to representative annual operating profiles (refer to **Section 6.3.1** and **Appendix 2.2**). The predicted concentrations for this scenario are considered more representative of the future situation rather than assuming maximum load continuously at the two plants and are relevant to all averaging periods. The results show that there are no exceedances of the PME AQSs or IFC Guidelines predicted for the pollutants considered with the existing power plants operating on gaseous fuel. The modelling showed that the highest predicted 1-hour concentrations were predicted to occur in July, whereas the highest 24-hour mean concentrations were predicted to occur in March.

Table 6-8: Baseline – Maximum ground level pollutant concentrations (scenario 1)

Scenario	Pollutant Concentration (µg/m^3)			
Maximum SO_2 Concentrations	Annual Mean	99.72%ile of 24-hr Mean	Maximum 1-hr Mean	10-min Mean[(a)]
Air Quality Standard	80	365	730	500
Scenario 1 – Baseline	1.48 (2%)[(b)]	9.50 (3%)	24.09 (3%)	40.82 (8%)
Maximum NO_2 Concentrations	Annual Mean		Maximum 1-hr Mean	
Air Quality Standard	100	No 24-hour Standard or Guideline Applicable	660	No 10-min Standard or Guideline Applicable
Scenario 1 – Baseline	18.65 (19%)		151.58 (23%)	
Maximum PM_{10} Concentrations	Annual Mean	99.72%ile of 24-hr Mean		
Air Quality Standard	80	340	No 1-hour Standard or Guideline Applicable	No 10-min Standard or Guideline Applicable
Scenario 1 – Baseline	3.44 (4%)	9.91 (3%)		

(a) No PME AQS exists for 10-minute mean SO_2 concentrations. The value shown is the IFC guideline.

(b) The value shown in the parentheses is the percentage of the PME AQS or IFC guideline the concentration represents.

Figure 6-3 and **Figure 6-4:** below are contour plots showing annual and 1-hour mean NO_2 concentrations for the baseline scenario, respectively, as the pollutant with the highest predicted concentrations relative to the AQSs. The figures clearly show the individual impacts of the plants, also demonstrating that the highest predicted concentrations occur on the power plant complex site and are well below the respective PME AQS (and also comply with the IFC Guidelines). The contour

plots also illustrate the rapid drop off of pollutant concentrations with distance from the complex boundary.

The highest predicted 1-hour mean NO_2 concentration at a sensitive receptor location is 31.6 µg/m^3, which is predicted to occur at the PP-12 Administration Building (Receptor 18). The highest predicted 1-hour mean NO_2 concentration at the IPP-11 permanent accommodation area is 21.7µg/m^3 (at Receptor 2), which is equivalent to 1.5% of the PME AQS. The highest predicted 1-hour NO_2 concentration at an off-site sensitive receptor location is 4.9 µg/m^3 (less than 1% of the PME AQS), which occurs at the wheat/fodder fields to the east of the plant.

For annual mean NO_2 concentrations, the highest concentration predicted for a residential location also occurs at the IPP-11 permanent accommodation area (Receptor 1) and is 2.1µg/m^3 (2% of the AQS). Concentrations significantly lower than this are predicted for all the off-site sensitive receptor locations.

For SO_2 and PM_{10}, the highest predicted concentrations for all averaging periods and at locations of relevant exposure (relevant to the averaging periods) are all markedly lower than the NO_2 concentrations relative to the applicable PME AQS and IFC Guideline. Therefore, the baseline air quality at the site and surrounding area where sensitive receptors are located is considered to be relatively good and the air shed would be considered as Non-degraded.

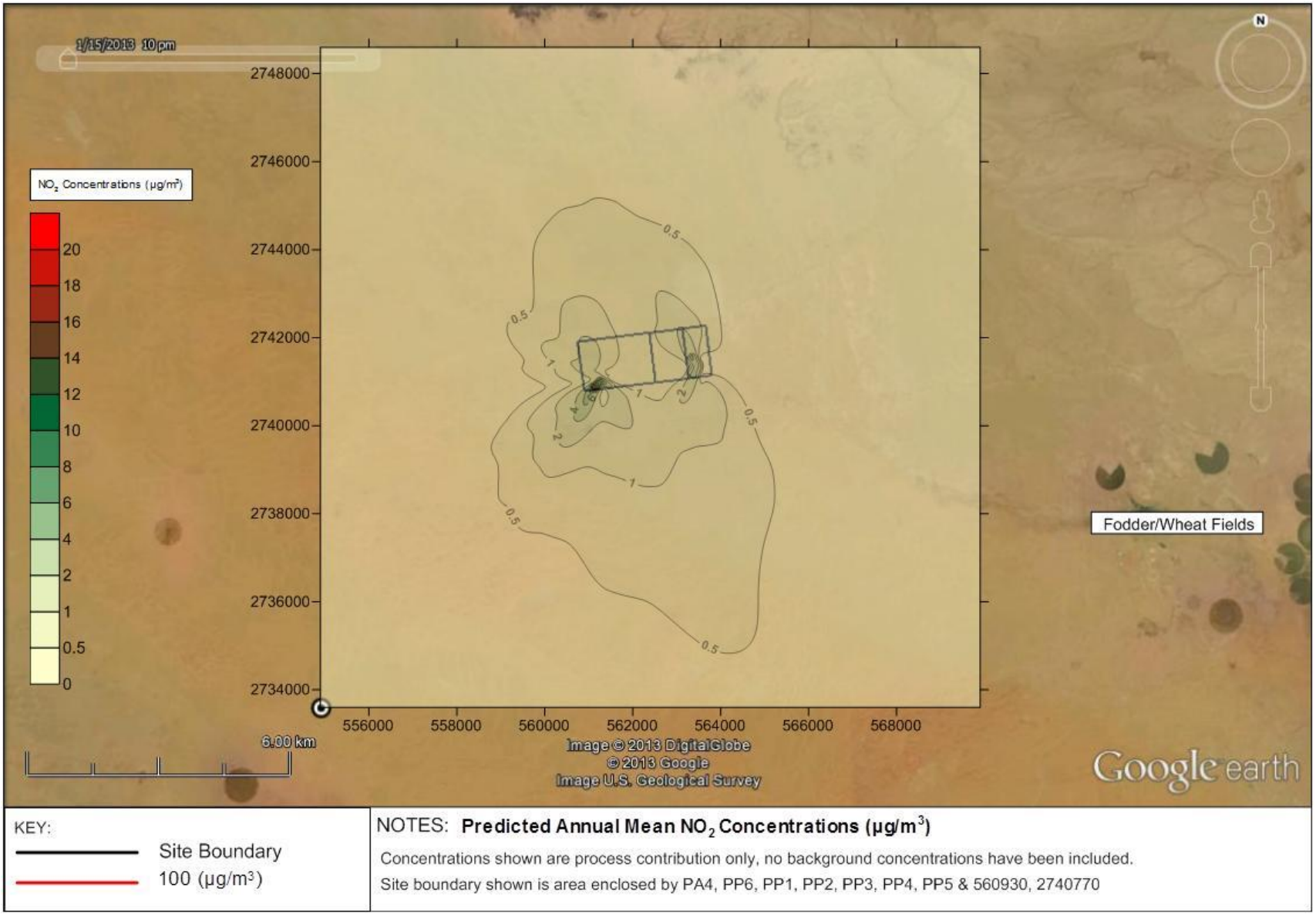


Figure 6-3 Baseline – Annual operating profile: annual mean NO_2 concentrations (scenario 1)

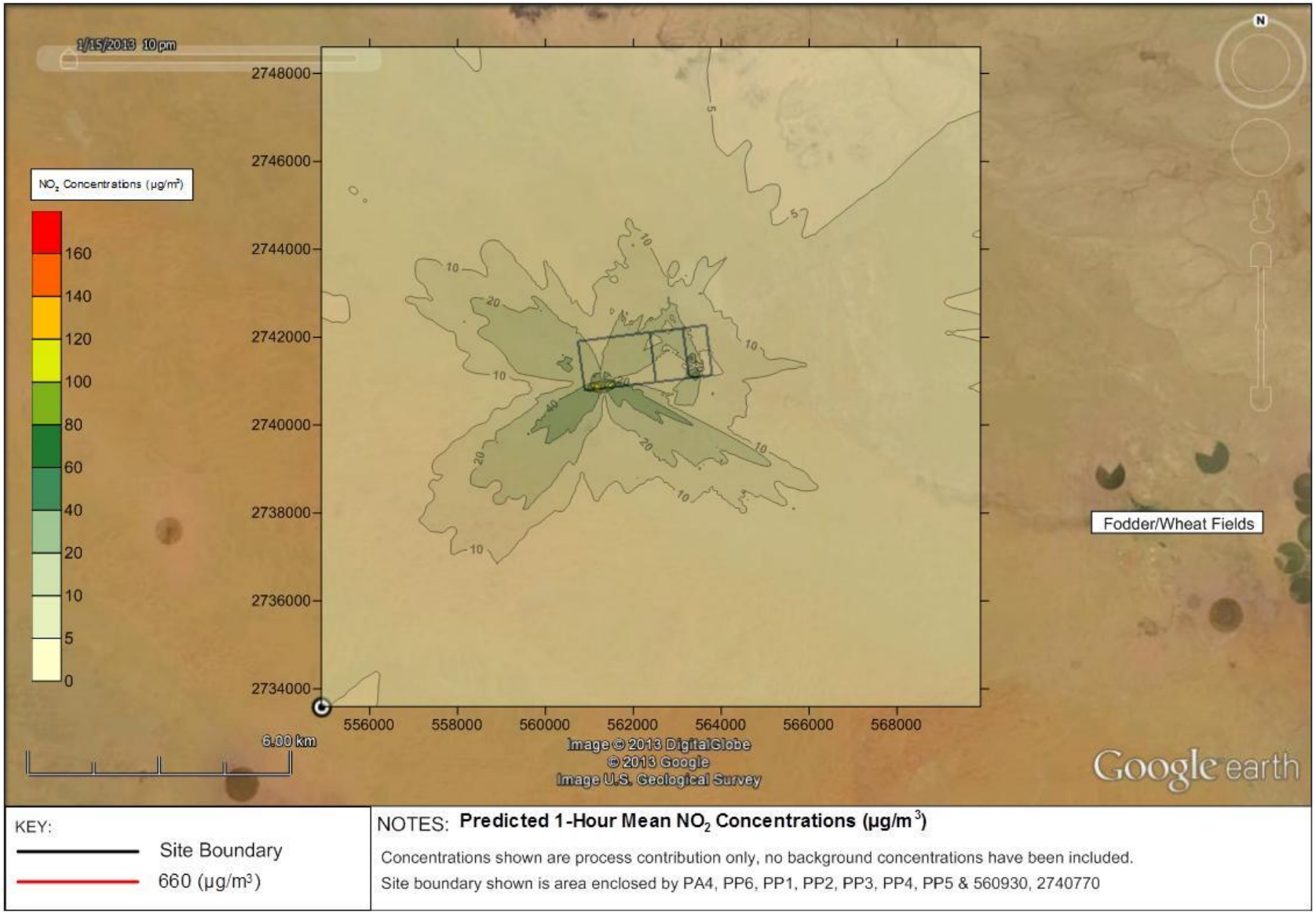


Figure 6-4: Baseline – annual operating profile: 1-hour mean NO_2 concentrations (scenario 1)

6.7.3 Future Operational Impacts

Riyadh PP-13 Combined Cycle Power Plant – Impact of Increasing Stack Heights

An analysis of the impact of varying the stack heights at the proposed PP-13 was undertaken assuming a continuous maximum load on the plant and using a full year of meteorological data. Stack heights starting from 60m (as the minimum design stack height) and increasing to 80m (in 5m increments) were modelled assuming operation on Sales Gas for NO_x emissions. NO_x was selected because this is the pollutant with the greatest mass emission rate (g/s). The highest predicted NO_2 concentrations for each of the stack heights are shown in **Table 6-9.**

Table 6-9: Riyadh PP-13 – Maximum ground level pollutant concentrations for increasing stack heights

Averaging Period/Stack Height	*Concentration (µg/m^3)*[(a)]				
	60m	***65m***	***70m***	***75m***	***80m***
Maximum 1-hr Mean	102.9 (16%)	89.7 (14%)	73.8 (11%)	57.5 (9%)	35.2 (5%)
Annual Mean	13.3 (13%)	8.9 (9%)	5.8 (6%)	3.2 (3%)	1.7 (2%)
(a) The value in the parentheses is the percentage of the relevant PME AQS.					

The results of the stack height analysis show that predicted ground level concentrations of NO_2 resulting from the operation of the plant would not exceed PME AQSs or IFC Guidelines for NO_2 for any of the stack heights considered. Increasing the stack height above the design minimum of 60m does reduce ground level NO_2 concentrations; however, the highest predicted concentrations for 60m stacks at the point of maximum impact were well below the respective PME AQS and occurred within the boundary of the power plant complex, with concentrations reducing rapidly with distance from the boundary. Therefore, it is considered that the 60m design stack height will ensure that pollutants emitted from the stacks at the plant are dispersed adequately before reaching ground level so as to prevent any exceedances of the PME AQS or IFC Guidelines.

Riyadh PP-13 Combined Cycle Power Plant – Operational Impacts

Table 6-10 shows the maximum predicted ground level pollutant concentrations for emissions from PP-13 operating according to the conditions for Scenarios 2A, 2B, 2C, 2D and 2E, which are presented in **Table 6-4** in **Section 6.3.1**. A full set of results for the modelling for PP-13 are provided in **Appendix 2.5**. The Scenarios cover combined cycle operation for both maximum plant load and according to an annual operating profile, together with simple cycle operation under maximum plant load. In addition, operation of the plant utilising the secondary fuels, ASL and diesel, have also been considered.

For Scenario 2A, the results show that even assuming worst case operational conditions (i.e. maximum load on the plant throughout the entire entire year) when utilising sales gas, the predicted concentrations at the point of maximum impact are well below the applicable PME AQSs and IFC Guidelines for short-term averaging periods.

Table 6-10: Riyadh PP-13 (standalone plant) – Maximum ground level pollutant concentrations

Scenario	**Pollutant Concentration (µg/m^3)**			
Maximum SO_2 Concentrations	**Annual Mean**	**99.72%ile of 24-hr Mean**	**Maximum 1-hr Mean**	**10-min Mean[(a)]**
Air Quality Standard	*80*	*365*	*730*	*500*
Scenario 2A	NA[(b)]	9.44 (3%)6.75 (2%)[(c)]	22.42 (316.35 (2%)	38.88 (830.44 (6%)
Scenario 2B	0.86 (1%)	8.675.29 (2%)	20.76 (315.91 (2%)	38.41 (829.10 (6%)
Scenario 2C[(d)]	NA	192.99 (53132.78 (36%)	525.42 (72388.49 (53%)	937.01 (187**767.84 (154%)**
Scenario 2D	NA	7.70 (2%)	18.63 (3%)	32.44 (6%)
Scenario 2E	NA	206.05 (56159.44 (44%)	506.11 (69435.44 (60%)	875.37 (175**731.96 (146%)**
Maximum NO_2 Concentrations	**Annual Mean**		**Maximum 1-hr Mean**	
Air Quality Standard	100	No 24-hour Standard or Guideline Applicable	660	No 10-min Standard or Guideline Applicable
Scenario 2A	NA		141.12 (21102.90 (16%)	
Scenario 2B	17.14 (1710.82 (11%)		130.66 (20100.11 (15%)	
Scenario 2C[(d)]	NA		2,448.97 (371**1,804.05 (273%)**	
Scenario 2D	NA		117.21 (18101.60 (15%)	
Scenario 2E	NA		**2,022.07 (306%)**	
Maximum PM_{10} Concentrations	**Annual Mean**	99.72**90%ile of 24-hr Mean**		
Air Quality Standard	*80*	*340*	No 1-hour Standard or Guideline Applicable	No 10-min Standard or Guideline Applicable
Scenario 2A	NA	21.80 (6.4 (2%)		
Scenario 2B	3.15 (41.99 (2%)	20.03 (65.70 (2%)		
Scenario 2C[(d)]	NA	25.81 (87.21 (2%)		
Scenario 2D	NA	17.79 (56.12 (2%)		
Scenario 2E	NA	27.56 (89.59 (3%)		

(a) No PME AQS exists for 10-minute mean SO_2 concentrations. The value shown is the IFC guideline.

(b) NA means not applicable. This is because these operating conditions would not prevail for 12 months, therefore the annual mean is not applicable to this scenario.

(c) The value shown in the parentheses is the percentage of the PME AQS or, in the absence of an AQS, the IFC guideline that the concentration represents.

(d) The concentrations shown for SO_2 and PM_{10} are for ASL; however, the concentration shown for NO_2 is for diesel, because a higher ground level concentration was predicted for diesel compared to ASL for NO_2, whereas the opposite was true for the other two pollutants.

The highest 1-hr mean concentrations (NO_2 and SO_2) are predicted to occur in September, when it is unlikely that all the GTs at the plant would be required to operate continuously at 100% load (i.e. all eight GTs at maximum load). Similarly, the highest 24-hour mean concentrations (SO_2 and PM_{10}) are predicted to occur in March, when the plant is again unlikely to be operating continuously at 100% load for 24 hours.

For sensitive receptor locations on and off-site, the highest predicted short-term pollutant concentrations are only a small fraction of the relevant PME AQS and/or IFC Guideline. The highest predicted 1-hour NO_2 concentration (as the pollutant with the highest predicted concentrations) at a sensitive receptor is 23.6µg/m^3 (4% of the PME AQS) and is predicted to occur at the PP-13 Administration Building (Receptor 20). For all sensitive receptor locations outside the power plant complex, short-term concentrations are below 1% of the PME AQS.

For Scenario 2B, where the assumed operating conditions are more representative of the operation of PP-13 throughout the year as power demand varies, it can be seen from the data in **Table 6-10** that the maximum short-term concentrations are lower than Scenario 2A. The highest 1-hour and 24-hour mean concentrations occur during the summer period when power demand is consistently at its highest and the plant was assumed to be operating at maximum load. The highest predicted short and long-term concentrations at sensitive receptor locations for Scenario 2B are consistently lower than those predicted for Scenario 2A. The short-term mean and annual mean concentrations are well below the PME AQS and IFC Guideline (where the latter is relevant) for each pollutant considered at the point of maximum impact. **Figure 6-5** and **Figure 6-6** are contour plots of the annual and 1-hour mean NO_2 concentrations, respectively, for Scenario 2B and clearly show that the maximum impacts are confined to within the boundary of the power plant and reduce rapidly with distance from the source.

The highest predicted short-term concentrations at sensitive receptor locations for Scenario 2B are only slightly reduced, if at all, compared to Scenario 2A because the maximums at these locations are predicted to occur in the summer months when the plant is assumed to be operating at maximum load. With the exception of two locations on the PP-13 site (Receptors 20 and 21), the maximum annual mean pollutant concentrations are below 1% of the respective PME AQS for all sensitive receptors.

Scenario 2C represents PP-13 operating in combined cycle mode on a secondary fuel (ASL or Diesel). The circumstances under which the plant will operate on the secondary fuels would be as a result of an interruption in the supply of gaseous fuel and would be relatively short duration; therefore, the annual averaging period is not relevant to this situation, as such annual mean concentrations have not been presented.

It should be noted that for this scenario it has been assumed that the plant is operating at maximum load for the entire year to ensure worst-case predictions have been captured. As can be seen from the results in **Table 6-10**, no exceedances of the PME AQSs are predicted for SO_2 or PM_{10}; however, the highest 1-hour mean NO_2 concentrations exceed the PME AQS and IFC Guideline by a large margin at the point of maximum impact; this is a similar case for 10-minute mean SO_2 concentrations, which may exceed the IFC Guideline.

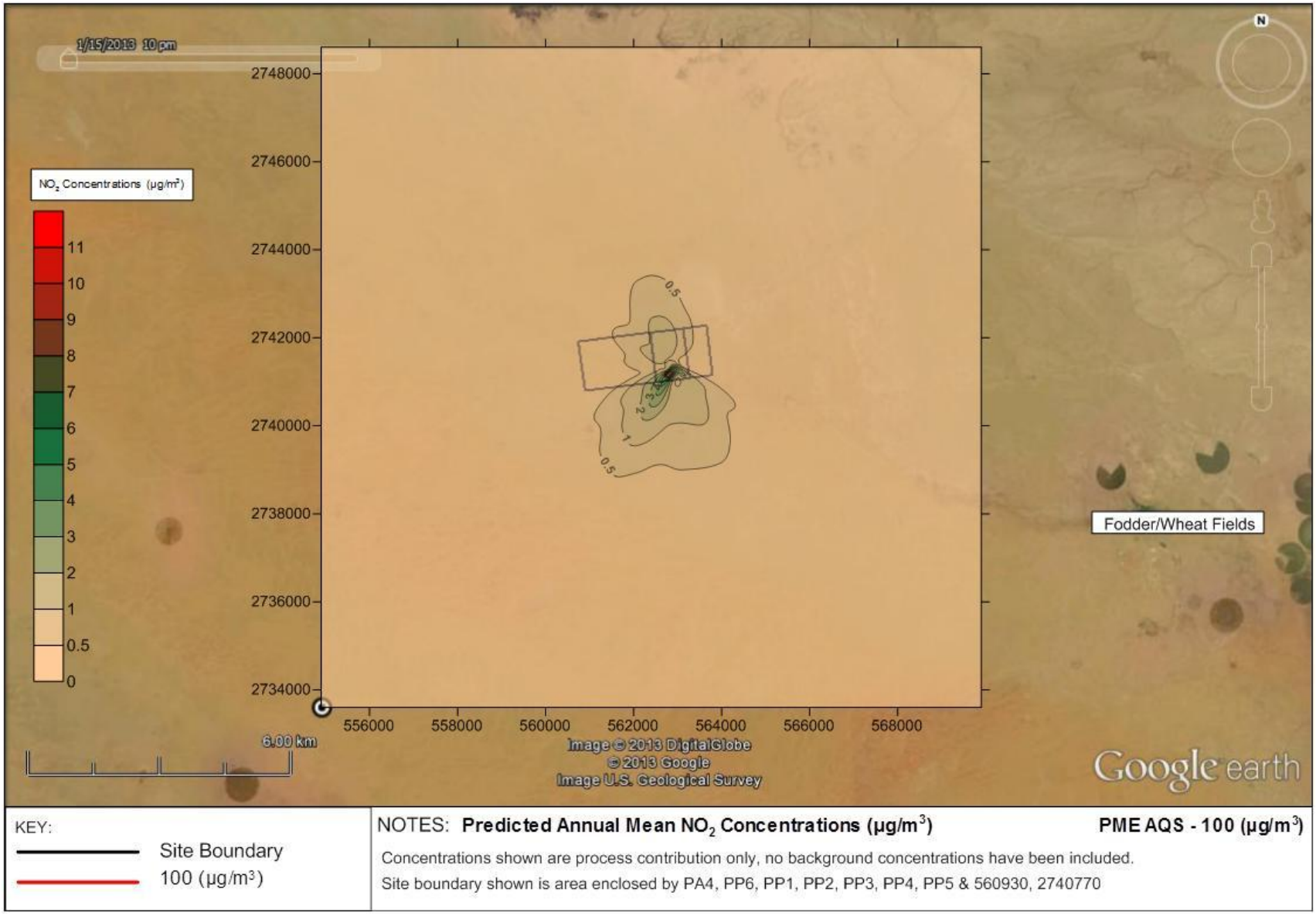


Figure 6-5: Riyadh PP-13 – Annual operating profile (combined cycle mode): annual mean NO_2 concentrations (scenario 2B)

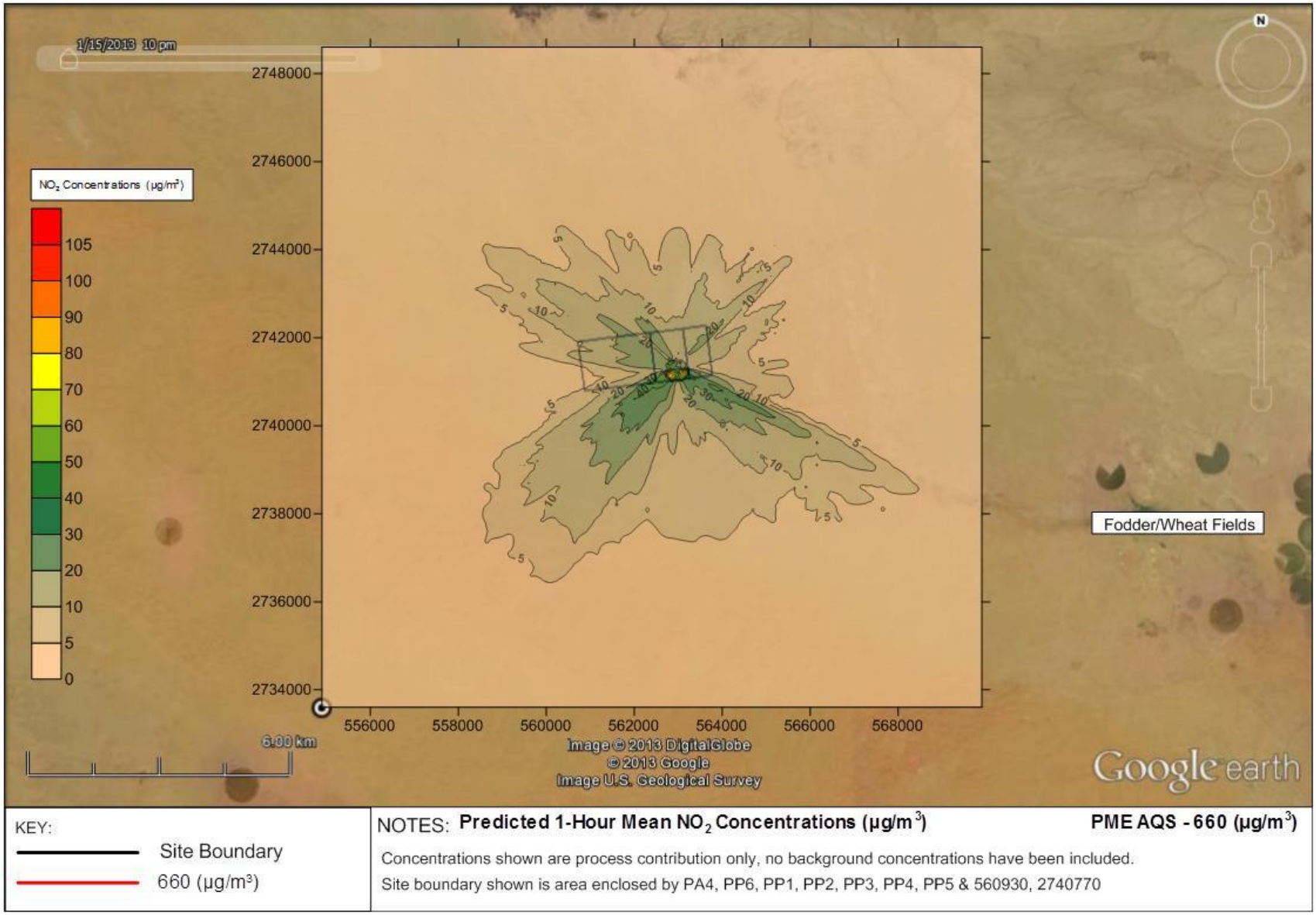


Figure 6-6: PP-13 – Annual operating profile (combined cycle mode): 1-hour mean NO_2 concentrations (scenario 2B)

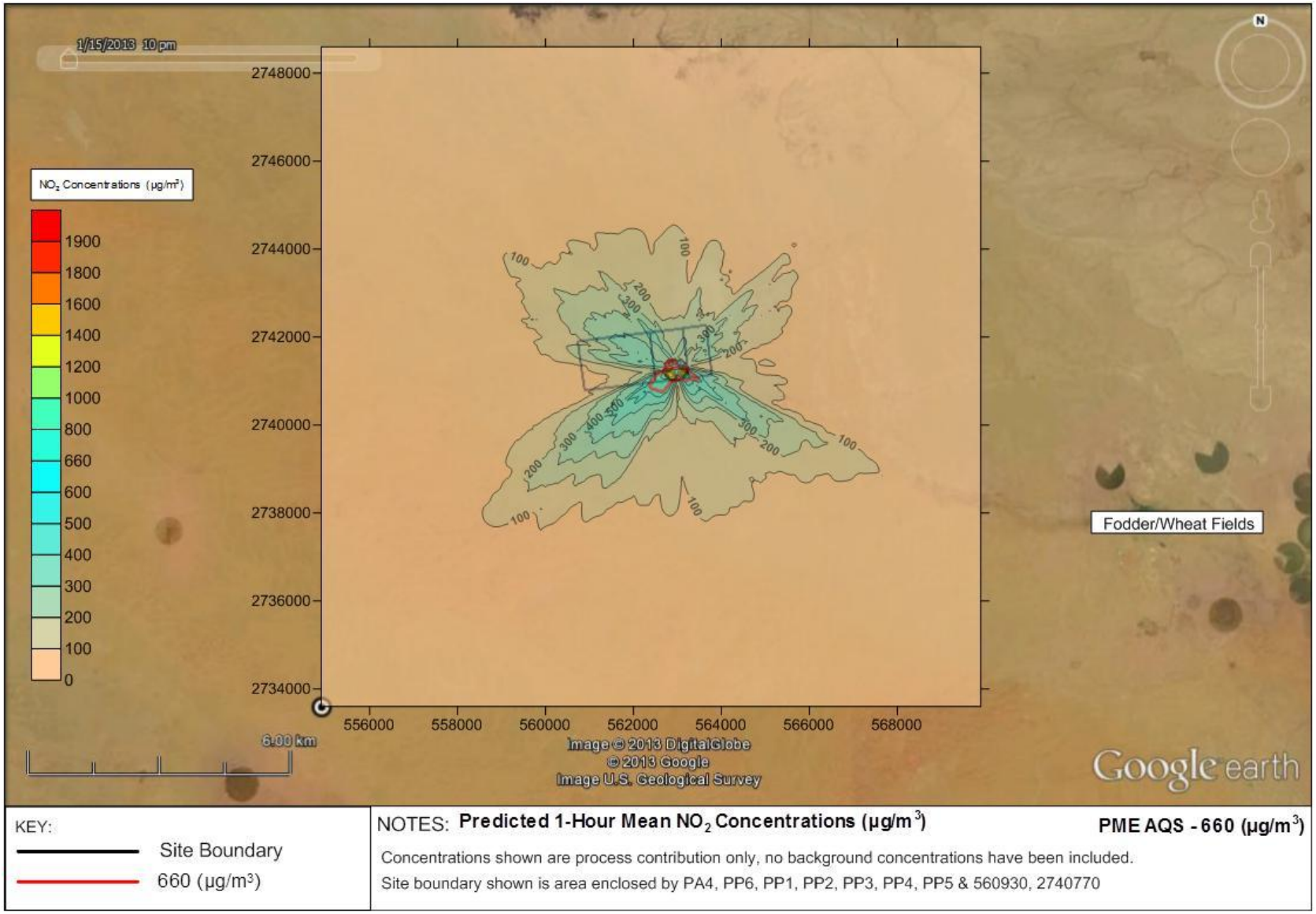


Figure 6-7: PP-13 – Plant at maximum load on diesel (combined cycle mode): 1-hour mean NO_2 concentrations (scenario 2C)

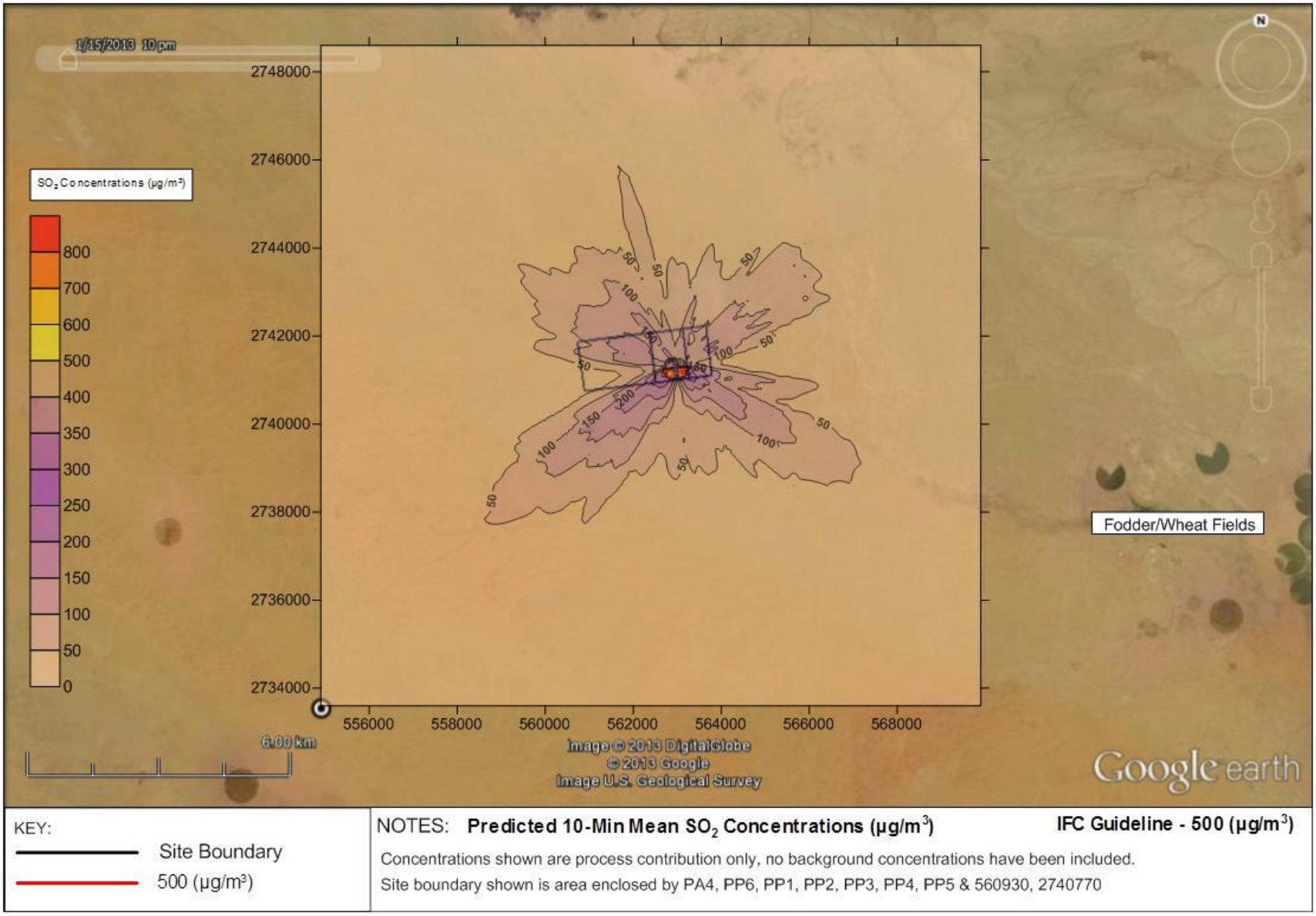


Figure 6-8: PP-13 – Plant at maximum load on diesel (combined cycle mode): 10-minute mean SO_2 concentrations (scenario 2C)

The highest predicted concentrations are again confined to within the boundary of the power plant; nevertheless, exceedances of the PME AQS for 1-hour mean NO_2 concentrations do extend beyond the boundary of the complex. **Figure 6-7** and **Figure 6-8** are contour plots of 1-hour mean NO_2 and 10-minute mean SO_2 concentrations (respectively) for Scenario 2C.

Figure 6-7 shows the geographical extent of the predicted exceedance of the PME AQS. The exceedances PME AQS for 1-hour mean NO_2 concentrations occur up to approximately 500m in a south-westerly direction and around 100 to 200m in a south-easterly direction from the boundary, in an area largely controlled by SEC.

The results suggest that exceedances of the IFC Guideline for 10-minute mean SO_2 concentrations may also occur; however, as can be seen from **Figure 6-8** the exceedances are unlikely to extend beyond boundary of the site to any great distance, particularly when compared with exceedances of the PME AQS and IFC Guideline for 1-hour mean NO_2 concentrations. It should also be noted that the 10-minutue mean is an estimate based on applying a factor to the maximum 1-hour mean SO_2 concentration and therefore, is associated with the most uncertainty (as such it has been included for indicative purposes only).

It is important to remember that the maximum predicted concentrations shown in **Table 6-10** for Scenario 2C would only occur if the worst case meteorological conditions (with respect to dispersion) coincided with the plant operating on ASL or diesel at maximum load. The modelling results show that the highest 1-hour concentration is predicted to occur in early May, which is a period of the year when demand in the plant is likely to be increasing, but that the plant may not be operating at maximum load on a frequent basis..

Further analysis of the predicted concentrations shows that the 99th percentile of 1-hour mean NO_2 concentrations is 619.1µg/m^3 at the maximum point of off-site impact. Therefore, it is for less than 1% of the time during the year (88 hours) that meteorological conditions could give rise to the predicted exceedances beyond the boundary of the site and then only if these conditions coincided with plant operating on ASL or diesel (which is estimated to be a maximum of 200 hours per year) and with the plant at maximum load (i.e. 6 x GTs at 100% output). Therefore, there is a very low probability of concentrations as high as those presented in **Table 6-10** occurring at the maximum point of impact, and in **Appendix 2.5** for sensitive receptors.

In addition to this, the predicted exceedances occur in an area where there is unlikely to be members of the public present to be exposed to these concentrations (in the unlikely event that they occur). Concentrations beyond the area of exceedance also decrease rapidly with distance, such that there are no exceedances for the PME AQS or IFC Guideline for 1-hour mean NO_2 concentrations or IFC Guideline for 10-minute mean SO_2 concentrations predicted at any of the sensitive receptor locations considered in the assessment, either on-site or off-site, which is primarily due to the prevailing winds at the site.

The National Environmental Standard (NES) produced by PME in 2014 for Control of Emissions to Air from Stationary Sources (PME 2014) includes provision for a dispersion zone in the vicinity of a source, where ground level pollutant concentrations may exceed PME AQSs provided the dispersion zone does not impinge on a sensitive receptor.

The NES defines a sensitive receptor as:

1. any area where there is a permanent human presence;
2. areas used for livestock or crop production; and
3. areas that are protected for conservation, ecological status or amenity value.

The areas where the exceedances of the PME AQS for 1-hour mean NO_2 concentrations and IFC Guideline for 10-minute mean SO_2 concentrations are predicted to occur do not include any of the above sensitive receptors. Therefore, because operation of the PP-13 Power Plant on ASL or diesel is not a normal operating condition and the area where exceedances could occur (if the operation coincided with the least favourable meteorological conditions and maximum plant load) is not a sensitive receptor, it is considered that this very low probability occurrence would be allowable under the dispersion zone provision of the NES.

Scenario 2D relates to PP-13 operating on gaseous fuel in simple cycle mode rather than combined cycle. It is not anticipated that PP-13 would be routinely operated in simple cycle and would only occur if there was an operational problem with the steam turbine in one or both of the blocks. Therefore, this scenario, like that of the plant operating on ASL or diesel represents abnormal or emergency operating conditions and would only prevail for a relatively short period of time.

The results presented in **Table 6-10** for this scenario show that the predicted short-term concentrations (annual mean concentrations are not applicable to this scenario) are consistently lower than those for the power plant operating in combined cycle. In simple cycle mode, exhaust emissions from the GTs are discharged from stacks attached directly to the GTs, referred to as by-pass stacks, rather than the main stacks of the HRSGs.

The by-pass stacks are assumed to be 40m based on the design of IPP-11 and PP-12, which are shorter than the main stacks; however, the discharge temperature and efflux velocity of the exhaust gases are much higher than for the main stacks (see **Appendix 2.3**). This provides greater thermal buoyancy and momentum to the plume as it is discharged and therefore allows for a greater level of plume dispersion prior to it coming to ground (despite the lower discharge height) and hence leads to the slightly lower predicted concentrations at the maximum point of impact and at the vast majority of sensitive receptor locations. Two sensitive receptor locations, which lie within the power plant complex (Administrative Buildings and Mosque at PP-13), were predicted to experience slightly higher short-term pollutant concentrations with the plant operating in simple cycle; however, the concentrations are still predicted to be well below the relevant PME AQS and IFC Guideline.

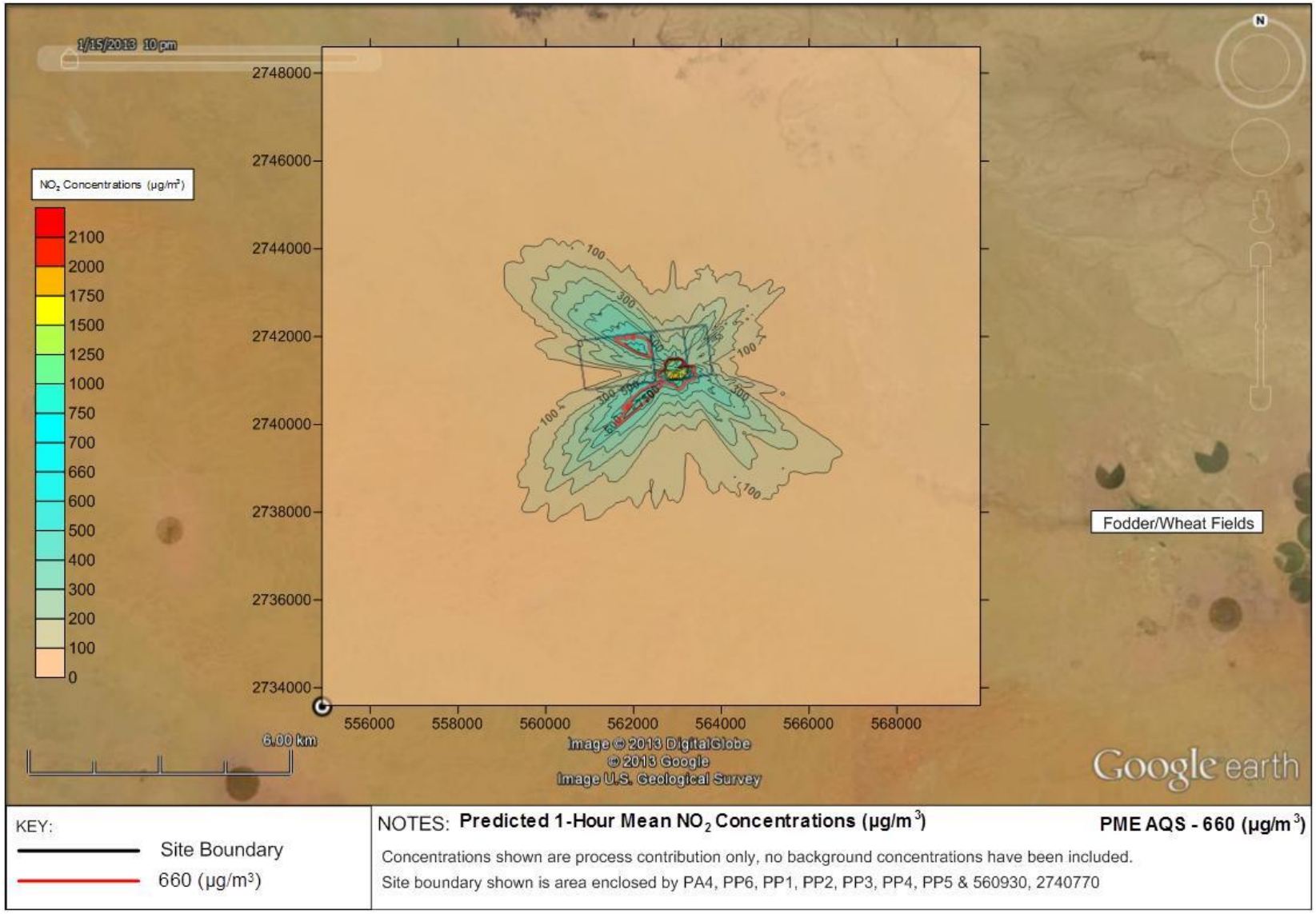


Figure 6-9: PP-13 – plant at maximum load on diesel (simple cycle mode): 1-hour mean NO_2 concentrations (scenario 2E)

Scenario 2E represents PP-13 operating in simple cycle on a secondary fuel. Similar to the results seen for Scenario 2C, the results presented in **Table 6-10** show that the predicted short-term SO_2 and PM_{10} concentrations are well below the applicable PME AQS for this scenario, but that the 1-hour mean NO_2 concentrations exceed the PME AQS and IFC Guideline by a considerable amount. The results again also suggest that exceedances of the IFC Guideline for 10-minute mean SO_2 concentrations may occur. **Figure 6-9** above is the contour plot showing 1-hour mean NO_2 concentrations for Scenario 2E. The results for Scenario 2C show that any exceedances of the IFC Guideline for 10-minute mean SO_2 concentrations would be confined to an area very close to the site boundary and this would also be the case for Scenario 2E.

The highest concentration at the point of maximum impact is predicted to be higher for Scenario 2E compared to combined cycle operation on diesel (Scenario 2C) and it can be seen in the contour plot (**Figure 6-9**) that exceedances of the PME AQS also extend over a larger area to the south of the power plant complex and also to the north within the complex site (relative to Scenario 2C). As with the modelling results for the operation of the plant on diesel in combined cycle (Scenario 2C), the worst case meteorological conditions would have to coincide with the plant operating on diesel or ASL at maximum load (as well as in simple cycle mode) for the concentrations presented in **Table 6-10** to occur.

Further analysis of the predicted concentrations for this scenario shows that the 92nd percentile of 1-hour mean NO_2 concentrations is is 644.5µg/m^3 (PME AQS is 660µg/m^3) at the maximum point of impact off-site. Therefore, it is for less than 3% of the time during the year (263 hours) that meteorological conditions could give rise to the predicted exceedances beyond the boundary of the site, but only if these conditions coincided with plant operating in simple cycle on ASL or diesel (maximum of 200 hours per year), with the plant at maximum load (6 x GTs at 100% output). Therefore, there is an even lower probability of concentrations as high as those presented in **Table 6-10** occurring at the maximum point of impact, and in **Appendix 2.5** for sensitive receptors. The same conclusion can be drawn for the potential exceedances of the IFC Guideline for 10-minute SO_2 concentrations; although the probability of the concentrations shown in **Table 1-10** occurring is even lower due to the exceedances being of lower magnitude and extent.

Although the exceedances of the PME AQS for 1-hour mean NO_2 concentrations are predicted to occur over a larger area than for PP-13 operating on ASL or diesel in combined cycle (which is also the case for exceedances of the IFC Guideline for 10-minute mean SO_2 concentrations, albeit over a much smaller area), the same points with regards potential exposure of members of the public apply to the modelling results for this scenario as they do for Scenario 2C. That is, in the unlikely event that all the above circumstances did coincide, relevant exposure in the area of the exceedances is unlikely to occur. Added to which, while exceedances of the AQS for 1-hour mean NO_2 concentrations are predicted to occur at location on the power plant complex site, the exceedances occur in narrow areas and concentrations decrease rapidly with distance such that there are no exceedances of the PME AQS or IFC Guidelines predicted at any sensitive receptor locations.

Therefore the conclusion regarding the modelling results for Scenario 2E is similar to that reached for Scenario 2C, that utilising ASL or diesel in combination with simple cycle is not a normal set of operating

conditions and the area where exceedances could occur (if these operational conditions coincided with the least favourable meteorological conditions and maximum plant load) is not a sensitive receptor location; as such, it is considered that this very low probability occurrence would be allowable under the dispersion zone provision of the NES.

Significance of Impacts Predicted for Riyadh PP-13

It can be seen from **Table 6-10** and **Appendix 2.5** that under normal operating conditions, i.e. combined cycle mode and utilising Sales Gas, that the significance of the impact of the emissions from the proposed PP-13 is **minor negative** for NO_2 and PM_{10} concentrations (only 24-hour means for the latter) at the point of maximum impact and **negligible** at all sensitive receptor locations, according to the criteria used in the assessment. For SO_2 concentrations, the impact of the emissions is of **negligible** significance at all locations.

When considering emissions from PP-13 utilising secondary fuels (abnormal operation), the results shown in **Table 6-10** and **Appendix 2.5** indicate that the significance of the impacts is potentially much greater than during normal operating conditions for both combined cycle and simple cycle operation for short-term mean concentrations (i.e. 1-hour and 24-hour).

According to the significance criteria used in the assessment (if they are applied to abnormal/emergency, short-term operating conditions), the significance the significance of the impacts at the maximum point of impact would range from **critical negative** for NO_2 concentrations, through **moderate negative** for SO_2 concentrations (while 10-minute mean SO_2 concentration have been considered in the assessment, significance has not been specifically assessed for this averaging period because the concentrations have been estimated using a factor and are indicative only) to **minor negative** for PM_{10} concentrations. At sensitive receptor locations, the significance of the impacts ranges from **major** (two on-site receptors only) to **negligible** for NO_2 concentrations and is of **minor negative** to **negligible** significance for SO_2 concentrations. For PM_{10} concentrations, the significance of the impact is **negligible** at all sensitive receptor locations.

However, as discussed above, these are abnormal or emergency operating conditions and the likelihood of the highest concentrations (either at the point of maximum impact or sensitive receptor locations) actually occurring is very low due to the need for a range of conditions to coincide. Therefore, the predicted impact significance is extremely conservative and is likely to be over-estimated with respect to emissions from the plant when operating on secondary fuels.

Riyadh PP-13 Combined Cycle Power Plant – Cumulative Impacts

To assess the potential cumulative impacts of PP-13 and the other existing sources at the power plant complex, emissions from PP-13 were modelled in combination with the other sources considered in the baseline scenarios (i.e. IPP-11 and PP-12).

Table 6-11 overleaf shows the maximum predicted pollutant concentrations for PP-13 operating according to an operating profile, with IPP-11 and PP-12 also operating according to the annual operating profile (Scenario 3A); for PP-13 operating at maximum load in combined cycle mode on ASL or diesel (Scenario 3B); and for all

three power plants operating on secondary full concurrently, at maximum load (Scenario 3C). A full set of modelling results for these scenarios is provided in **Appendix 2.6**. **Figure 6-10:** and **Figure 6-11:** are contour plots showing the highest annual and 1-hour mean NO_2 concentrations, respectively, for Scenario 3A. **Figure 6-12:** and **Figure 6-13**:are contour plots showing the highest 1-hour mean NO_2 concentrations for Scenario 3B and Scenario 3C, respectively.

Table 6-11: Cumulative impacts – maximum ground level pollutant concentrations

Scenario	Pollutant Concentration (µg/m^3)			
Maximum SO_2 Concentrations	Annual Mean	99.73%ile of 24-hr Mean	Maximum 1-hr Mean	10-minute Mean[(a)]
Air Quality Standard	80	365	730	500
Scenario 3A	1.50 (2%)[(b)]	9.52 (3%)	24.09 (3%)	40.82 (8%)
Scenario 3B[(c)]	NA[(d)]	132.83 (36%)	388.49 (53%)	767.85 (154%)
Scenario 3C	NA	208.25 (57%)	576.60 (79%)	977.33 (195%)
Maximum NO_2 Concentrations	Annual Mean		Maximum 1-hr Mean	
Air Quality Standard	100	No 24-hour Standard or Guideline Applicable	660	No 10-min Standard or Guideline Applicable
Scenario 3A	18.88 (19%)		151.60 (23%)	
Scenario 3B	NA		1,809.35 (274%)	
Scenario 3C	NA		2,687.62 (407%)	
Maximum PM_{10} Concentrations	Annual Mean	90%ile of 24-hr Mean		
Air Quality Standard	80	340	No 1-hour Standard or Guideline Applicable	No 10-min Standard or Guideline Applicable
Scenario 3A	3.46 (4%)	10.01 (3%)		
Scenario 3B	NA	10.07 (3%)		
Scenario 3C	NA	11.82 (3%)		

(a) No PME AQS exists for 10-minute mean SO_2 concentrations. The value shown is the IFC guideline.

(b) The value shown in the parentheses is the percentage of the PME AQS or IFC guideline the concentration represents.

(c) The concentrations shown for SO_2 and PM_{10} are for ASL; however, the concentration shown for NO_2 is for diesel, because a higher ground level concentration was predicted for diesel compared to ASL for NO_2, whereas the opposite was true for the other two pollutants.

(d) NA means not applicable. This is because these operating conditions would not prevail for 12 months, therefore the annual mean is not applicable to this scenario.

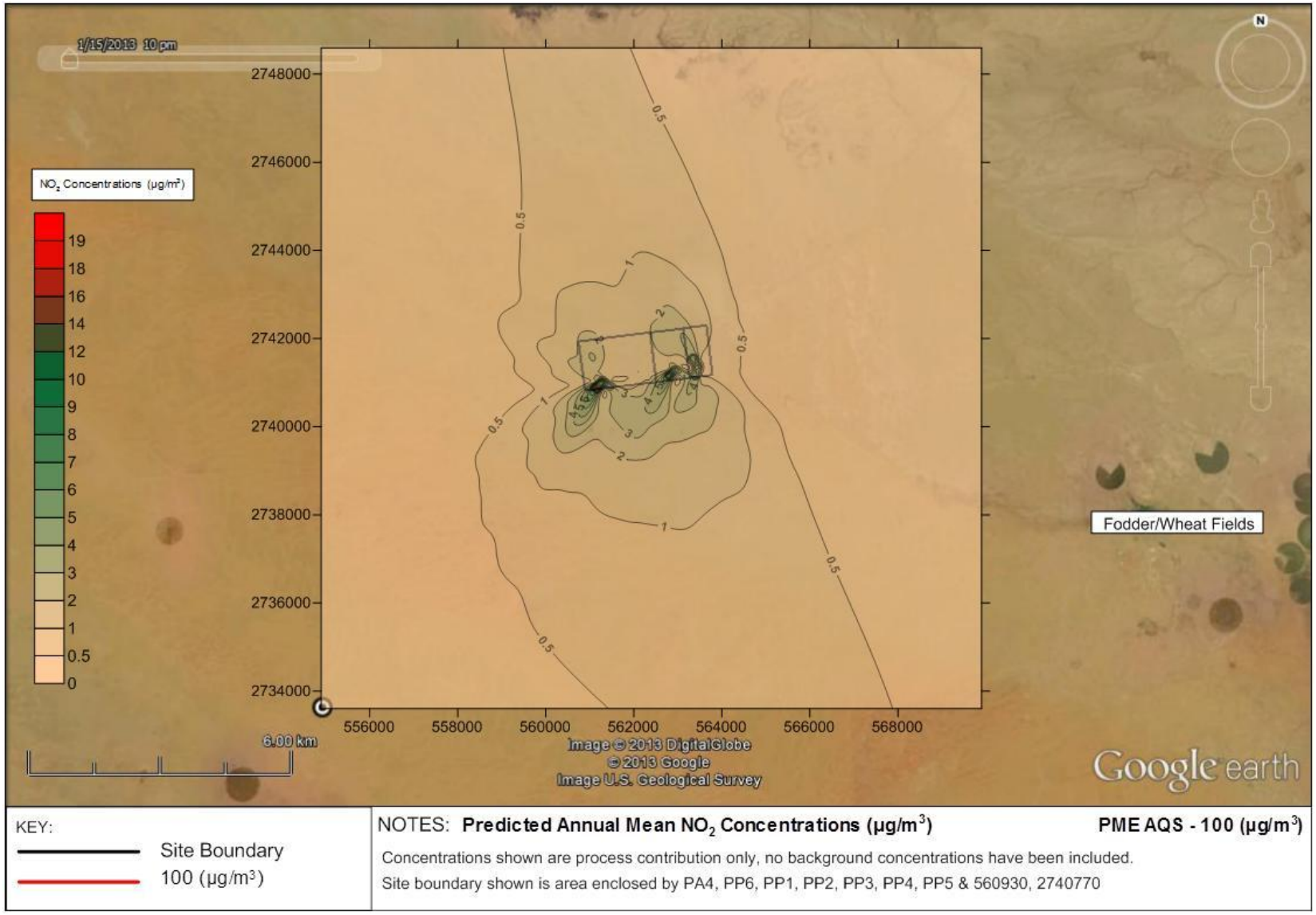


Figure 6-10: Cumulative impacts – All plants on annual operating profile: (sale gas): annual mean NO_2 concentrations (scenario 3A)

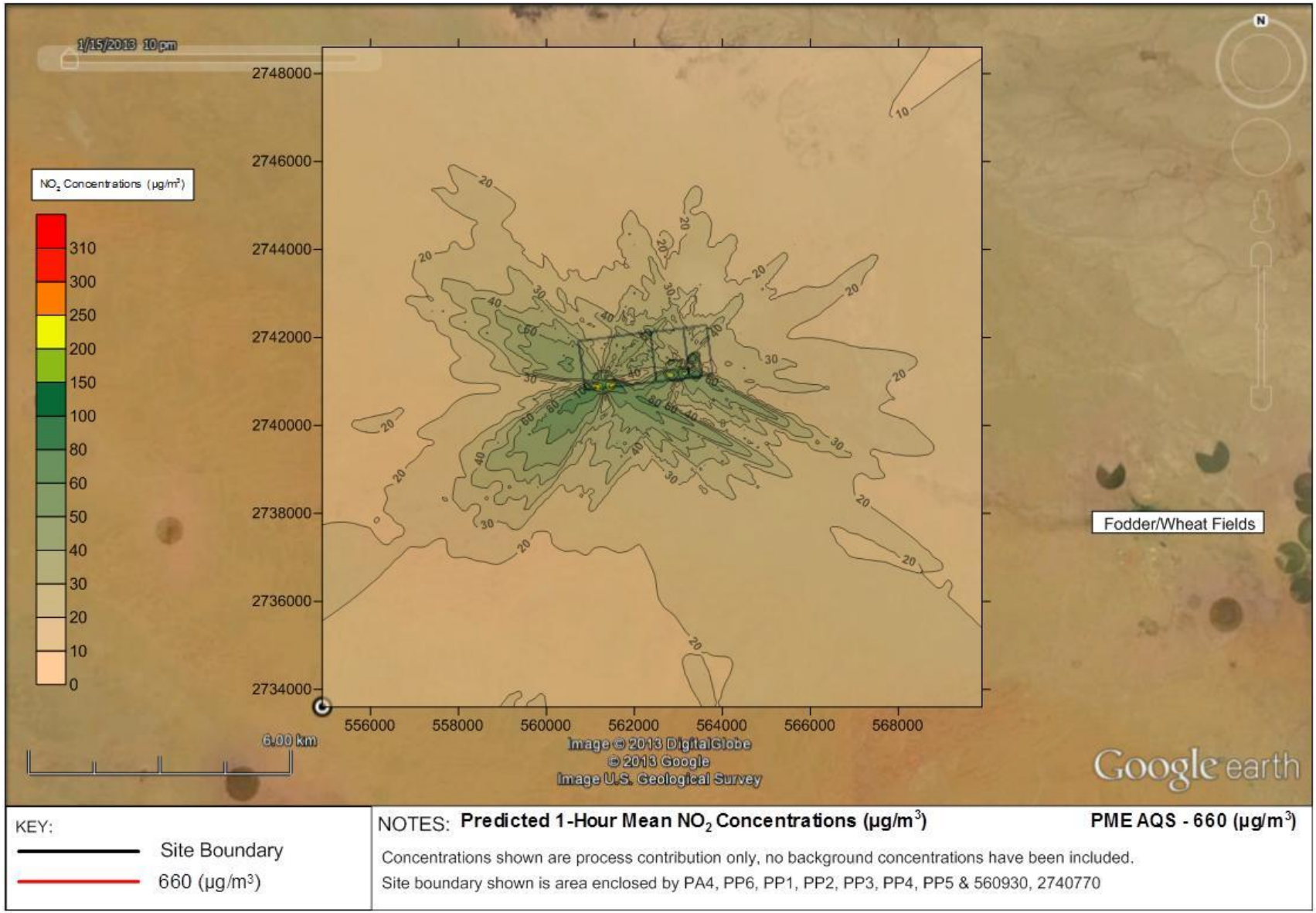


Figure 6-11: Cumulative impacts – AAll plants on annual operating profile (sale gas): 1-hour mean NO_2 concentrations (scenario 3A)

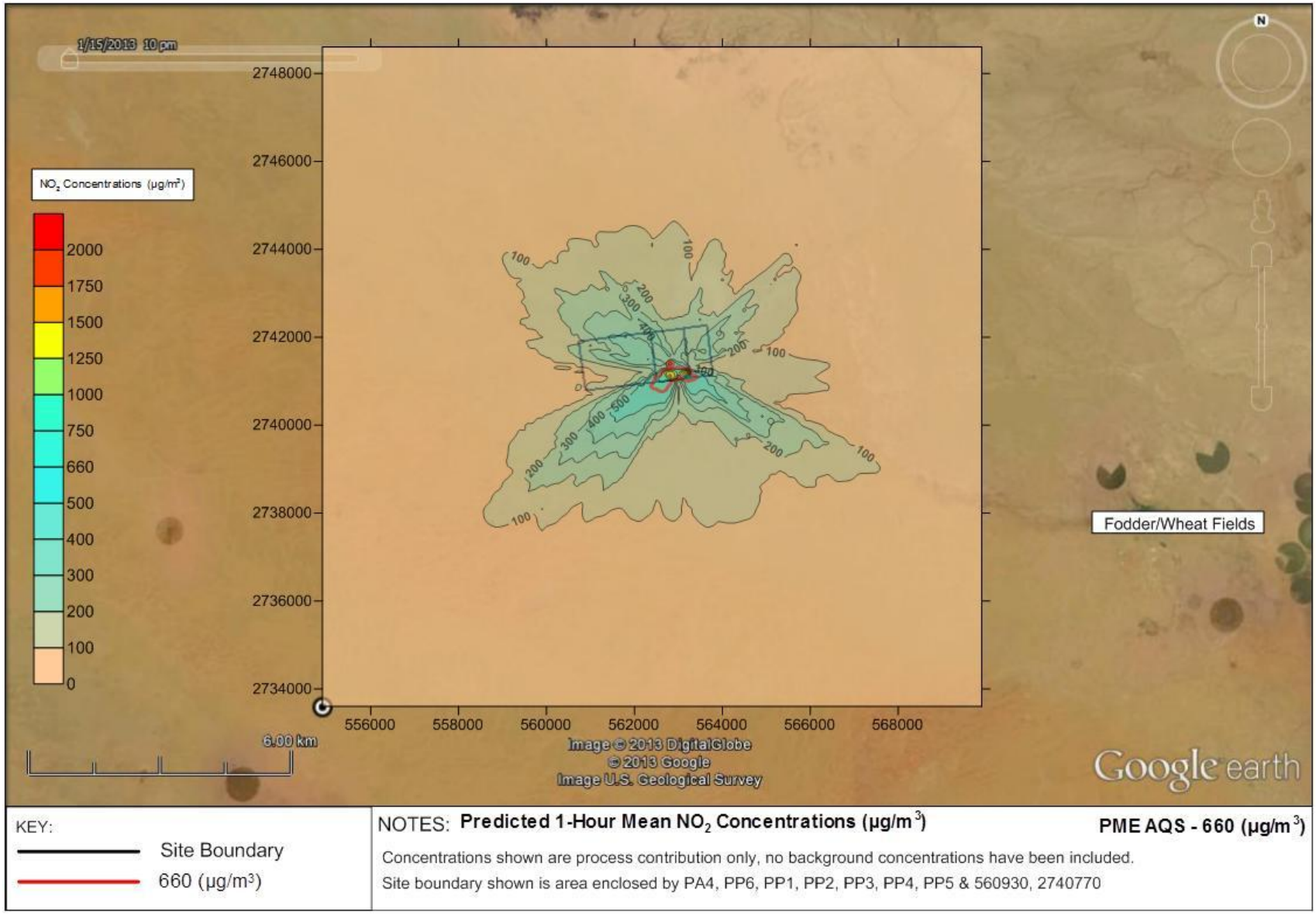


Figure 6-12: Cumulative impacts – PP-13 maximum load on secondary fuel: 1-hour mean NO_2 concentrations (scenario 3B)

The results show that there are no exceedances of the PME AQSs or IFC Guideline for the pollutants considered with all three power plants operating on gaseous fuel. The modelling shows that the highest predicted 1-hour concentrations were predicted to occur in July, with the highest 24-hour mean concentrations predicted to occur in March, which is the same as for the baseline scenario.

It can be seen from the results in **Table 6-11** and those presented in **Table 6-8**, that there is little or no increase in ground level concentrations due to emissions from the proposed PP-13 when compared to the baseline scenario for normal operating conditions. This likely to be largely due to the prevailing winds at the site being predominantly from the north and south and the east-west alignment of the plants; because of this, the plumes of the three power plants do not overlap significantly. This is most clearly illustrated by comparing **Figure 6-10:** and **Figure 6-3,** where the influence of the proposed PP-13 located between the two existing plants extends the 0.5µg/m^3 contour to go beyond the modelling domain. The separate and individual maximum impact areas on both annual mean and 1-hour mean concentrations are clearly evident in the Figures, with the plumes only overlapping once a high level of dispersion has already occurred.

The same points discussed in relation to the maximum ground level pollutant concentrations predicted for the baseline scenarios apply to the cumulative scenarios, i.e. that no exceedances of the PME AQSs or IFC Guideline are predicted to occur at the maximum point of impact or at any of the sensitive receptor locations considered in the assessment.

The emissions from PP-13 only slightly increase pollutant concentrations at the point of maximum impact and at sensitive receptor locations under normal operating conditions and supports the findings of the previous section that the impact of the emissions from the proposed PP-13 are likely to be minor negative at the maximum point of impact (which occurs on-site) for NO_2 concentrations and negligible at all other locations and for SO_2 and PM_{10} concentrations.

The results for the cumulative impact scenarios also indicate that any permanent accommodation that is proposed for construction on the PP-12 or PP-13 sites should be placed to the north or northwest of the power plants as far as practicable.

With respect to PP-13 operating on secondary fuel (Scenario 3B), the results in **Table 6-11** show that emissions from the existing two power plants would not exacerbate the predicted exceedances of the PME AQS and IFC Guideline for 1-hour mean NO_2 concentrations or exceedances of the IFC Guideline for 10-minute mean SO_2 concentrations resulting from the emissions from PP-13 under these conditions. This can be clearly seen by comparing **Figure 6-12** and **Figure 6-7** above where the contour representing the PME AQS for 1-hour NO_2 concentration does not increase in geographical extent.

Therefore, the frequency and significance of the potential exceedances arising from PP-13 operating on secondary fuel would not increase as a result of the emissions from the other two power plants in the complex in the highly unlikely event that all the conditions required to give rise to the predicted exceedances of the PME for 1-hour NO_2 concentrations coincided.

For Scenario 3C, which assumes an interruption to the gas supply to all the power plants (e.g. a problem with the gas pipeline upstream of all three power plants) and hence all plants operating on secondary fuel, the impact is understandably predicted to be greater than for only PP13 operating on secondary fuel.

The results in **Table 6-11** show that no exceedances of the PME AQSs are predicted for SO_2 or PM_{10}; however, the highest 1-hour mean NO_2 concentrations exceed the PME AQS and IFC Guideline by a greater margin at the point of maximum impact than for PP-13 only operating on secondary fuel.

The highest predicted concentrations are again confined to within the boundary of the power plant; however, exceedances of the PME AQS for 1-hour mean NO_2 concentrations extend over a larger area beyond the boundary of the complex as a result of the emissions from all three plants.

For potential exceedances of the IFC Guideline for 10-minute mean SO_2 concentrations, as referred to above, the exceedances will be confined to areas much closer to the boundary of the site than those of the PME AQS for 1-hour mean NO_2 concentrations. The potential exceedances extend only a very short distance beyond the boundary, but additional areas of exceedance are likely to occur in a similar (but slightly larger) proximity to PP12 as estimated for PP13 (which would be expected given the same emission data has been used for the two plants, but PP12 being larger). This can be seen in **Figure 6-14** below, which shows the distinct and individual impacts of PP12 and PP13 for this averaging period.

The results shown in **Appendix 2.6** illustrate the increase in pollutant concentrations predicted at sensitive receptor locations due to all three power plants operating on secondary fuel; however, even under these extreme worst-case conditions, no exceedances of the PME AQSs for the pollutants considered is predicted to occur at any sensitive receptor location. This is also the case for the IFC Guideline for 10-minute mean SO_2 concentrations.

As discussed previously, the maximum concentrations predicted for Scenario 3C would only occur if the worst case meteorological conditions coincided with the plant operating on ASL or diesel at maximum load. The modelling results show that the highest 1-hour concentration is again predicted to occur in July, which is a period of the year when it would be expected that the plants would be operating at maximum load on a frequent basis.

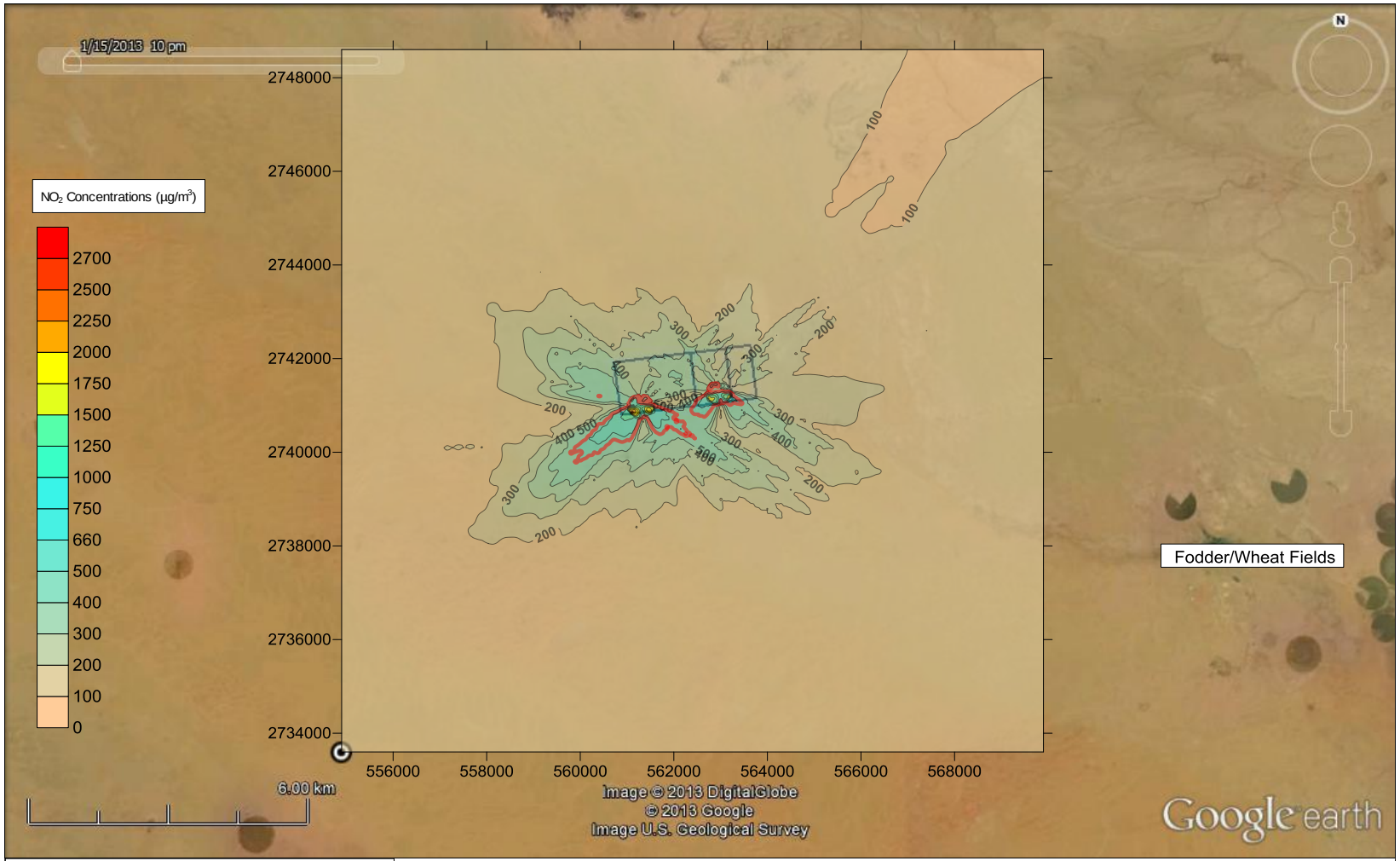
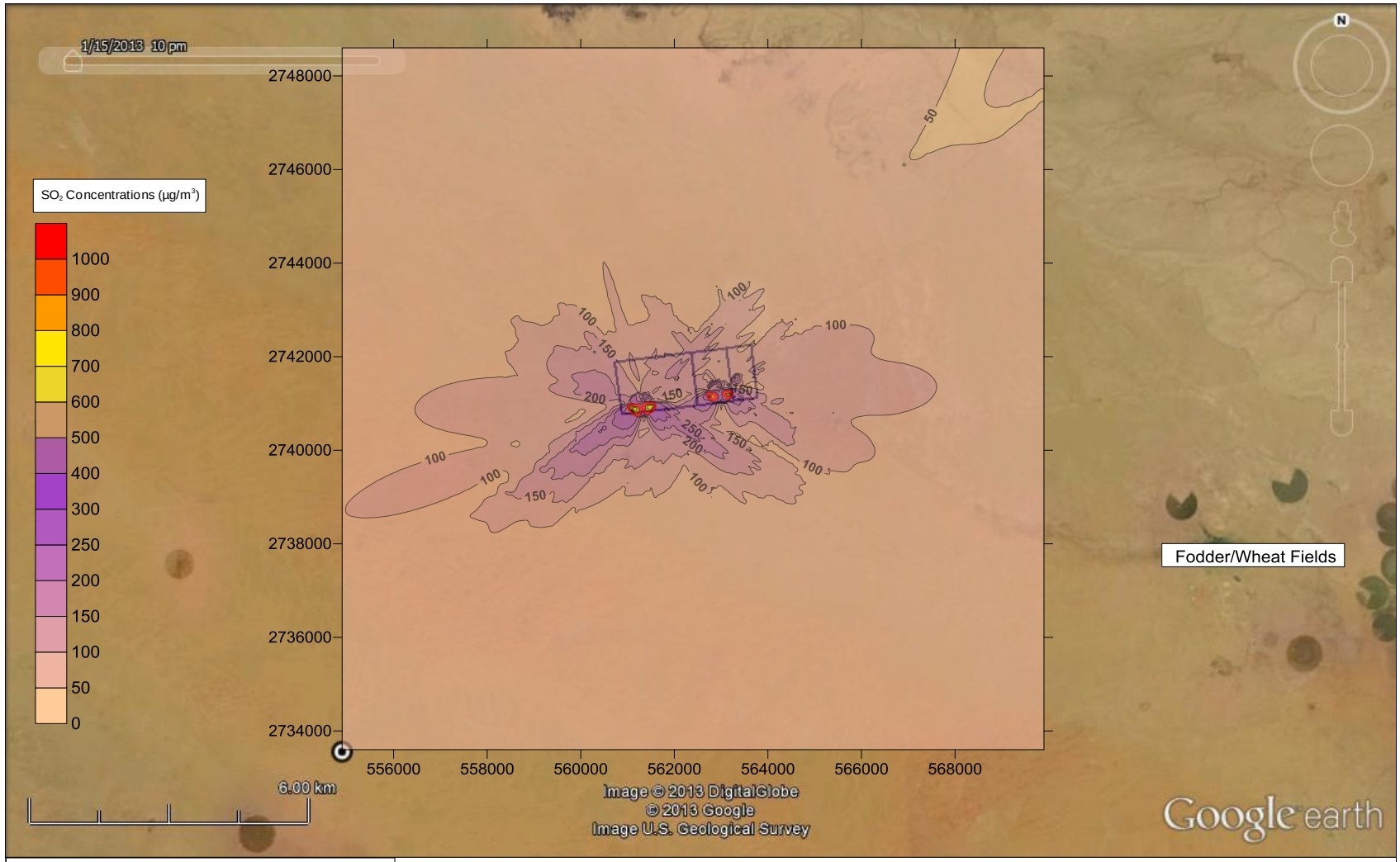


Figure 6-13: Cumulative Impacts – All power plants on seconday fuel (annual profile): 1-hour mean NO_2 concentrations (scenario 3C)



KEY:

Site Boundary

500 (µg/m^3)

NOTES: **Predicted 10-Min Mean SO_2 Concentrations (µg/m^3)** **IFC Guideline - 500 (µg/m^3)**

Concentrations shown are process contribution only, no background concentrations have been included.

Site boundary shown is area enclosed by PA4, PP6, PP1, PP2, PP3, PP4, PP5 & 560930, 2740770

Figure 6-14: Cumulative Impacts – All power plants on asl (annual profile): 10-Min Mean SO_2 concentrations (Scenario 3C)

Further analysis of the predicted concentrations shows that the 96th percentile of 1-hour mean NO_2 concentrations is 628.1µg/m^3 at the maximum point of impact off-site. Therefore, it is for less than 4% of the time during the year (350 hours) that meteorological conditions could give rise to the predicted exceedances beyond the boundary of the site and then only if these conditions coincided with a major problem with the gas pipeline upstream of the Riyadh power plant complex and each of the plants operating at maximum or close to maximum load (i.e. 5 to 6 x GTs at 100% output) on the secondary fuel. Therefore, there is again a very low probability of concentrations as high as those presented in **Table 6-11** occurring at the maximum point of impact and in **Appendix 2.6** for sensitive receptors. For 10-minute SO_2 concentrations, it can be concluded that worst case meteorological conditions would occur even less often due to the smaller magnitude and extend of the potential exceedances and thus there would be a lower probability of the concentrations in **Table 6-11** occurring.

In addition to this, although the predicted exceedances extend over a greater area than for PP-13 alone operating on secondary fuel, it remains unlikely that members of the public would be in this area to be exposed to the concentrations (in the unlikely event that they occur). It should also be noted that despite the emissions from all three plants, concentrations beyond the area of exceedance are still predicted to decrease rapidly with distance, such that there are no exceedances for the PME AQS predicted at any of the sensitive receptor locations considered in the assessment, either on-site or off-site. Exceedances of the IFC Guideline for 1-hour mean NO_2 concentrations are predicted at nine of the twenty one receptors considered; which are all located within the power plant complex.

Therefore the conclusions reached for Scenarios 2C, 2E and 3B apply to the predicted impacts for Scenario 3C, that is, the areas where the exceedances of the PME AQS for 1-hour mean NO_2 concentrations and IFC Guideline for 10-minute SO_2 concentrations do not include any sensitive receptors. Thus, because operation of the three power plants on ASL (or diesel) are not a normal operating conditions and the area where exceedances could occur (if the operation coincided with the least favourable meteorological conditions and maximum plant load) is not a sensitive receptor, it is considered that this low probability occurrence would be allowable under the dispersion zone provision of the NES.

Greenhouse Gas Emissions

The primary fuel for the operation of the proposed Riyadh PP-13 will be Sales Gas, with ASL (or diesel) used as a back-up fuel in the event of gas supply interruption. The combustion of these fossil fuels will produce CO_2 emissions and, to a far lesser extent, methane (CH_4) emissions (as a result of incomplete combustion), particularly for the liquid fuels. CO_2 and methane emissions are accepted as contributing to global warming and known as Greenhouse Gases (GHG). Calculation of global warming potential (GWP) allows comparison with other sources and provides some context for the plant. GWP is measured in terms of equivalent emissions of CO_2; hence the GWP factor of CO_2 is 1. CH_4 has a GWP factor of 21, i.e. an emission of 1kg of CH_4 is defined as having 21 times the GWP of an emission of 1kg of CO_2.

The use of emission factors in combination with fuel consumption or power generated is a widely accepted method for calculating GHG emissions from a range of industrial activities including power generation. Fuel consumption rates for the GTs were not contained in the Parsons Brinckerhoff report, so CO_2 and methane emissions from the proposed plant have been calculated based on the assumed fuel consumption of the plant at maximum load based on fuel consumption data for turbines at IPP-11. The International Panel on Climate Change (IPCC) have published methane emission factors for turbines fired on gas and fuel-oil and it is these factors that have been used in the calculations. Fugitive emissions of natural gas (methane) from the gas transmission system serving the proposed PP-13 have not been quantified as they will not be significant compared to the emissions from fuel combustion. The data used for the calculation of annual GWP emissions is presented in **Table 6-12** below.

Table 6-12: Calculation of annual carbon dioxide emissions for Riyadh PP-13

Parameter	Sales Gas	ASL	Units
CO_2 content in GT exhaust	37,500	35,800	ppm
Relative Molecular Weight of CO_2	44.01		g/mol
CO_2 Concentration in GT exhaust	19,086.6	18,221.3	mg/m^3
Exhaust flow rate (per GT)	508.1	558.9	m^3/s
Hourly CO_2 emissions (per GT)	34,912	36,662	kg/hr
Annual operational time (per GT)	8000	200	hours
Annual CO_2 emissions (per GT)	279,299	7,332	Tonnes per annum
Annual CO_2 emissions (PP-13)	2,234,393	58,659	Tonnes per annum
Total Annual CO_2 emission rate for PP-13	2,293,052		Tonnes per annum
Fuel Calorific Value	42,001	44,531	kJ/kg
Fuel Consumption (per GT)	11.99	11.19	kg/s
	43,157	40,286	kg/hour
	1,812,643	1,793,974	MJ/hour
Average Operational Hours (per GT)	8,000	200	Hours
Annual Fuel Consumption (per GT)	14,501	359	TJ/year
Annual Fuel Consumption (Plant)	116,009	2,870	TJ/year
IPCC Guidelines CH_4 Emission Factor	1	3	kg CH_4/TJ
Riyadh PP-13 Annual CH_4 Emissions	116	9	tCH_4 per annum
Riyadh PP-13 Annual CH_4 Emissions	2,436	189	tCO_2 equivalents per annum
Riyadh PP-13 Annual GHG Emissions (GWP)	2,295,677		tCO_2 equivalents per annum

The data in **Table 6-12** shows that assuming maximum load for Riyadh PP-13 for 8000 hours per year per GT on Sales Gas and 200 hours per year on ASL, the additional annual GHG emissions would be 5,040,847 tonnes CO_2 equivalents, which represents the (worst-case) maximum annual GHG emissions from the plant. If the plant is assumed to operate according to the annual operating profile used for the dispersion modelling (see **Appendix 2.2**) the annual GHG emissions would be 2,077,344 tonnes CO_2 equivalents.

6.7.4 Accuracy and Uncertainty of Impact Assessment

As referred to earlier in the assessment, detailed design information is not currently available for PP-13. In addition to this, only limited emission data was available for PP-12 relative to that available for IPP-11. Therefore, a number of assumptions were required for the dispersion modelling and GHG emission estimations undertaken for this assessment. Every effort was made to ensure that the assumptions made reasonably reflect the likely operation of the proposed PP-13 facility on the basis of design and emission data for the existing IPP-11 and soon to be operational PP-12, because these plants are similar in design and operation (including combustion plant, fuels used and total power output capacity and loads). Where assumptions were required to develop the necessary modelling input and emissions data, these were conservative so as ensure worst-case predictions and prevent, as far as practicable, under estimation of potential air quality impacts or global warming potential.

Therefore, once more detailed design and emissions data for the proposed PP-13 becomes available (i.e. when an EPC has been appointed for the project) and PP-12 becomes operational, this should be compared against the input data used and assumptions made for this assessment to determine whether further detailed assessment (e.g. re-modelling of emissions) is required to fully characterise the potential impacts of the plant on air quality and determine whether further mitigation measures are required.

6.8 Mitigation Measures, Residual and Cumulative Impacts

6.8.1 Construction Phase Mitigation Measures

Although the site benefits from being located in an area with little development surrounding it, activities associated with the construction of a plant of the plant have the potential to have a **minor negative** impact off-site if not controlled adequately at source.

Mitigation measures representing best practice for construction sites should be employed during the construction of PP-13 to ensure dust emissions and construction traffic/plant exhaust emissions are minimised to an extent where adverse impacts beyond the boundary of the site would be minimal. Dust mitigation measures and monitoring provisions are included in **Chapter 17 – Framework Construction Environmental Management Plan**. A full Construction Environmental Management Plan (CEMP) for the project would be prepared in the basis of this framework. The mitigation measures which will be implemented during construction include the following:

- Measures to reduce dust arising through appropriate stockpile management;
- Controlling dust arising through management of vehicle movements and speeds;
- Appropriate materials handling (e.g. minimising drop heights);
- Measures to reduce dust impacts when grading;
- Correct use of cement batching;
- Reducing exposed areas of open ground;
- Preventing certain types of work in windy conditions;
- Controls of excavation, piling and sandblasting works (where relevant); and
- Minimising emissions from construction vehicles and plant through regular servicing and maintenance.

6.8.2 Construction Phase Residual Effects

Residual impacts, should they occur, following the implementation of mitigation measures would be temporary, of limited duration and **negligible** in impact at sensitive receptor locations.

6.8.3 Construction Phase Cumulative Effects

The construction of PP-13 and associated infrastructure will be the only construction works in the larger area, therefore there will be no cumulative impacts beyond those associated with the PP-13 facility; therefore, potential impacts would remain the same as above: temporary, of limited duration and **negligible** effect.

6.8.4 Operational Phase Mitigation Measures

Operational Emissions

At this stage it is understood by WSP that low NO_x mitigation measures are not included within the design of the PP-13 facility. It is therefore recommended that dry low NO_x burners are considered for inclusion in the design of the GTs for PP13 to minimise NO_x emission under normal operating conditions, in accordance with best practice principles. Furthermore, given the results of the modelling for the operation of the plant on secondary fuel, it is recommended that further mitigation measures (e.g. water injection) are also considered in the design of PP13 for operation on secondary fuels to reduce NO_x emissions under such operational conditions.

All plant on-site will be regularly maintained to ensure optimal efficiency and ensure, as far as practicable, all equipment is in good working order at all times.

Emissions of NO_x, SO_2 and PM_{10} from the Riyadh PP-13 Combined Cycle Power Plant will be continuously monitored. This monitoring would provide data to confirm assumptions made for the dispersion modelling. This would accurately determine pollutant concentrations in the emissions and provide an indication of any temporal variation in emissions from the plant and further assist in verifying the modelling predictions and/or allow further, more accurate modelling to be undertaken in the future to determine potential air quality impacts.

GHG Emissions

The use of natural gas has significant advantages over other fossil fuels:

- Each unit of energy provided by the combustion of natural gas results in less global warming emissions than other fossil fuels; and
- Its energy content can be converted to electricity in efficiencies in the order of 60% within CCGT power stations. This is significantly more efficient than other combustion based electricity production technologies, particularly coal or heavy fuel oil.

The combination of low emissions per unit of released energy in combination with efficient technologies for the conversion into electricity and ready transportability of natural gas allows the production of electricity from natural gas with considerably less greenhouse gas emissions than other fossil fuels.

The plant will incorporate leading combustion technology and will be operated to a high standard to ensure the efficiency of the combustion plant is maximised as far as practicable to prevent incomplete combustion and minimise methane emissions from this source. The design will be to a high specification and the facilities will be maintained to a standard which will control the unnecessary emission of gas (methane) from leaks. Minimising fugitive releases is a priority for the site to control associated risks to safety and the loss of product. Leak detection and repair procedures will be implemented at the site as part of the larger service and maintenance programme for the plant, which will ensure that fugitive emissions of natural gas are prevented or minimised as far as practicable.

6.8.5 Operational Phase Effects

The Riyadh PP-13 Combined Cycle Power Plant will be located within an area where there will be two operational power plants (Riyadh IPP-11 and PP-12); however, based on the results of the modelling of the baseline situation, the air shed is not considered degraded according to the IFC Guidelines..

The scenarios modelled for this assessment take account of the design features of Riyadh PP-13, such as minimum design stack heights. No specific emission reduction measures have been assumed to be incorporated into the design of the plant. Therefore the predicted concentrations referred to in the assessment of impacts above and presented in **Appendices 4.4, 4.5** and **4.6** represent the effects of the emissions from the proposed PP-13 in the operational phase.

It is considered that normal operating conditions for the power plant (combined cycle on Sales Gas) and simple cycle operating conditions (on Sales Gas) would have an impact on local air quality of **minor adverse** significance at the point of maximum impact (which occurs on-site) for NO_2 and **negligible** significance for SO_2 and PM_{10}. At sensitive receptor locations, the impacts are considered to be of **negligible** impact for all pollutants and averaging periods according to the significance criteria used in the assessment.

For abnormal or emergency operating conditions (i.e. operating on secondary fuel), the significance of the impacts at sensitive receptor locations ranges from **major** (two on-site receptors only) to **negligible** for NO_2

concentrations and is of **minor negative** to **negligible** significance for SO_2 concentrations. For PM_{10} concentrations, the significance of the impact is **negligible** at all sensitive receptor locations. While potential 10-minute mean SO_2 concentrations were considered in the assessment, significance was not specifically assessed for this averaging period because the SO_2 concentrations have been estimated using a factor and are indicative only. It should be noted that for the maximum predicted concentrations to occur during emergency operating conditions, the plant would have to be operating at maximum load at the same time the least favourable meteorological conditions occurred.

However, in the unlikely event that these circumstance did arise, it is considered that area where potential exceedances are predicted to occur under emergency or abnormal conditions would be considered a dispersion zone in accordance with the provisions of the PME National Environmental Standard and further mitigation measures are not required to address these operational conditions.

6.9 Conclusions

Future Baseline

The modelling results for the baseline conditions in the area of the PP-13 site indicate that no exceedances of the PME AQS or IFC Guidelines for NO_2, SO_2 or PM_{10} are likely to occur as a result of the emissions from IPP-11 and PP-12 under normal operating conditions. On the basis of the results, the air shed within which the PP-13 site lies is considered to be non-degraded according to the IFC Guidelines for Air Emissions and Ambient Air Quality.

PP-13 Process Contribution

Modelling of the emissions from the proposed Riyadh PP-13 indicate that the minimum design height for the main stacks at the plant of 60m will be sufficient to ensure that emissions are adequately dispersed and and the PME AQS for combustion pollutants (e.g. NO_2, SO_2 and PM_{10}) are not exceeded when operating on sales gas (the primary fuel for the power plant) in combined cycle mode. This was also the case with the plant operating in simple cycle mode, with emissions discharged from the 40m by-pass stacks.

As such, under normal operating conditions for the power plant (combined cycle on sales gas) and simple cycle operating conditions (on sales gas) the plant would have a impact on local air quality of **minor adverse** significance at the point of maximum impact for NO_2 and **negligible** significance for SO_2 and PM_{10}; and at sensitive receptor locations, the impacts are considered to be of **negligible** impact for all pollutants and averaging periods.

The modelling showed that in emergency or abnormal operating conditions, that is, the plant operating on secondary fuel (ASL or diesel), the significance of the impact on short-term NO_2 (1-hour mean) and SO_2 (10-minute, 1-hour and 24-hour mean) concentrations would be much greater at the point of maximum impact and that exceedances of the PME AQS and IFC Guideline for 1-hour NO_2 and IFC Guideline for 10-minute mean

SO_2 concentrations could potentially in off-site locations, although, not at any of the sensitive receptor locations considered (no exceedances of the relevant PME AQS was predicted for the other pollutants considered).

However, the predicted maximum pollutant concentrations would only occur if the operation of the plant on secondary fuels (at maximum output) coincided with the least favourable meteorological conditions (in terms of dispersion) and if the plant operating at full load. For combined cycle operation, the modelling showed that such meteorological conditions occur for less than 1% of the time and, for simple cycle operation, for less than 3% of the time for 1-hour mean NO_2 concentrations. The frequency of worst case meteorological conditions was even lower for 10-minute mean SO_2 concentrations. Given that it is anticipated that PP-13 would only operate for a maximum of 200 hours per year on secondary fuel, the probability of the maximum predicted (worst-case) concentrations occurring is very low.

In addition to the low probability of occurrence, the exceedances are predicted to occur in an area with no sensitive receptors present and concentrations are predicted to decrease rapidly with distance from the point of maximum impact. No exceedances are predicted to occur at sensitive receptors even under these worst-case conditions and, therefore, predicted concentrations at sensitive receptor locations are of **major negative** (at two on-site receptors for 1-hour mean concentrations) to **negligible** significance (if the significance criteria used in the assessment are applied to the emergency or abnormal scenarios)

It is considered that area where potential exceedances are predicted to occur under emergency or abnormal conditions would be classified as a dispersion zone in accordance with the provisions of the PME National Environmental Standard[20] and further mitigation measures are not required to address these operational conditions.

Cumulative Impacts

Modelling of the Riyadh PP-13 Power Plant emissions in conjunction with the two power plants (IPP-11 and PP-12) showed that under normal operating conditions, no exceedances of the respective PME AQSs or IFC Guidelines were predicted for the pollutants considered and all concentrations were well below the standards.

The maximum predicted pollutant concentrations for PP-13 operating under emergency or abnormal conditions (i.e. on ASL) were not predicted to be exacerbated by the emissions from the existing two plants, as the predicted exceedances of the PME AQS for 1-hour NO_2 concentrations were not predicted to increase in magnitude or geographical extent.

In the event that the gas supply to all three power plants was interrupted and they were all required to continue to operate on secondary fuel (very worst-case) concurrently, the assessment showed that exceedances of the PME AQS and IFC Guideline for 1-hour mean NO_2 concentrations and the IFC Guideline

[20] Article II (2) – Dispersion Zones and Stack Heights sub-section (b) & (c); Presidency of Meteorology and Environment; KSA Environmental Standards: Control of Emission to Air from Stationary Sources (2014)

for 10-minute mean SO_2 concentrations were likely to occur over a larger area, but that no exceedances were predicted to occur at any off-site sensitive receptor locations.

However, again, it is considered that, in the highly unlikely event that all three power plants were required to operate under emergency or abnormal conditions, the area where exceedances were predicted would be classified as a dispersion zone in accordance with the provisions of the PME National Environmental Standard and further mitigation measures are not required to address these emergency operating conditions.

GHG Emissions

The operation of Riyadh PP-13 would generate additional GHG emissions of 5,040,847 tCO_2 equivalents per year, assuming continuous operation of the GTs at the plant at maximum load (8000 hour per year per GT on Sales Gas and 200 hours on ASL). Assuming operation of the Riyadh PP-13 in accordance with the assumed annual operating profile would generate 5,649,939 tCO_2 equivalents per year.

Further Impact Assessment

Detailed design information is not currently available for PP-13. In addition to this, only limited emission data was available for PP-12 relative to that available for IPP-11. Therefore, a number of assumptions were required for the dispersion modelling and GHG emission estimations undertaken for this assessment. Where assumptions were required to develop the necessary modelling input and emissions data, these were conservative so as ensure worst-case predictions and prevent, as far as practicable, under estimation of potential air quality impacts or global warming potential.

Therefore, once more detail becomes available on plant design and technology, any proposed emissions mitigation and emissions data for the proposed PP-13 (i.e. when an EPC has been appointed for the project) and PP-12 becomes operational, this should be compared against the input data used and assumptions made for this assessment to determine whether further detailed assessment (e.g. re-modelling of emissions) is required to fully characterise the potential impacts of the plant on air quality and determine whether further mitigation measures are required.

6.10 References

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- Presidency for Meteorology and Environment (2006). General Environmental Regulations and Rules for Implementation,
- Presidency for Meteorology and Environment (2014). National Environmental Standard, Control of Emission to Air from Stationary Sources, Article II (2) – Dispersion Zones and Stack Heights (B) and (C).
- WSP Environment & Energy (2010), *Social and Environmental Assessment, Riyadh Independent Power Project, Air Quality Chapter*, prepared by WSP Environmental (Middle East) on behalf of the Saudi Electricity Company.

7 Noise and Vibration

7.1 Introduction

This chapter addresses the potential noise and vibration impacts associated with the construction and operation of PP-13, adjacent to IPP-11, in the valley of Al Batin approximately 110km west of Riyadh.

A discussion of the results of a baseline noise survey near the site are also provided and mitigation measures have been recommend (where appropriate) to reduce the noise and vibration impact. These measures are set out in full in **Chapter 17 – Framework Construction Environmental Management Plan** and **Chapter 18 – Framework Operational Environmental Management Plan.**

7.2 Relevant Standards and Legislation

7.2.1 Construction Phase Impacts

The Presidency of Meteorology (PME) in the Kingdom of Saudi Arabia (KSA) has established environmental noise standards which are detailed in the document Kingdom of Saudi Arabia National Environmental Standard - Environmental Noise.

The PME noise criteria set out maximum permissible façade noise limits for General Construction which will depend on the designated area types in Article VI – Noise from construction activities. The permissible noise levels are presented in **Table 7-1**.

Table 7-1: General construction maximum permissible facade noise levels

Area Classification	Daytime $L_{Aeq, 12h}$ dB (5min)	Evening $L_{Aeq, 12h}$ dB (5min)	Night-time $L_{Aeq,12h}$ dB (5min)
A, B, C	75	65	45
D	80	80	80

The area classification is as follows:

- A: Quiet areas – These areas are designated quiet areas as they hold value in terms of being places of worship, important tourist attractions, recreational park land and those areas surrounding hospitals, schools and noise sensitive natural habitats.
- B: Sensitive – Areas designated in this category will typically be dominated by residential properties (including hostels and hotels) and may range from sparse population densities to suburban districts of cities.

- C: Mixed – This designation applies to mixed areas often within cities where there is a mix of residential and commercial activities. This designation will also apply to retail and financial districts.
- D: Non-Sensitive – The final classification of district is a predominantly industrial area where there are few residential properties and commercial premises. This classification also applies to industrial cities and land that is generally unpopulated.

On the basis of the descriptions provided above for each category, it can be concluded that the Project can be classified with an area classification of 'D' (non-sensitive), for construction noise. The construction noise limits, at the facades of nearby receptors, are therefore 80 dB L_{Aeq} for day, evening and night periods.

It should be noted that **Table 7-1**, taken verbatim from the PME standards, indicates $L_{Aeq,12h}$ indices for the evening as well as the night time periods. However the $L_{Aeq,12h}$ noise level is generally a *day* time index and the evening and night times are usually measured in terms $L_{Aeq,4h}$ and $L_{Aeq,8h}$ respectively. For this assessment, the 24 hour day is split into three segments; 12 hour day-time (0700-1900), 4 hour evening (1900-2300) and 8 hour night-time (2300-0700).

Due to the absence of any legislation or policy guidance in the KSA regarding the preferred methodologies for predicting construction noise and vibration, British Standard *BS 5228:2009 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise* has been adopted for predicting noise and vibration levels at nearby sensitive receptors.

This document details a methodology for estimating construction noise levels from a site based on the type of plant, usage, and distance to receiver, barriers and ground conditions. The assessment is carried out for multiple sources and multiple receivers.

7.2.2 Operational Phase Impacts

For industrial equipment located in a remote locations, the PME provides criteria in Article V – Noise from industrial units in areas set aside primarily for industrial facilities. These are provided in **Table 7-2.**

Table 7-2: Maximum permissible free-field noise levels

Site	Daytime $L_{Aeq,\,T}$ dB	Evening $L_{Aeq,\,T}$ dB	Night-time $L_{Aeq,\,T}$ dB
A1	55	50	45
A2	55	50	45
A3	55	50	45
A4	65	60	50
A5	75	65	55

T- This is understood to be 12 hours for Day, 4 hours for Evening and 8 hours for Night time periods.

The site classification is as follows:

- A1 – Retail refers to areas that are entirely dominated by retail, dining and recreational properties.
- A2 – Warehousing refers to areas where units predominantly store products or goods for distribution and there are no or very limited process activities.
- A3 – Light industrial refers to those areas which may be mixed with or adjacent to residential properties where minor manufacturing processes take place.
- A4 – Medium density industrial areas are those when a range of manufacturing processes including combustion take place on small to medium size sites and there is an absence of residential properties.
- A5 – High density industrial refers to designated industrial cities and complexes where large scale manufacturing, refining and petrochemical processes exist. Cement manufacture is specifically included.

On the basis of the descriptions provided above for each category, it can be concluded that the site can be classified with an area classification of 'A4' for operational noise. The free-field operational noise limits, at nearby receptors, are therefore 65 dB L_{Aeq} for day, 60 dB L_{Aeq} for evening and 50 dB L_{Aeq} for night periods.

In addition to the Local Environmental Standards, the IFC World Bank General EHS Guidelines are presented in **Table 7-3**.

Table 7-3: IFC noise level guidelines

Receptor	Daytime 0700-2200 $L_{Aeq, 1h}$ dB	Nigh-time 2200-0700 $L_{Aeq, 1h}$ dB
Residential; institutional; educational	55	45
Industrial; commercial	70	70

7.3 Methodology

7.3.1 Construction Phase

As a detailed construction programme for PP-13 is not available at this stage, an assessment was made based on the typical activities expected during the construction phase. Construction noise was assessed using the methodology set out in BS 5228 Part 1. It is understood the main construction phases are as follows:

- Site preparation;
- Civil works;
- Supply and installation of plant and equipment; and,
- MEP works.

The assumed noise levels, which are in accordance with BS 5228, are presented in **Table 7-4**.

Table 7-4: Construction noise emission data

Equipment	Sound Pressure Level, L_{Aeq} dB @10m			
	Site Preparation	Civil Works	Plant and Equipment	MEP Works
Dozer (41 t)	80	80	-	-
Tracked Excavator (40t)	79	79	-	-
Wheeled Loader	80	80	-	-
Articulated dump truck (tipping fill)	81	-	-	-
Lorry	80	80	80	80
Vibratory Roller	74	74	-	-
Large Rotary Bored piling rig	83	-	-	-
Cement Mixer truck	-	75	-	-
Tracked Mobile Crane	-	77	77	-
Lifting Platform	-	-	67	67
Tower Crane	-	77	77	77
Power for site cabins	66	66	66	66
Water pump (diesel)	68	68	-	-
Angle Grinder	-	80	80	-

In addition, the following was assumed:

- There is one of each item of equipment on the site,
- The ground is hard and reflective; and
- The works are spread evenly across the work site.

Using the stated assumptions and noise data listed above, a noise model for the construction phase scenario was developed using the Datakustic CadnaA noise modelling software.

The nearest occupied buildings to the proposed site are located more than 500m north and 300m north-east of the construction area. At this distance, the impact from vibrations generated at the site, during either the construction or operational phases, will be negligible to building occupants.

Consequently, the impact of vibration during both the construction and operational phase of the project is deemed negligible and has not been considered further.

7.3.2 Operational Phase

A detailed specification for the noise generating equipment at PP-13, with associated noise levels, is not available at this stage. Therefore the equipment used at IPP-11 has been assumed for PP-13. The noise levels for the equipment at IPP-11, as predicted by Hyundai Maritime Research Institute (HMRI), were used as the basis for this noise assessment.

Operational noise levels have been assessed using the methodology set out in ISO 9613:2. This methodology uses the following parameters to estimate environmental noise levels:

- Noise source sound power level;
- Geometric spreading;
- Screening;
- Air absorption; and
- Ground effects.

The following operational scenarios were considered in this assessment:

- Single cycle – where the gas turbines (GTs) are used to generate electricity;
- Combined cycle – where exhaust gas from GTs are fed into the Heat Recovery Steam Generator (HRSGs) which are then feed into the Steam Turbines (STs)

Operational scenarios involving short-term, or atypical, conditions were not assessed. These include the following;

- Start-up/shut down of the power plant;
- Commissioning phase;
- Failure conditions;
- Emergency conditions.

The noise levels used for the assessment are presented in the following tables.

Table 7-5: Sound power levels of the gas turbine generator

Section	Sound Power Level								
	Overall dB(A)	Octave Band Centre Frequencies Hz, dB							
		63	125	250	500	1000	2000	4000	8000
Inlet Ducting (including filter house)	88	101	94	93	82	74	82	54	26
Inlet Filter Face	99	111	104	100	95	93	90	84	76
Accessory Module	103	107	101	98	97	97	99	93	88
Inlet Plenum	103	93	90	92	91	92	101	92	80
Turbine Compartment	113	115	110	108	106	104	109	104	99
GT Exhaust Diffuser Enclosure	112	121	115	111	108	104	104	103	100
GT Load Compartment	105	109	109	104	99	97	100	97	90
GT Generator	107	105	105	101	104	102	101	96	87
Cooling Water Module	107	99	113	105	104	104	94	89	91

Table 7-6: Sound power levels for the steam turbine package

Section	Sound Power Level								
	Overall dB(A)	Octave Band Centre Frequencies Hz, dB							
		63	125	250	500	1000	2000	4000	8000
STG Summary	107	112	108	107	106	101	96	94	93
STG Generator	108	106	105	102	104	103	102	97	88

Table 7-7: Sound power levels for the HRSG

Section	Sound Power Level								
	Overall dB(A)	Octave Band Centre Frequencies Hz, dB							
		63	125	250	500	1000	2000	4000	8000
HRSG Wall	96	84	89	92	88	83	79	55	20
Stack Wall	91	84	88	86	79	66	71	29	20
Stack Exit (90-degrees)	95	91	92	77	75	80	70	46	24

Table 7-8: Sound power levels for the closed cooling water cooler

Section	Sound Power Level								
	Overall dB(A)	Octave Band Centre Frequencies Hz, dB							
		63	125	250	500	1000	2000	4000	8000
Fan	99	104	104	101	96	94	88	82	76

The sound pressure levels for the gas turbine step-up transformer, steam turbine step-up transformer as well as the auxiliary transformer were assumed to have a diffuse sound field pressure of 75 dB(A). Furthermore 85 dB(A) at 1m was utilized for the sound pressure levels of all pumps used at the plant.

In addition it has been assumed that the building fabric of all buildings including Gas Turbine Generators (GTG), Heat Recovery Steam Generators (HRSG), Steam Turbine Generator (STG) enclosures and pump enclosures will provide a minimum weighted sound reduction index of R_w 30. This is typically achieved using an aluminium cladding panel.

Using the stated assumptions and noise data listed above, noise models for each of the operational scenarios were developed using the Datakustic CadnaA noise modelling software.

7.4 Existing Baseline Conditions

The baseline noise conditions in the vicinity of PP-13 were measured in 2010 as part of an assessment for the IPP-11 proposal. This baseline survey was combination of attended and fully-automated environmental noise measurements. In this section, the previously reported methodology and results are given in full. For the purpose of this study, it is assumed the results presented below are also applicable for the PP-13 development.

7.4.1 Study Area and Sensitive Receptors

The only significant noise source in the vicinity of the Proposed Development is IPP-11, located adjacent to the site. The only sensitive receptors noted within the vicinity of the Proposed Development are temporary accommodation units due north of the site and permanent accommodation units to the east.

The area beyond the site is sparsely inhabited; the nearest population centre being the town of Dhurma (Adh Dharma) located approximately 50 km to the south east. Noise levels at these locations due to the development will be negligible and therefore they will not be considered further in this assessment.

An overview of the proposed site showing adjacent land uses and sensitive receptors (units) are illustrated in **Figure 7-1** below.

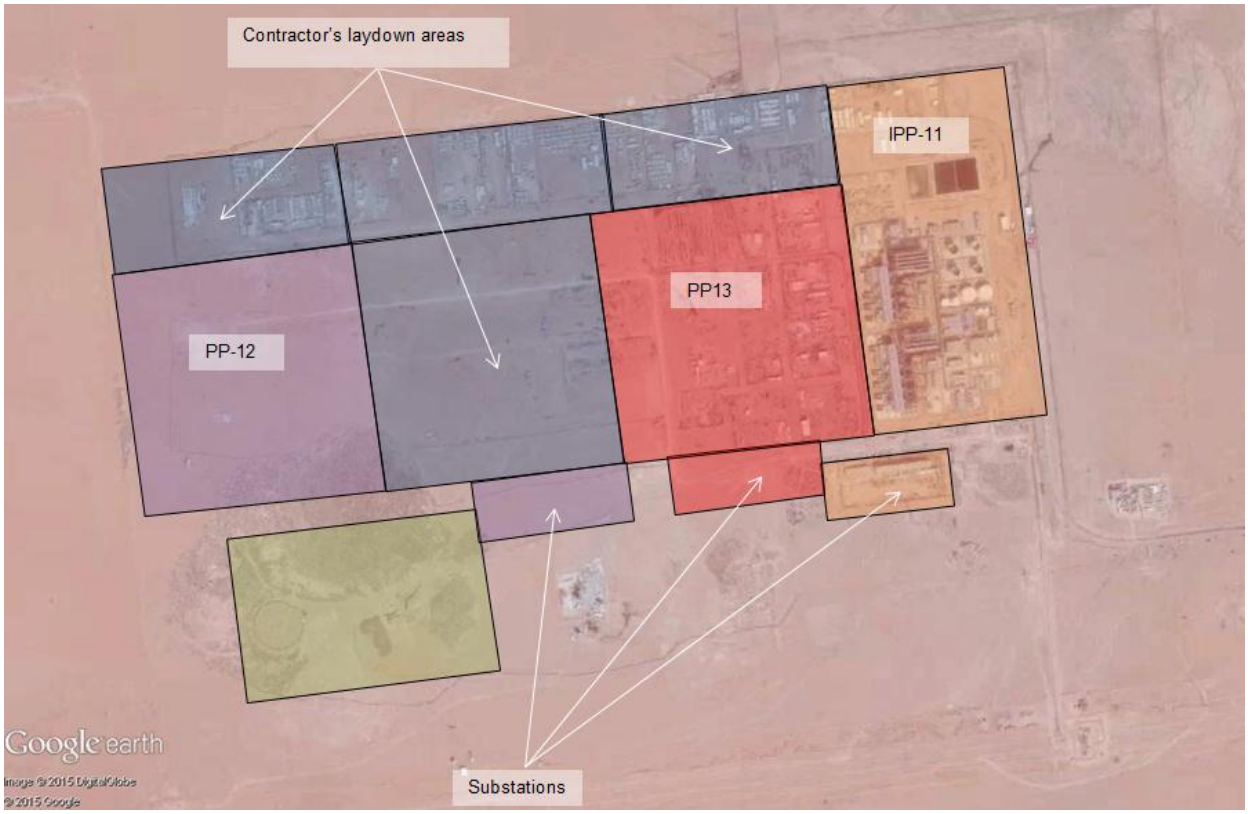


Figure 7-1: Overview of project site and surrounds

7.4.2 Methodology

Attended and fully-automated unattended environmental noise monitoring was undertaken between 18th and 21st March 2010 at three positions around the site of the proposed Riyadh IPP facility.

Measurements were taken of the A-weighted (dBA) equivalent continuous $L_{Aeq,T}$, L_{A90}, L_{A10} and L_{Amax} sound pressure levels taken at 1 second intervals. Data has subsequently been concatenated to wider time periods for ease of graphical presentation (15 minutes), but datasets are subsequently available using any time period required. Atypical noises were excluded as far as reasonably possible. The noise levels measured are therefore assumed to be representative of the noise climate during the period in which the measurements were taken.

In addition, at each position typical L_{Aeq} and octave band spectra (from 63Hz to 8kHz) were taken in order to gain a more detailed description of the prevailing noise climate.

7.4.3 Measurement Positions

The noise level measurements were undertaken at three positions around the development site. The positions were selected to coincide with the proposed site boundary so that a direct comparison can be made between historic and operational noise levels at the appropriate time. The measurement locations are shown in **Figure 7-2** below and the GPS coordinates given in **Table 7-9**.



Figure 7-2: Measurement locations, relative to PP13 site boundary

Table 7-9: Measurement positions

Position	GPS coordinates	
1 – South East site boundary	24°46'32.80"N	45°38'0.10"E
2 – South West site boundary	24°46'27.49"N	45°36'49.13"E
3 – North site boundary	24°46'59.33"N	45°36'44.16"E

The noise monitoring equipment was fixed to boundary fences approximately 1.5m from the ground and more than 3m from the nearest reflective façade and was therefore considered commensurate with measurements taken in free-field conditions.

7.4.4 Instrumentation

The equipment used for the noise survey is listed in **Table 7-10** below.

Table 7-10: Instrumentation

Set	Manufacturer and instrument type number	Serial no.
SIP D	01dB-Stell SIP 95 sound level meter	10565
	01dB-Stell Pre 12 N microphone pre-amplifier	002557
	Microtech Gefell MCE 212 ½" condenser microphone	92308
Solo 1	01dB-Stell Solo integrating data logging sound level meter (Class 1)	60586
	01dB-Stell Pre 21 S microphone pre-amplifier	13171
	Gras "MCE 212"condenser microphone	59612
Cal 21	Sound Calibrator, 01dB-Metravib "Cal 21"	35242334

7.4.5 Description of the Noise Environment

During the survey period the wind conditions varied between Moderate (approximately 5.5 m/s) and Calm (0m/s) and from a Southerly direction. The sky was generally clear, although a degree of residual particulate matter was present near ground level due to prevailing sandstorm activity.

During the majority of the first day of the survey, wind speeds were generally in excess of 5m/s, which had a noticeable effect on the measured noise levels. Wind speeds dropped significantly in the evening and at night which resulted in true background noise readings and acceptable data captured over the 24-hour period.

Elevated noise levels during the daytime at measurement positions 1 & 2 can be clearly seen from the ambient background graphs and data which can be found in the appendices of this report. The conditions over the course of the survey period were generally considered suitable for obtaining representative measurement datasets.

Table 7-11: Survey results of lowest measured background daytime and night time noise levels (24 hours)

Position	$L_{A90, 15min}$ Sound Pressure Levels dB	
	Daytime (07:00 – 22:00)	Night Time (22:00 – 07:00)
1	32.2	18.1
2	28.6	24.0
3	26.4	22.3

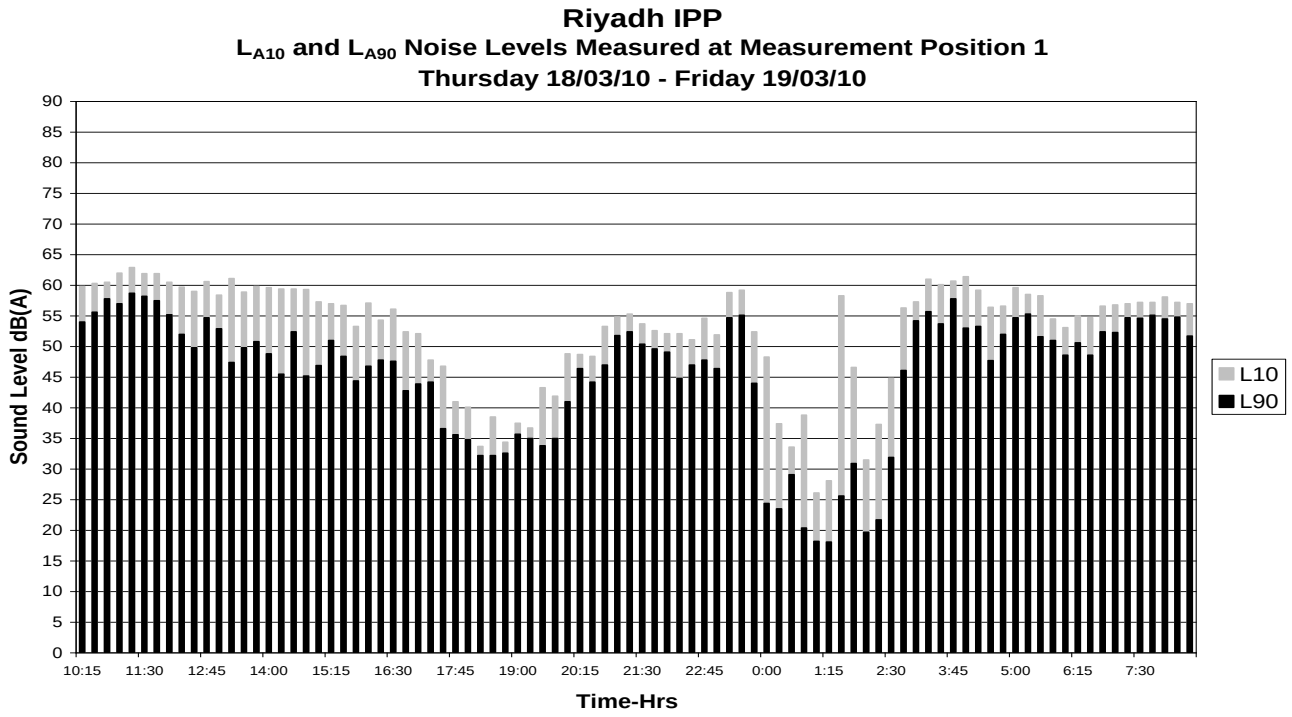


Figure 7-3: L_{A10} and L_{A90} noise levels measured at position 1

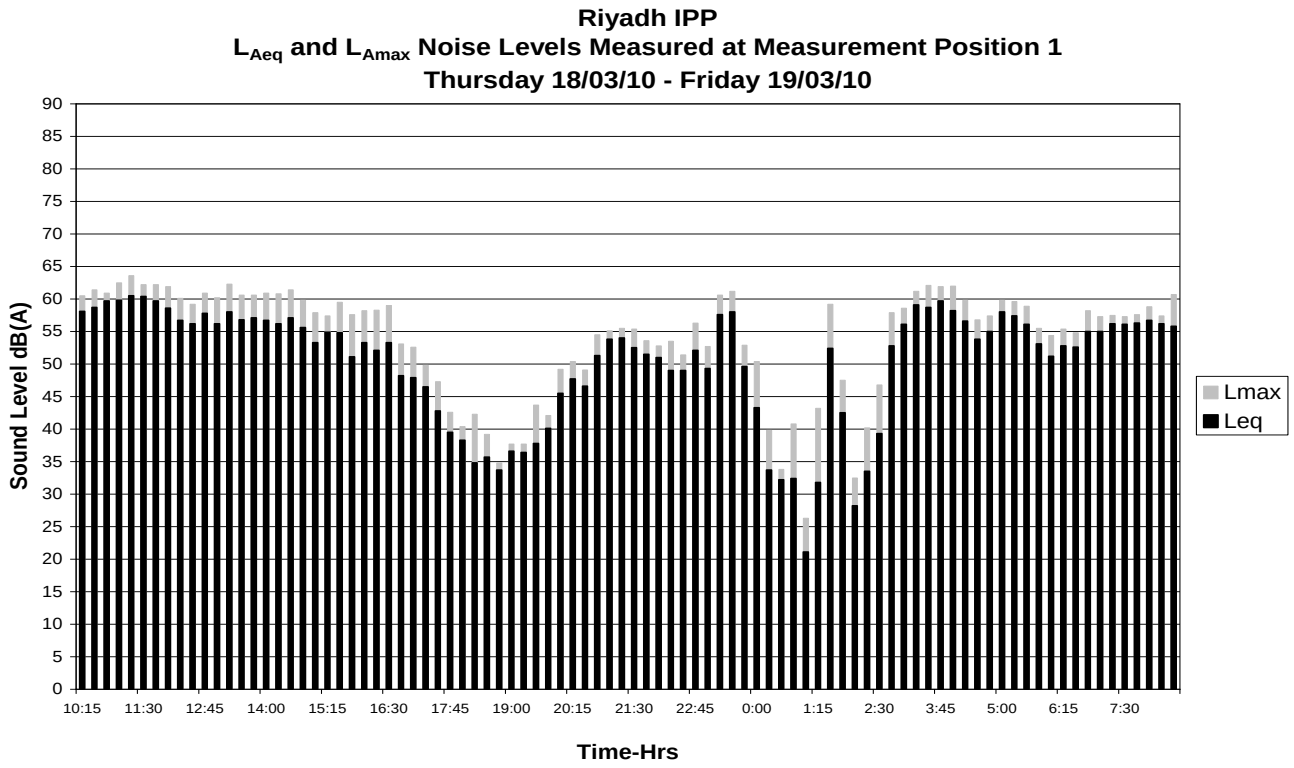


Figure 7-4: L_{Aeq} and L_{Amax} noise levels measured at position 1

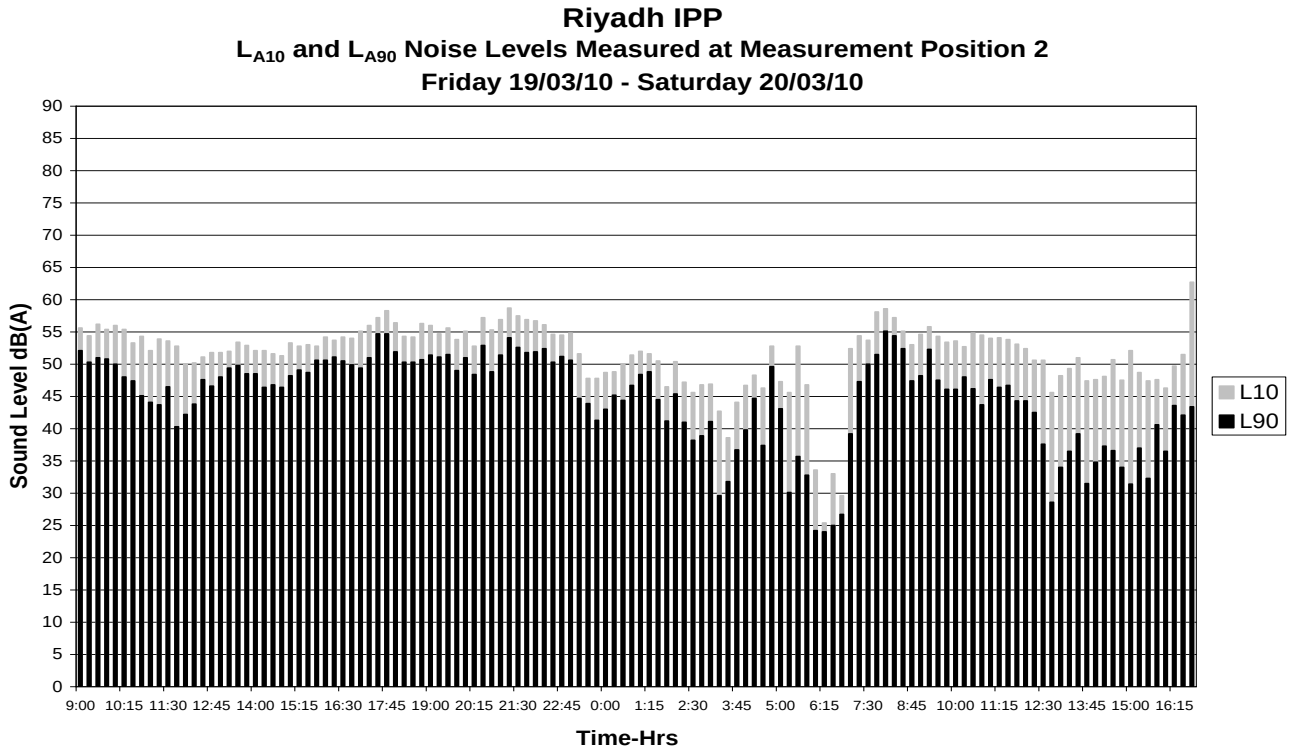


Figure 7-5: L_{A10} and L_{A90} noise levels measured at position 2

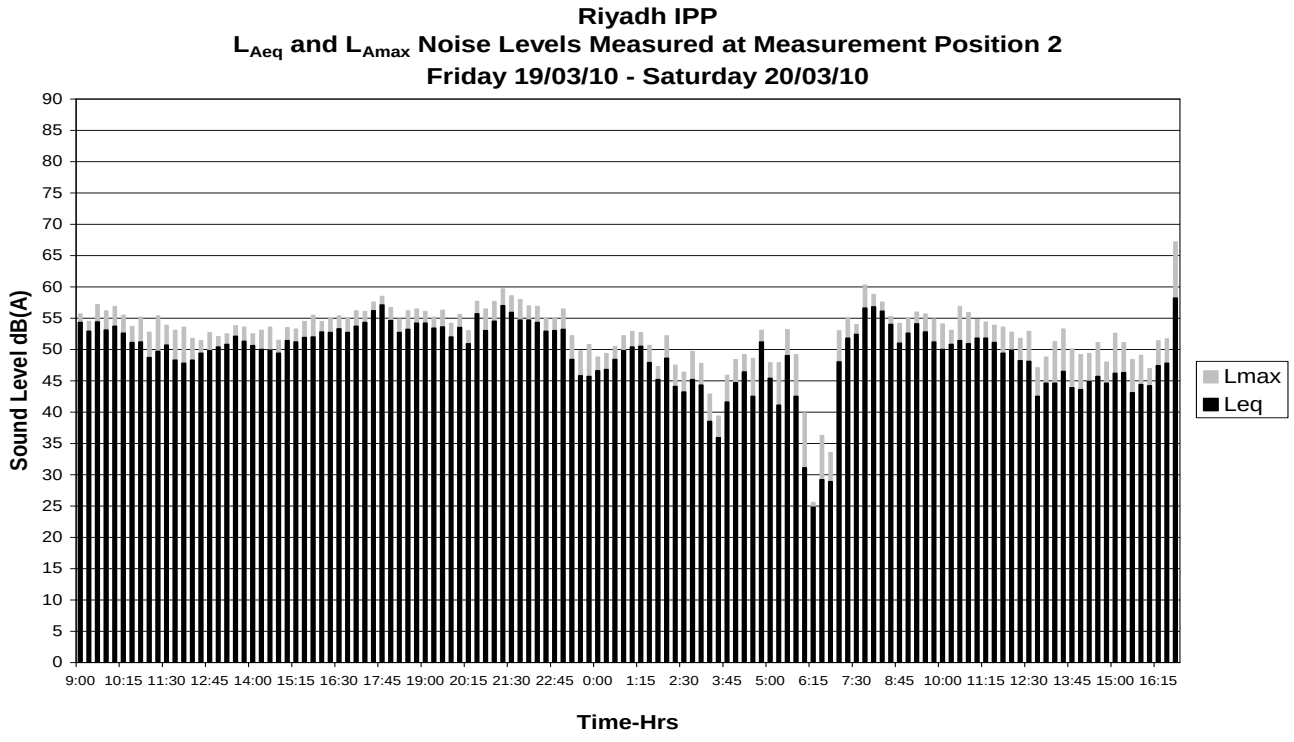


Figure 7-6: L_{Aeq} and L_{Amax} noise levels measured at position 2

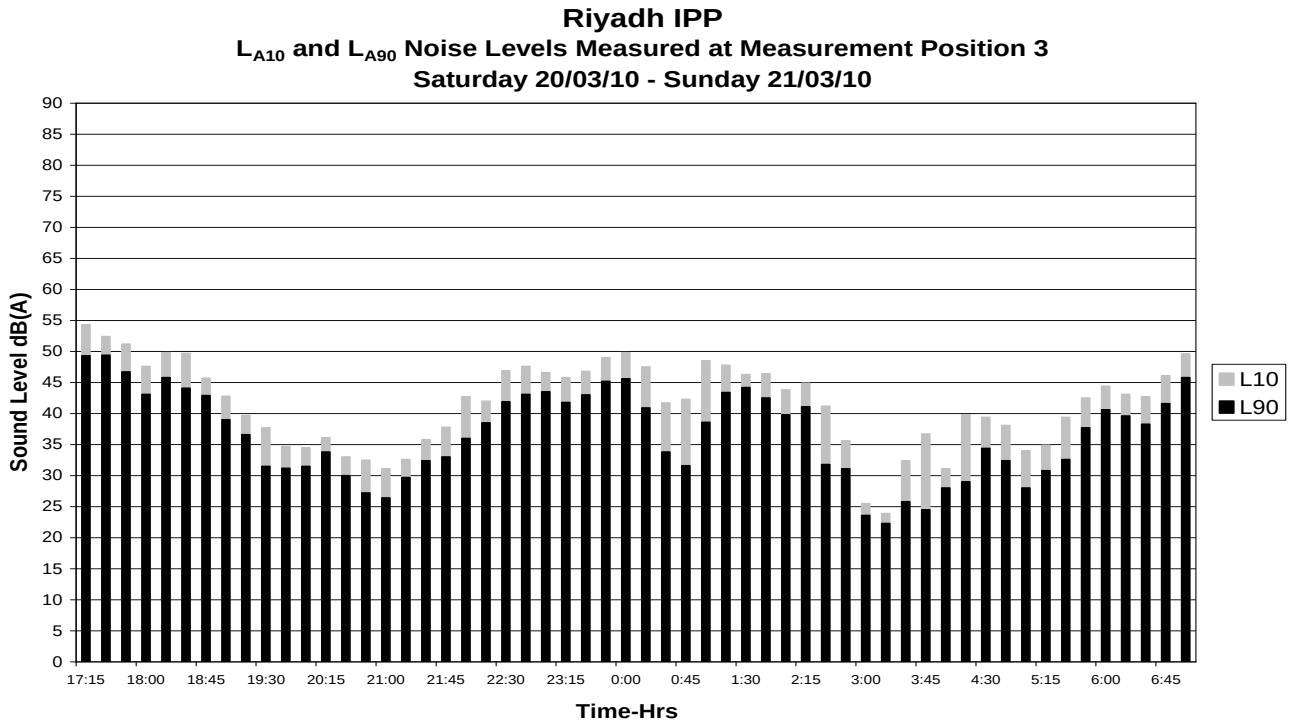


Figure 7-7: L_{A10} and L_{A90} noise levels measured at position 3

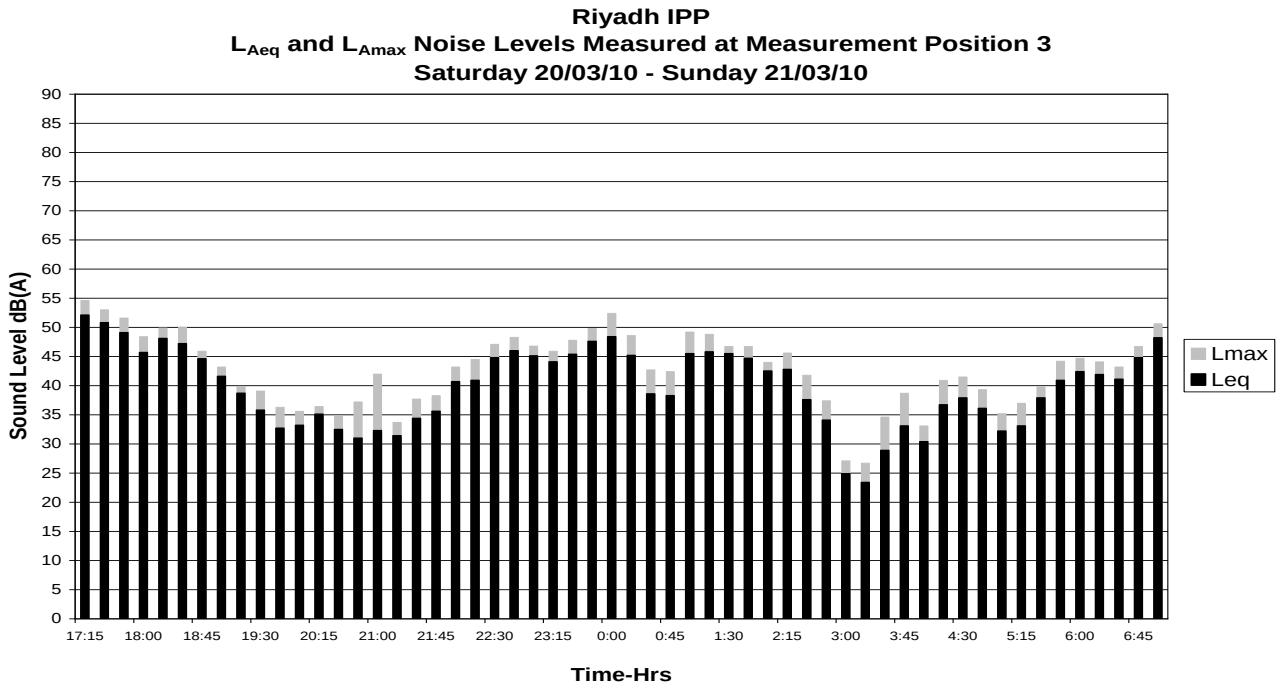


Figure 7-8: L_{Aeq} and L_{Amax} Noise levels measured at position 3

The existing conditions at monitoring sites 1 and 2 are shown in **Figure 7-9** and **Figure 7-10** below.



Figure 7-9: View of adjacent undeveloped desert



Figure 7-10: View of noise monitoring location

7.5 Assessment of Construction and Operational Impacts

7.5.1 Construction Phase Impacts

Construction phase noise levels across the project site, and surrounds, were predicted using the methodology specified in **Section 7.3.1**.

Two scenarios were modelled (site preparation and civil works) and noise contour maps for each were produced. These are given in **Figure 7-11** and **Figure 7-12** respectively, which show the extent of the modelled domain.

It is assumed that construction will be occurring 24 hours per day, and therefore the noise levels shown are for all periods (day, evening and night)

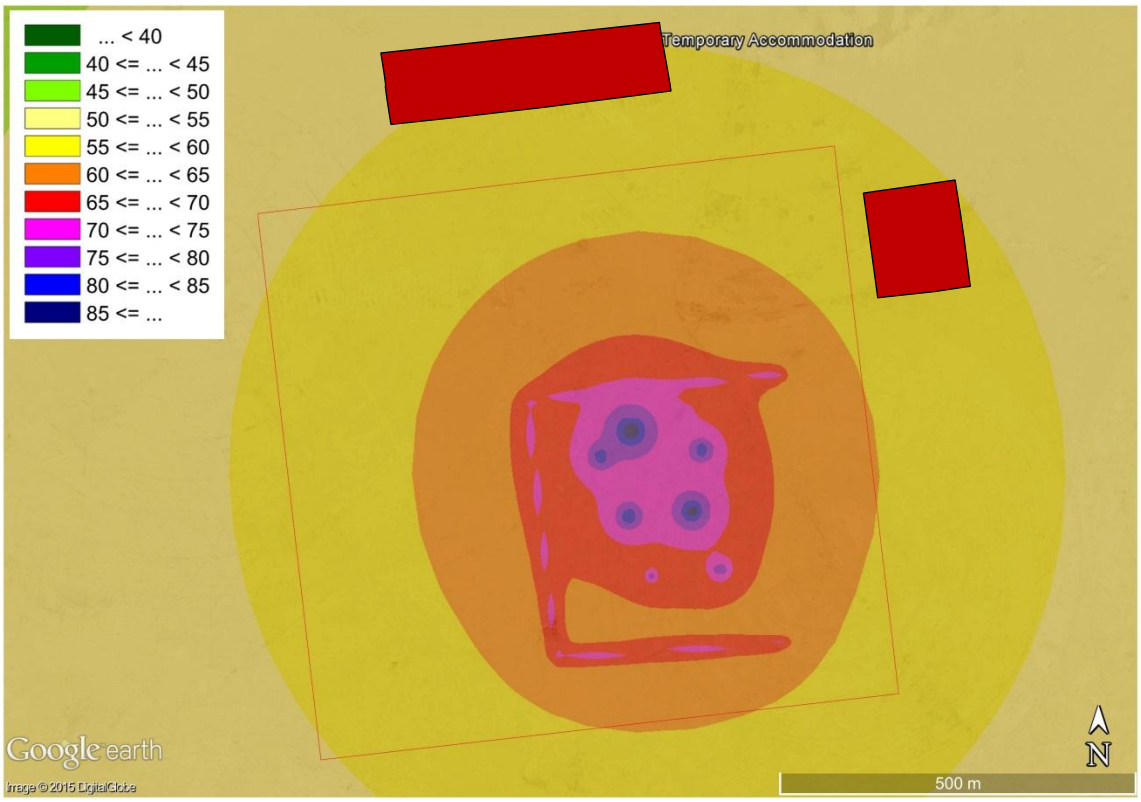


Figure 7-11: Site preparation noise map

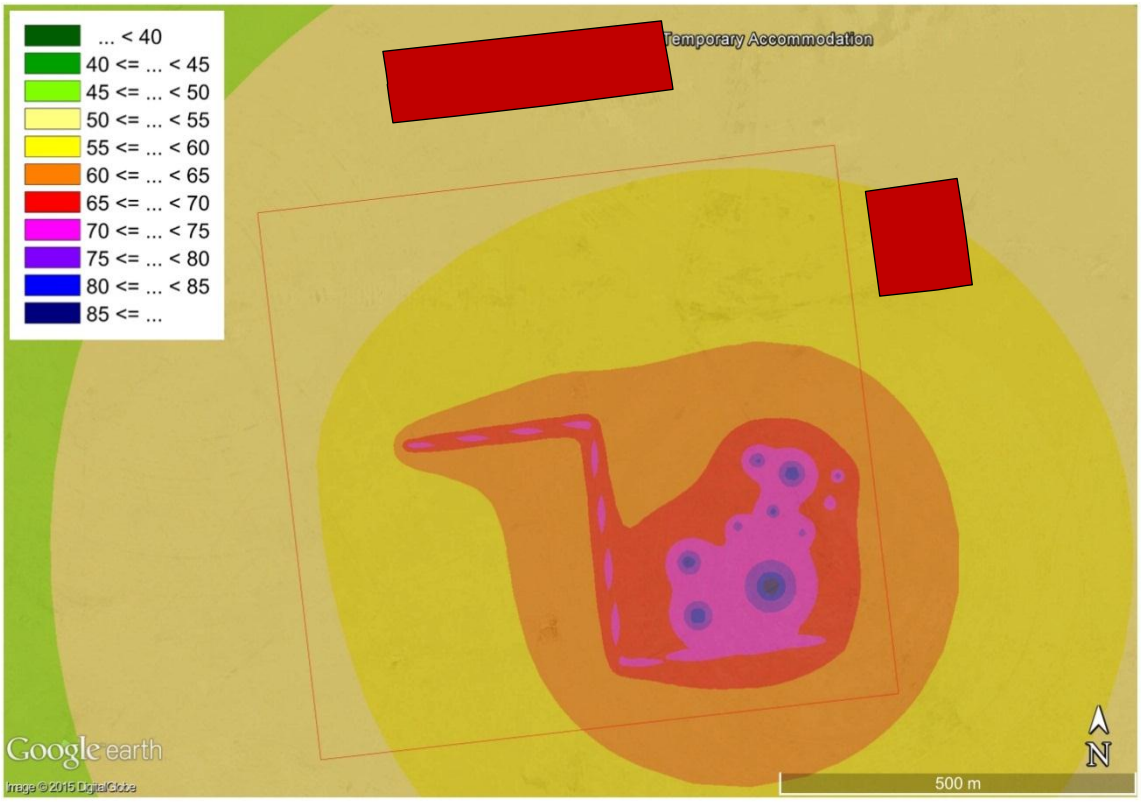


Figure 7-12: Civil works noise map

In **Section 7.2.1** it was established that, for this development, L_{Aeq} 80 dB(A) was the appropriate limit for construction noise levels at the facades of nearby noise sensitive receptors.

Based on the predicted noise levels presented in **Figure 7-11** and **Figure 7-12**, the greatest *free-field* noise level at the nearby sensitive receptors will be 57 dB(A). Assuming a standard 3 dB(A) increase due to façade reflections, this corresponds to a noise level of 60 dB(A).

This noise level is well below the L_{Aeq} 80 dB(A) criterion applicable to day, evening and night periods and therefore construction noise is predicted to **comply** with the nominated noise limits.

7.5.2 Operational Phase Impacts – PP13 Only

Operational phase noise levels across the project site, and surrounds, were predicted using the methodology specified in **Section 7.3.2.**

Two scenarios were modelled (single cycle and combined cycle) and noise contour maps for each were produced. These are given in **Figure 7-13** and **Figure 7-14** respectively

Overall noise emission, from the combined impact of PP-13 and IPP-11 operating concurrently, will be assessed in **Section 7.5.3**.

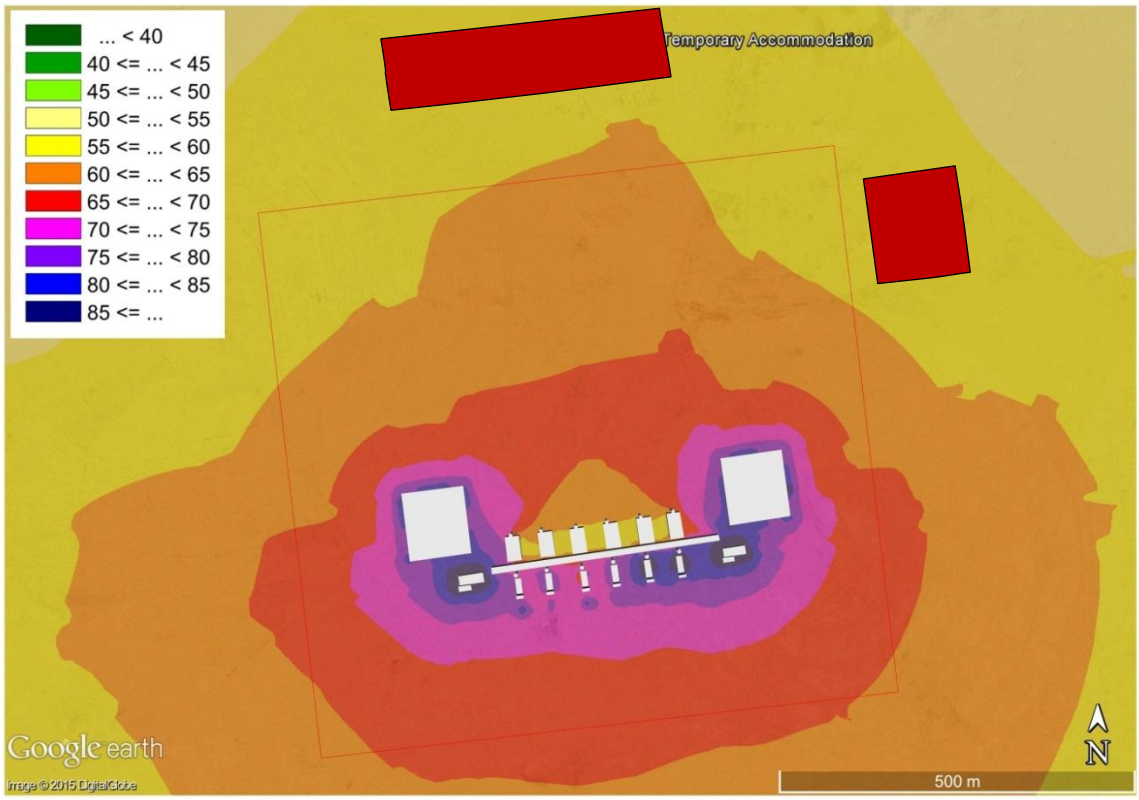


Figure 7-13: PP-13 single cycle operation noise map

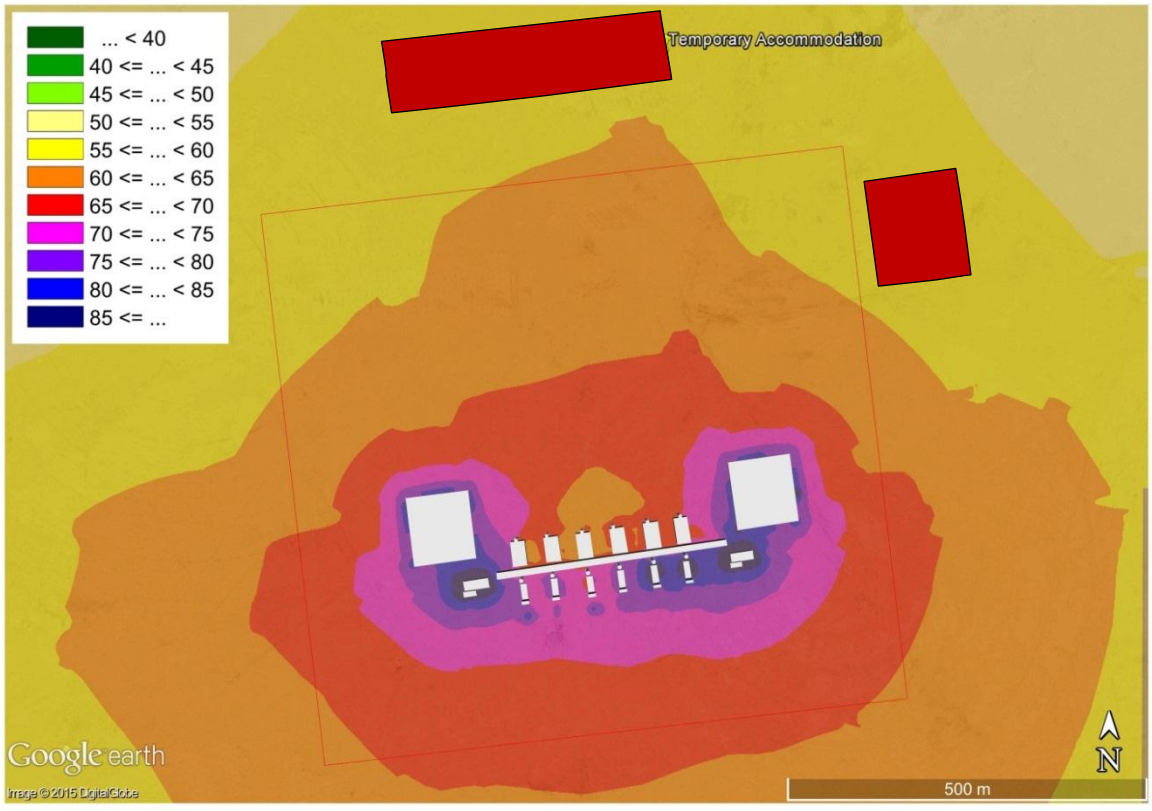


Figure 7-14: PP-13 combined cycle operation noise map

The temporary accommodation buildings located in the contractor laydown area to the north are likely to be removed or demolished once the construction phase has completed and therefore will not be present when PP-13 is operational. On this basis, they have not been considered further as part of the operational noise assessment.

The permanent accommodation units within the IPP-11 site boundary will be present during the operational phase of PP-13 however and so have been assessed.

In **Section 7.2.2**, it was shown that the operational noise criteria varied depending on the type of receptor and the time of day. The noise criteria applicable to the accommodation buildings north of the site are summarised in **Table 7-12** below.

Table 7-12: Summary of operational noise criteria for accommodation buildings

Guidance Document	Measurement Location	Daytime $L_{Aeq, T}$ dB	Evening $L_{Aeq, T}$ dB	Night-time $L_{Aeq, T}$ dB
PME Noise	At all receptors	65	60	50
IFC World Bank	At residences	55	55	45

It is assumed that PP-13 will operate 24 hours per day and so the assessment has considered day, evening and night criteria.

Based on **Figure 7-13** and **Figure 7-14**, noise levels up to 58 dB(A) are predicted for day, evening and night periods at the IPP-11 accommodation units to the north-east.

Therefore, the following conclusions can be drawn:

- Operational noise levels are predicted to comply with the PME Noise criteria during day and evening periods, but not during night periods.
- Operational noise levels are not predicted to comply with the IFC criteria during any periods.

Although the operational noise levels are predicted to exceed both sets of criteria, it should be noted that the temporary accommodation buildings are located in contractor laydown areas. Therefore, these buildings are likely to be removed or demolished once the construction phase has completed and therefore will not be present by the time PP-13 becomes operational.

If there are no noise sensitive receptors in the vicinity of PP-13 during the operational phase, it follows that the noise impact will be negligible.

7.5.3 Operational Phase Impacts – PP13 and IPP-11

An assessment of noise levels with both IPP-11 and PP-13 operating concurrently (in combined cycle mode) was undertaken.

The results are given in **Figure 7-15** and indicate that noise levels up to 70 dB(A) are predicted for day, evening and night periods at the IPP-11 accommodation units.

Given that the contribution from PP-13 was established in **Section 7.5.2** above as being no greater than 58 dB(A), it can be concluded that the noise levels at these units are wholly dominated by noise from IPP-11.

It should be noted however that these results are based on 'worst case' conditions that have not factored in the noise mitigation measures that would have been implemented following recommendations provided in the 2010 noise impact assessment for IPP-11

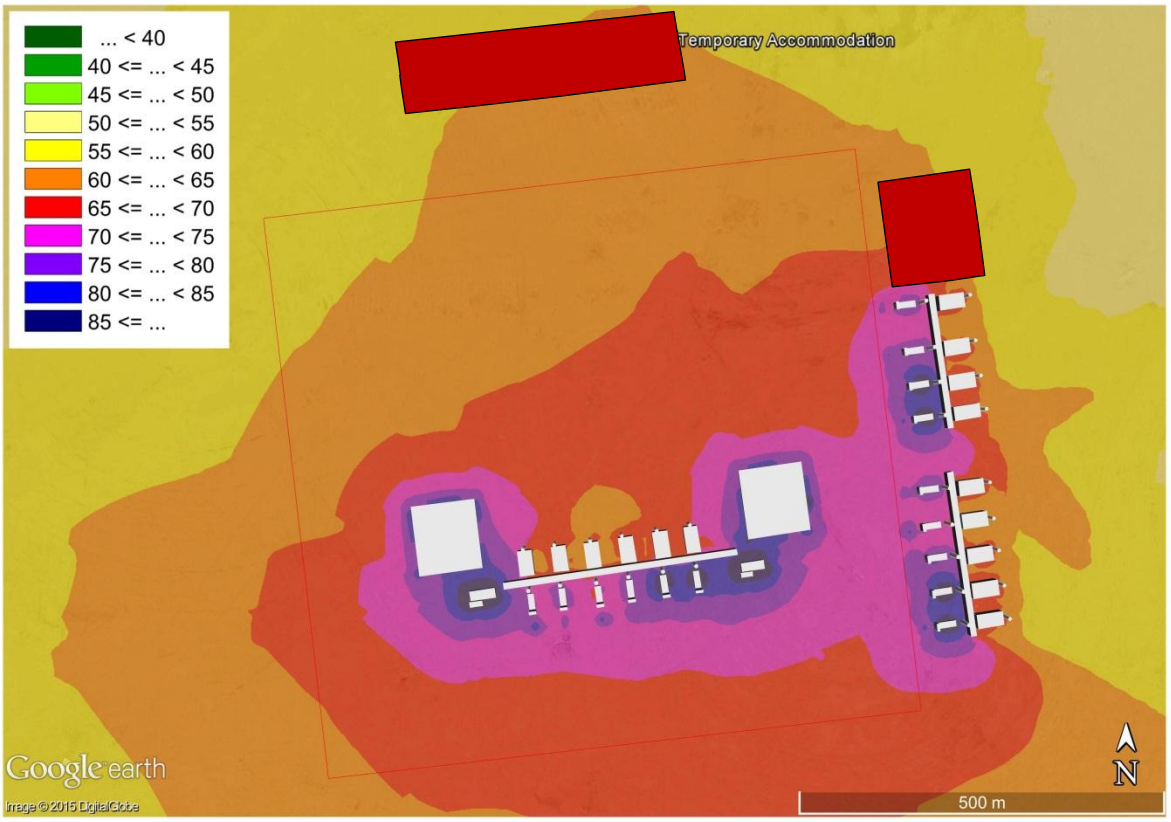


Figure 7-15: PP-13 combined cycle operation noise map, with IPP-11 operating at full capacity

7.6 Mitigation Measures, Residual and Cumulative Effects

7.6.1 Construction Phase Mitigation Measures

The predicted noise levels during the construction phase are compliant with the criterion and therefore no mitigation measures are required. It is however recommended to follow 'as low as reasonably practicable' methods of noise and vibration control such as:

- Undertake regular noise monitoring within close proximity of the noise sensitive locations, if future works include activities which are known to cause significant levels of noise;

- In order to control the duration of noise from the construction activities, no noise from the works should be audible at the accommodation building outside the hours of:
    - Saturday to Thursday 07:00 - 19:00; and
    - Public Holidays.
- If noise exceeds the required standards the use of acoustic screens or noise attenuation measures should be implemented;
- Stationary machinery such as generators must be kept in enclosed structures for noise control during the night;
- Items of plant on site operating intermittently will be shut down in the periods between use;
- Electrically powered plant should be preferred, where practicable, to mechanically powered alternatives.
- All mechanically powered plant should be fitted with suitable silencers;
- Use of vibratory hammer for piling rather than impact hammer to reduce noise levels;
- High frequency vibrator hammer to be used rather than low frequency based on the type of piling;
- Moveable acoustic sound barriers for the hammer and piling equipment to be provided near to receptors such as the adjacent staff accommodation and other facilities;
- Delivery vehicles should be prohibited from waiting within or near the construction site with their engines running. The movement of heavy vehicles during the night will be avoided wherever practical;
- Noisy equipment and machinery will be replaced with less noisy alternatives or provide equipment that is specifically designed with noise inhibitors, such as generators and compressors with silencers and muffled jackhammers; and
- It is recommended that a grievance procedure be implemented by the EPC Contractor. This will provide a mechanism for adjacent staff or nearby residents to make representations if significant noise disturbance occurs.

7.6.2 Construction Phase Residual Effects

Given that elevated noise levels during the construction phase are both (1) temporary and (2) predicted to be compliant with the criterion during day, evening and night periods, it is anticipated that the residual impact for construction works will be of **negligible** significance.

7.6.3 Construction Phase Cumulative Effects

The contribution of the construction phase to overall noise levels in the vicinity of the development will be significant, resulting in noise levels at the facades of units of up to 60 dB(A). Given that pre-construction noise levels were measured at levels as low as 18 dB(A), this represents a significant increase in overall noise levels.

However, it should be reiterated that although the increase in noise levels is significant, they still comply with PME's construction noise standards.

On this basis, the cumulative noise impact is classed as **moderate**

7.6.4 Operational Phase Mitigation Measures

The combined use of PP-13 and IPP-11 was predicted to result in a significant noise impact. However, it was shown in **Section 7.5.3** that this was wholly due to unmitigated noise emission from IPP-11, with PP-13 providing a negligible contribution to overall noise levels.

Given that recommendations for noise mitigation were provided for IPP-11 previously as part of the 2010 noise assessment for that development, it is expected that these measures were implemented as recommended and actual noise levels at the IPP-11 accommodation units during the operational phase will be controlled.

Given that the contribution from PP-13 is negligible, relative to IPP-11, at these units, the noise control measures implemented as part of the IPP-11 will be sufficient to control noise from PP-13.

If no specific noise control measures were implemented at these units as part of the IPP-11 development, it is expected that internal noise levels will be still be significantly lower as a result of the type of construction typical for the region (i.e. double-glazed windows).

If additional measures to reduce noise are optioned, then the following can be considered:

- Relocating the plant nearer to the western site boundary;
- Selecting equipment with lower noise levels;
- Incorporating silencers, enclosures and other noise attenuation with the plant;
- Noise barriers along the south and west perimeters of the IPP-11 accommodation units;
- Upgrading the facades of the IPP-11 accommodation units to provided higher sound insulation.

It is also important to note that there are occupational noise standards that need to be maintained as part of the Health and Safety of the employees at the facility. It is therefore important that noise levels in working areas are limited to less than 85 dB(A) at 1m from any noise generating equipment. It is recommended that a full occupational noise survey is undertaken in the interests of the health and safety of the site employees.

7.6.5 Operational Phase Residual Effects

As discussed in **Section 7.6.4**, the impact will be **negligible** due to the absence of any sensitive receptors during the operational phase

7.6.6 Operational Phase Cumulative Effects

It is expected that the noise control measures recommended for IPP-11 previously, as part of the 2010 noise assessment for that development, will have been implemented. These measures may be supplemented by the additional measures outlined in **Section 7.6.4** above.

On this basis, the post-mitigation cumulative noise impact would be classed as **moderate.**

7.7 Summary and Conclusions

An assessment of the potential noise and vibration effects for the PP-13 development, during both construction and operation, has been undertaken.

A noise survey was undertaken in the vicinity of the project site between 18th and 21st March 2010 and the measured results indicated very low background (L_{A90}) noise levels, with daytime levels between 26 to 32 dB(A) and night-time levels between 18 to 22 dB(A).

The construction phase noise levels at both the temporary and permanent accommodation units have been predicted and are expected to comply with the construction noise limits, despite the significant increase in ambient noise levels. The impact is therefore predicted to be **moderate**. Recommendations for on-going monitoring of the noise levels associated with construction activity have been made.

Unmitigated noise levels at the IPP-11 accommodation units due to operational phase noise emission from PP-13 alone, as well as PP-13 operating concurrently with IPP-11, were predicted and found to have a significant noise impact.

However, it is expected that the noise control measures recommended for IPP-11 previously, as part of the 2010 noise assessment for that development, will have been implemented and would be sufficient to control noise from PP-13. Generic noise-control measures have been provided in the event that the measures recommended for IPP-11 previously were not implemented.

On this basis, the post-mitigation cumulative noise impact would be classed as **moderate.**

Due to the distance between the project site and surrounding receptors, the impact of vibration has been deemed **negligible**.

7.8 References

- British Standard 5228-1: 2009 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise, BSi, 2009.
- British Standard 5228-2: 2009 Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration, BSi, 2009.

- Environmental, Health and Safety (EHS) Guidelines; General EHS Guidelines: Environmental – Noise Management, International Finance Corporation World Bank Group, 2007.
- International Standard ISO 9613:1 – 1996 – Acoustics – Attenuation of sound during propagation outdoors – Part 1: Calculation of absorption of the sound by the atmosphere, ISO, 1996.
- International Standard ISO 9613:1 – 1996 – Acoustics – Attenuation of sound during propagation outdoors – Part 2: General Method of calculation, ISO, 1996.
- British Standard 7445-1:1991 – Description and measurement of environmental noise – Part 1: Guide to quantities and procedures, BSi, 1991.
- British Standard 7445-2:1991 – Description and measurement of environmental noise – Part 2: Guide to the acquisition of data pertinent to land use, BSi, 1991.
- British Standard 7445-3:1991 – Description and measurement of environmental noise – Part 3: Guide to application to noise limits, BSi, 1991.
- Kingdom of Saudi Arabia National Environmental Standard – Environmental Noise

8 Waste and Hazardous Materials

8.1 Introduction

This chapter presents the results of a solid waste assessment for the Project. The potential impacts that may arise from waste generated during the construction and operational phases are identified.

The chapter also details opportunities for implementing mitigation measures together with good practice for the storage, transfer and disposal of waste in order to reduce the potential impacts arising during each phase of the development. These measures are summarised below and set out in full in **Chapter 17 – Framework Construction Environmental Management Plan** and **Chapter 18 – Framework Operational Environmental Management Plan.**

8.2 Relevant Standards and Legislation

8.2.1 National Legislation and Standards

The GER, 2001 makes specific reference to the control of solid waste materials and, in particular, waste materials which are classified as hazardous in terms of their impacts on the environment. The following are of particular note:

- Article 14 (Hazardous Waste Management) identifies the Presidency of Meteorology and the Environment (PME) as the responsible authority for the regulation of waste materials; and
- GER Appendix 4 “Hazardous Waste Control Rules and Procedures” provides details regarding the classifications of waste and the obligations placed on producers, transporters and waste disposal authorities to ensure environmental pollution is avoided. Prior to shipping any hazardous waste outside the facility, the generator of hazardous waste shall comply with the requirements for packaging, record keeping and duty of care obligations.

Further, the revised PME environmental standards issued in 2012 include the following, which are of relevance to this assessment:

- Environmental Standard 8 - Waste Acceptance Criteria;
- Environmental Standards 9 - Waste Classification;
- Environmental Standard 12 - Waste Control;
- Environmental Standard 13 – Waste Handling and Storage;
- Environmental Standard 14 – Waste Training and Operators; and
- Environmental Standard 15 – Waste Transport.

In particular, the Environmental Standard 12 makes specific reference to the control of solid waste materials and in particular waste materials which are classified as hazardous in terms of their impacts on the environment:

> *Article 4 (Purpose) identifies that PME is charged with protecting the natural environment and is therefore obliged to issue controls over waste activities in KSA'.*

The Waste Classification Standard for KSA provides the following:

"A national classification system that may be employed within KSA by all waste generators, transporters, facility operators and the relevant competent agencies and other interested parties. The standard provides classification, coding and defining of all waste types so they can be handled treated or disposed of accordingly".

8.2.2 IFC Standards

The IFC Environmental, Health and Safety (EHS) Guidelines for Thermal Power Plants (December, 2008) requires:

"Management of ash disposal and reclamation so as to minimize environmental impacts – especially the migration of toxic metals, if present, to nearby surface and groundwater bodies, in addition to the transport of suspended solids in surface runoff due to seasonal precipitation and flooding. In particular, construction, operation, and maintenance of surface impoundments should be conducted in accordance with internationally recognized standards."

Section 1.5 of the IFC General EHS Guidelines covers Hazardous Materials Management and Section 1.6 deals with Waste Management and is applicable to all projects that generate, store or handle any quantity of waste. The waste management guidelines state that facilities that generate and store wastes should practice the following:

- Establish waste management priorities at the outset of activities based on an understanding of potential Environmental, Health, and Safety risks and impacts;
- Establish a waste management hierarchy that considers prevention, reduction, reuse, recovery, recycling, removal and finally disposal of wastes;
- Avoid or minimize the generation waste materials, as far as practicable;
- Where waste generation cannot be avoided but has been minimized then options for recovering and reusing waste should be developed; and
- Where waste cannot be recovered or reused, identify means of treating, destroying, and disposing of it in an environmentally sound manner.

This assessment also considers the likely impacts upon soils and geology as a result of Project activities in relation to the updated IFC Performance Standards; namely:

- Performance Standard 3: Resource Efficiency and Pollution Prevention.

It is a requirement of this performance standard to implement measures to ensure the following:

- 'Avoid the generation of hazardous and non-hazardous waste materials. Where waste generation cannot be avoided, the client will reduce the generation of waste and recover and reuse waste in a manner that is safe for human health and the environment. Where waste cannot be recovered or reused, the client will treat, destroy or dispose of it in an environmentally sound manner that includes the appropriate control of emissions and residues resulting from the handling and processing of the waste material';
- 'When hazardous waste disposal is conducted by third parties, the client will use contractors that are reputable and legitimate enterprises licensed by the relevant government regulatory agencies and obtain chain of custody documentation to the final destination';
- 'The client will avoid or, when avoidance is not possible, minimise and control the release of hazardous materials….The client will avoid the manufacture, trade and use of chemicals and hazardous materials subject to international bans or phase-outs due to their high toxicity to living organisms, environmental persistence, potential for bio accumulation or potential for depletion of the ozone layer'; and
- 'This section also provides guidelines for the segregation of waste into hazardous and non-hazardous streams and how to manage these waste streams. The Project should seek to demonstrate compliance with the principles and guidelines set out within this document'

8.3 Methodology

The principal aim of this assessment is to consider the key waste management issues associated with the proposed PP-13 with particular reference to identifying opportunities for the reduction of the severity or likelihood of significant environmental impacts.

The methodology adhered to comprised a number of tasks including

- Site visit in February 2013 and in December 2014 to gain an understanding of any issues regarding waste;
- A desk top review to collate existing information relevant to waste generation and disposal within the Riyadh region;
- A review of existing proposal and plans for the proposed PP-13 in relation to waste storage and transfer requirements; and
- A review of available and accessible waste guidance and policy information.

8.4 Existing Baseline Conditions

8.4.1 Introduction

The existing baseline conditions on site have been assessed based on a site visit undertaken in February 2013 as well as a desktop analysis of the waste situation in KSA and implications of these for the Project.

8.4.2 Waste Management in KSA

The responsible management of solid waste materials has become a pressing need for all developing and modern economies, including Saudi Arabia. There are strong economic and environmental reasons for tackling the growing quantity of solid waste.

Waste management sites and facilities in Saudi Arabia are operated and managed by private companies or local municipalities, with PME currently providing an advisory role in their operation. When new sites are proposed and constructed, PME plays an important role in advising the operators on the environmental protection requirements for the facility.

The economic growth in Saudi Arabia, in addition to correlating urbanisation and population growth has resulted in a significant increase in the quantities of solid waste generated. It is estimated that 15 million tons of solid waste are generated annually, which equates to a per capita waste generation rate of between 1.5 to 1.8kg per person per day[21]. The vast majority of municipal solid waste is sent directly to landfill, with an estimated 10-15% recycled. Although both recycling and composting activities are undertaken on a small scale in comparison to the amounts of waste generated nationally, increasing interest is being placed in these sectors, with the Saudi government being acutely aware of the pressing need to identify solutions to the existing waste management issues facing the country[22].

8.4.3 Existing Site Conditions

There are few existing waste management issues at the project site. The main issue for the PP-13 project will relate to the historical use of parts of the site area as contractor laydown and storage areas for the construction of IPP-11 and PP-12 which is likely to have resulted in the generation of waste materials within the Project site. It is however assumed that the site area has been cleared of any waste materials prior to the commencement of construction of PP-13, including the compaction and excavation works within the PP-13 Project footprint area.

[21] Zafar, S. (2013) Solid Waste Management in Saudi Arabia. EcoMENA: Powering Sustainable Development in MENA. Available online at: www.ecomena.org/solid-waste-management-in-saudi-arabia/. [Accessed 25 April 2013].

[22] Ibid.

8.5 Sensitive Receptors

Potentially sensitive receptors include the soil within the site which could be adversely affected in the event of a contamination event due to inadequate storage provisions or through windblown litter. Additionally, workers may also represent sensitive receptors and could be exposed to hazardous materials or asbestos containing materials if adequate procedures have not been implemented to ensure the abatement, correct storage and transport of these materials and contamination of the environment resulting from releases of hazardous substances. These are discussed below and dealt with in **Chapter 9 – Soils, Geology and Contamination** and **Chapter 12 – Socio-Economic Issues**.

There is also the potential for increased traffic generated by the requirement for waste removal throughout the construction and operational phases of the Project, which may also render local road networks as sensitive receptors. Traffic impacts are discussed in **Chapter 15 – Traffic and Transportation**.

8.6 Assessment of Construction and Operational Impacts

8.6.1 Construction Phase Impacts

A summary of the potentially significant effects associated with the construction phase waste management is presented below.

Excavation Waste

A quantitative impact assessment cannot be undertaken at this stage due to limited data regarding the expected quantities of excavation material generated through excavation works on site.

It is anticipated that a significant quantity of excavation waste will be generated, through the construction of foundations across all parts of the site, pile arisings and the construction of service trenches.

It is expected that the majority of excavated material will comprise of natural ground, which has not previously been developed and is therefore likely to be classified as non-hazardous.

It is not considered that excavated material would require disposal to landfill as they could be reused or spread within the project site area. There will therefore be no impact upon landfill facilities.

Management of Construction Waste

Raw material waste from the construction of buildings and plant infrastructure may require off-site disposal. Some of the waste streams are likely to be generated during the construction of the building frame, internal fittings, electrical installations and external works and include the following waste streams:

- Class I Wastes including: solvents, thinners, cleaners, cutting oils, paints, contaminated rags, packaging and containers, adhesives, light bulbs and batteries;

- Class II Wastes including: food and canteen waste, scrap metal waste, waste paper, textiles, wood, cardboard packaging; and,
- Class III Wastes including: glass, uncontaminated soil and rubble, plastics and rubber.

Based on information currently available, it is not possible to undertake any calculations relating to waste generation estimates.

Additionally, the high number of construction workers expected to be required at the site during the construction phase will result in domestic waste generation.

Prior to mitigation, this is likely to have an impact on the capacity of current landfill and recycling services within the wider Riyadh area. It is anticipated that prior to implementation of appropriate mitigation measures, the generation of both hazardous and non-hazardous waste materials may result in a **minor negative impact**.

Storage of Construction Waste

The impacts associated with the poor storage of construction materials on-site may result in the potential wastage of large volumes of raw materials. It is anticipated that prior to the implementation of appropriate mitigation measures that this will result in a **minor negative impact**.

Contamination issues associated with the poor storage of construction wastes are dealt with in **Chapter 9 – Soils, Geology and Contamination**.

Movement of Construction Waste

The potential impact from the off-site movement and disposal of waste, either to an appropriate landfill site or to a recycling centre, may result in increased traffic movements from the Riyadh PP-13 site. If no minimisation or re-use initiatives are implemented at the site, this is likely to result in the increase of off-site lorry movements (noise and dust generation), and an increase in the amount of waste disposed of to landfill sites, consequently resulting in a **minor negative impact**.

Generation of Hazardous Wastes

Hazardous wastes likely to be produced will include oil (both liquid and sludge), paint, thinners, contaminated painting equipment and chemicals associated with construction activities.

It is anticipated that potential impacts of hazardous waste streams generated from construction activities of the facility are likely to be of **moderate negative significance** due to the potential to cause contamination if not managed or disposed of properly. It is also noted that not all landfills in the Kingdom are lined which suggests that the leaching of hazardous materials to the surrounding soil strata and groundwater may occur. The contamination impacts associated with hazardous wastes are described in the Chapter 9: Soil, Groundwater and Contamination.

8.6.2 Operational Phase Impacts

The types of solid waste materials generated during the operational phase will be associated with the maintenance works of the plant equipment and general municipal waste streams generated from the administration buildings and site canteen. During operation, a number of hazardous materials will be stored on site, including chemicals and fuel hydrocarbons. It is understood that a detailed product list and storage facilities design will be provided during the detailed design stage.

The key waste streams that are likely to be generated from maintenance and plant activities are likely to include pipe work, metals, wood, cardboard and plastics associated with replacement parts and sludge arising from treatment works. The predominant waste stream during maintenance will be used turbine air intake filters.

The key waste streams that are likely to be generated from the administration and canteen areas of the plant will be general waste streams of a predominately non-hazardous nature and include:

- Paper- waste paper may be generated during the general administration process and on site record keeping;
- Organic food waste – left over food waste and preparation waste from canteen areas;
- Cardboard - waste cardboard may be generated from deliveries of material to the site;
- Green waste - from on-site landscaping;
- Plastic packaging – waste plastic packaging in the form of shrink and bubble wrap; and
- General mixed waste- this may include some biodegradable waste including food waste.

Table 8-1 provides an estimate of the annual waste arisings from the site.

Table 8-1: Waste generation estimates during the operational phase

Waste Classification	Hazardous or Non-Hazardous	Source	Quantity (tonne/year)	Composition	Treatment or Disposal
Oil sludge	Hazardous	Oil/Water separator	10	Oil (10%) / Water (90%)	Disposal to engineered landfill
Solid waste	Non-Hazardous	General activities	120	Residual Waste, organic and dry recyclables	Disposal to engineered landfill
Industrial Waste Water Sludge	Hazardous	Sewage treatment	15	Sewage sludge	Disposal to engineered landfill
Sanitary Waste Water Sludge	Non-Hazardous	Wastewater Treatment	730	SS (20%) / Water (80%)	Disposal to engineered landfill

In the absence of project specific waste generation calculations, the waste estimates provided in **Table 8-1** have been utilised to allow a high level assessment of potential operational impacts. These have been based on benchmarks from previous EIAs (the Marafiq IWPP in KSA and the Al-Dur IWPP in Bahrain) prepared by WSP and included as examples within the SEA prepared for the adjacent IPP-11 facility.

The Project is unlikely to result in a significant generation of general solid waste during operation and it is anticipated that prior to the implementation of mitigation measures, waste streams generated from the maintenance works, plant processes and administration areas, that potential impacts are likely to of **minor negative significance**.

Generation of Hazardous Wastes

Hazardous wastes likely to be produced will include hydrocarbons and oils, solvents, contaminated rags, steel and plastic drums, filters, paints and greases. Periodically it may also include pipe work, metals and plastics associated with plant maintenance or filter media and sludge arising from treatment works.

It is anticipated that potential impacts of hazardous waste streams generated from the maintenance works and plant processes of the Project are likely to be of **moderate negative** significance due to their potential to cause contamination if not managed or disposed of properly. Uncontrolled or unlicensed dumping of waste is also common in the region and steps should be taken to ensure this does not happen in order to prevent significant environmental damage.

Sludge generated from the sanitary waste treatment plant will need to be disposed of by an appropriately licensed contractor. It has been assumed that the storm drains will not be connected to the sewage system. Should there be any interconnectivity between these systems, sanitary sludge would need to be disposed of

as hazardous waste, since the potential exists for hazardous substances such as chemicals through accidental spills, to enter and contaminate this system. The issue of liquid wastes from wastewater treatment processes is considered **in Chapter 10 – Water Resources and Wastewater**.

The contamination impacts associated with hazardous wastes are described in full in **Chapter 9 – Soils, Geology and Contamination**.

8.7 Mitigation Measures, Residual and Cumulative Effects

The mitigation measures applicable to waste management are set out within this section and are summarised in **Chapter 17 – Framework Construction Environmental Management Plan** and **Chapter 18 – Framework Operational Environmental Management Plan**.

8.7.1 Construction Phase Mitigation Measures

Excavated Waste

It is expected that excavated materials could be re-used or spread within the project site area, which would not require mitigation. If however contamination is suspected or identified, this material must be disposed of to a suitably licensed facility.

Management of Construction Waste

The appointed construction contractor will be required to incorporate the requirements and recommendations set out below within a site specific CEMP to reduce waste impacts during the construction phase in accordance with the IFC EHS Guidelines relating to waste management and hazardous materials management.

The approved contractor will be required to minimise the impacts on the environment that may arise as a result of construction works. The construction contractor will also promote emphasis on the commitment to continual improvement and the identification of appropriate opportunities to reduce waste and where practicable, promote recycling and the potential re–use of materials.

Efforts will be to effectively design waste out as far as possible from the outset through:

- The initial project planning phase;
- The consideration of the types of materials used;
- The methods of transportation and how materials are handled, stored and disposed of on – site, particularly any excavated material from building foundations; and
- Retention of excavated materials on site (within the PP-13 boundary).

The aim of the proposed mitigation measures during the construction phase is to ensure adherence to the waste management hierarchy of the ‘3 Rs’ (Reduce – Reuse – Recycle) illustrated in **Figure 8-1** and to

present procedures for the correct segregation and disposal of waste material. Waste streams will be collected by locally registered waste contractors and transferred to appropriately licensed waste management facilities for recycling or disposal. A chain of custody relating to the waste should be implemented with the aim of ensuring the waste is handled and disposed of correctly by suitable qualified contractors.

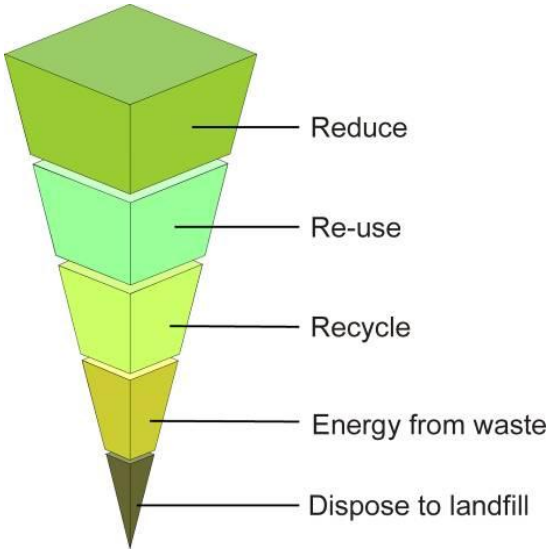


Figure 8-1: Waste hierarchy

Recommendations should be set out within the CEMP prepared by the construction contractor detailing requirements for the identification of the types and quantities of waste that can be minimised or effectively segregated for recycling/re-use and the materials that require disposal to landfill. All wastes that can be segregated, either for re-use on site or for off-site recycling will be diverted from landfill. As part of this process, clearly labelled waste skips will be provided for the separation of specific waste materials such as metal, wood, cardboard and polythene for recycling. Separate skips or containers will also be provided for residual waste streams generated during the construction phase which cannot be reused or recycled, including excavated soil material from building foundations. All skips will be located in a centralised storage area on an impermeable hardstanding surface and under cover and will be located in the on-site construction compound.

Any additional remedial activities required to protect end users of the proposed PP-13 or the wider environment (and deemed necessary under consultation with the relevant authorities) will be undertaken in accordance with a Remediation Strategy to be informed by future site investigation and agreed with the regulators prior to the commencement of works on site.

Any waste fuels, oils and chemicals will be stored separately in a bunded compound situated on an impermeable surface in order to prevent any potential spillage and contamination issues prior to collection for appropriate disposal and will be located in the on-site construction compound.

In accordance with IFC EHS Guidelines (Hazardous Materials Management), all materials deemed as hazardous will require a Hazardous Waste Assessment to be undertaken in order to determine the characteristics of the material and determine the best method for its handling and disposal.

In addition, in accordance with the IFC EHS Guidelines (Waste Management), waste minimisation will be encouraged among suppliers of raw materials. This is likely to involve suppliers committing to reducing surplus packaging associated with any construction raw materials; particularly common packaging materials such as plastics (shrink wrap and bubble wrap), cardboard and wooden pallets. This may also involve improved procurement and consultation with selected suppliers regarding commitments to waste minimisation, recycling and the emphasis on continual improvements in environmental performance. **Table 8-2** below, summarises the most important mitigation measures that will be implemented to minimise the potential waste of on-site materials during construction.

In addition, in order to ensure that such a system of reuse and recycling is effective the CEMP will set out a programme of on-site auditing at each stage of the construction process. This will assist in implementing appropriate on-site waste targets and programme of monitoring at the PP-13 site to focus upon:

- Quantifying raw material wastage;
- Quantifying the generation of each waste stream;
- Any improvements in current working practices, including scheduled timings for waste collection trips to avoid peak traffic hours;
- Methods by which the waste streams are being handled and stored; and
- Quantifying the material disposed of offsite to landfill facilities.

In addition to emphasising minimisation, it is important that best practice measures are adopted by the workforce and the sub-contractors working on the Project. This will be implemented by ensuring increased awareness among construction workers of waste minimisation and recycling initiatives, and developing more sustainable working practices. This will be achieved through 'Tool Box Talks' to ensure that all workforce and sub-contractors are adequately informed.

Setting provisional waste targets and undertaking future measurement and monitoring will assist in determining the success of waste management initiatives employed at Riyadh PP-13 during the construction process. This will ultimately lead to continual improvement as the construction process progresses.

In order to ensure that target setting and monitoring is undertaken and construction waste is managed effectively a Site Waste Management Plan (SWMP) will be developed. A SWMP is a tool used to ensure that developers and contractors plan and design new projects to ensure waste reduction and improve resource efficiency during the construction stage of a new development.

The Plan will focus largely on on-site construction operations and primarily will identify:

- The types of waste that will be generated;

- Identify responsibility;
- Resource management options;
- The use of appropriate and licensed waste management contractors; and
- A plan for monitoring and reporting on resource use and the quantity of waste generated.
- It will be the appointed construction contractors responsibility to ensure that the SWMP is filled out on a daily basis.

Storage of Construction Waste

In accordance with the IFC EHS Guidelines for Waste Management and Hazardous Materials Management, provision will be made for suitable storage facilities on-site which are clearly labelled and will include:

- Storage areas for raw materials which will be located under cover on an impermeable hardstanding surface and will be located in the on-site construction compound;
- Dedicated skips for segregated waste streams for re-use/recycling and will be located under cover on an impermeable hardstanding surface and will be located in the onsite construction compound; and,
- Dedicated skips for any residual construction waste that requires off-site disposal will be located under cover on an impermeable hardstanding surface. Key waste streams will include any excavated soil from building foundations and waste chemicals / oils will be located in the on-site construction compound.

Table 8-2: Measures to reduce the waste of on-site materials

Ordering	**Delivery**
Avoid: ■ Of over-ordering (order 'just in time'); ■ Ordering standard lengths rather than lengths required; ■ Ordering for delivery at the wrong time (update programme regularly).	Avoid: ■ Damage during unloading; ■ Delivery to inappropriate areas of the site; ■ Accepting incorrect deliveries, specifications, or quantities.
Storage	**Handling**
Avoid: ■ Damage to materials from incorrect storage; ■ Loss, theft, or vandalism through secure storage and on-site security.	Avoid: ■ Damage or spillage through incorrect or repetitive handling.

Good working practices will also be encouraged on-site within the CEMP, particularly in relation to the storage and disposal of waste materials. All on-site workers will be made aware of the location of storage areas and the requirements of such areas. Good working practices will also be encouraged as a means of minimising waste, including:

- The purchase of concrete/cement from local ready mix works, if appropriate, to allow materials to be generated when necessary, minimising the generation of waste material;
- Efficient planning of material deliveries to the site by local contractors and subcontractors to avoid damage to the materials and the unnecessary generation of waste;
- Effective co-ordination between local contractors and suppliers to avoid the excessive purchase of raw materials and to prevent the risk of materials being lost, stolen or damaged; and,
- Effective handling and storage of delivered materials to prevent loss or damage through exposure to the weather, mud and on-site vehicles.

It is anticipated that the incorporation of key waste management principles of waste minimisation and re-use/recycling requirements will be set out within the CEMP to ensure good waste practices are adopted during the construction process. This on-site educational process of good waste management practices will be achieved through:

- Adopting good site working practices; and
- Ensuring that suitable storage areas are provided for the containment of raw materials and segregated waste materials.

In addition to the provision of effective storage areas for construction materials, the areas will be secure and well maintained to prevent any loss of materials from vandalism or theft of material. Security will be supported by:

- Ensuring well-timed deliveries to the site;
- Providing on-site security; and,
- Installing temporary site security fencing.

Any fuels, oils and chemicals waste streams on-site during the construction process will be stored in appropriate containers, clearly labelled and stored within a secure secondary containment system/bunded compound prior to collection and appropriate disposal to the nearest hazardous landfill site within the Riyadh area.

Movement of Construction Waste

Good working practices are also encouraged on-site within the CEMP, particularly in relation to the movement of waste materials. Good working practices will also be encouraged as a means of minimising the amounts of waste transported, including:

- Efficient planning of material deliveries to the site by local contractors and subcontractors to avoid damage to the materials and the unnecessary generation of waste;
- Effective handling and storage of delivered materials to prevent loss or damage through exposure to the weather, mud and on-site vehicles;

- According to “Duty of Care” best practices all consignments of waste for disposal should be recorded, and the type, destination and name of the carrier should be specified; this is to ensure that materials final destination is documented; and
- The transport of wastes from the site should be scheduled to minimise journeys during peak traffic times. The minimisation of collection frequency is also important; however this will depend on storage space availability at the development construction site.

8.7.2 Construction Phase Residual Effects

Excavated Waste

The implementation of the excavated waste management measures will render the impact from excavation waste to be of **negligible** residual effect.

Management of Construction Waste

Waste management must be included within the EPC contractor’s EHS plan and CEMP. These should provide the necessary framework for the management of waste on-site during the construction process. This should include encouraging waste minimisation practices during the construction process, setting waste diversion targets and segregating waste streams for reuse/recycling. It will also help to ensure that waste is disposed of at suitable licensed facilities and reduce the amount of waste disposed of thereby reducing the associated traffic impact. It is anticipated that the implementation of best practice measures highlighted above and in accordance with the aforementioned IFC guidelines, will reduce the possibility of contamination occurring. Such an approach will result in the impact of construction waste reducing from being of **minor negative** significance to a **negligible** impact.

Following the implementation of appropriate controls such as testing for contaminants, and subsequent remediation if required, it is considered that the residual impacts associated with excavation and demolition waste will be **negligible**.

Assuming that hazardous waste streams are handled by a locally registered waste contractor and transferred to an appropriately licensed hazardous waste facility, and control measures are implemented to prevent accidental spillages and ensure appropriate storage, the residual impact of the generation of hazardous waste is considered to be of **negligible** significance.

Storage of Construction Waste

It is anticipated that implementation of the best practice measures highlighted above and in accordance with the aforementioned IFC guidelines, will reduce the possibility of contamination occurring. The potential for contamination to occur associated with the storage of construction waste is assessed in the chapter on soils, geology, and contamination. It is anticipated that such an approach will result in a reduced effect although construction waste remains of **minor negative** concern.

8.7.3 Construction Phase Cumulative Effects

The cumulative waste impacts associated with the project are not at this stage known. Clearly, the operational IPP-11 facilities will generate both hazardous and non-hazardous wastes, which combined with waste generated as a result of the construction of the PP-12 and PP-13 facilities would be considered to result in cumulative effects. The cumulative effects are however likely to be broader in scope – in this case the cumulative impacts upon existing waste management facilities is also dependent upon other waste producers operating in the region and therefore cannot be quantified. The implementation of best practice measures, as set out above, by the EPC Contractor will however reduce such cumulative impacts as far as practicable.

8.7.4 Operational Phase Mitigation Measures

It is anticipated that the operational phase will generate waste streams associated with the plant operation, maintenance works and administration functions. Once the plant is in operation, it is important that a comprehensive OEMP is developed by the appointed O&M Company and that waste management is considered a priority.

A formal and structured way of monitoring and recording waste and associated impacts shall be developed. A schedule of monitoring and periodic audits to inform the OEMP process shall be established. Procedures for waste management will be clearly defined. Plans will be drawn up for waste generated due to emergencies and accidents. Responsibilities of individuals relating to waste management shall be clearly assigned. The financial resources necessary to implement and operate a suitable waste management system shall be specified, as well as those people responsible for making those resources available. Capacity building and training needs shall be identified to ensure that waste can be properly managed and controlled. Staffing requirements and other supporting arrangements shall be identified to demonstrate capacity to manage waste generated at the site. A framework for the development of an OEMP is presented in **Chapter 18 – Framework Operational Environmental Management Plan**.

Waste Strategy

Current international best practice, including the IFC guidelines, advocates the need to operate sustainable waste management practices for major industrial developments. Such guidance sets out scenarios for dealing with waste in a preferential order from waste prevention and reduction through to re-use, recovery (energy and materials) and disposal via landfill. The waste hierarchy can be expressed as in **Figure 8-1**.

Therefore, in accordance with preferred scenarios of waste minimisation and re-use/recycling, operating good waste management practices at the Riyadh PP-13 site will involve some of the following key points:

- Ensuring compliance with national and international best practice guidance;
- Encouraging opportunities to minimise waste;
- Providing good on-site storage practices;

- Providing suitable waste receptacles for the segregation of waste streams for recycling and general waste for disposal to landfill; and
- Dedicated personnel responsible for waste management issues.

Management of General Waste – Industrial Facilities

Industrial wastes that do not leach toxic substances or other contaminants of concern to the environment may be disposed by suitably licensed contractors in landfills or at other disposal sites provided they do not impact nearby water bodies.

Management of Hazardous Waste

The hazardous waste generated from maintenance works and plant operations are likely to include waste oils, fuels, chemicals, empty containers and filters and replaced parts which may have associated hazardous properties. Hazardous waste streams should be handled by a locally registered waste contractor and transferred either to an appropriately licensed hazardous waste facility for disposal or an on-site waste incinerator should be established for the treatment of hazardous waste.

The GER Appendix 4 (2006) “Hazardous Waste Control Rules and Procedures” details the requirements for managing hazardous waste. A few of the key requirements are included below, which will need to be complied with during the operation of the PP-13 facility:

- Containerise and pack hazardous waste in a proper and environmentally sound manner placing warning labels on each package in accordance with the specifications and standards applicable in the Kingdom;
- Accurately fill up the product data on the appropriate section of the hazardous waste transportation document in accordance with the instructions provided in the document;
- Confirm with the PME, that the storage, treatment or disposal facility designated in the transportation document is capable of managing the waste that will be sent to it;
- Make the necessary arrangements with both the transporter who will carry the waste and the receiving facility designated in the transportation documents as the destination for the waste (such as providing the facility with full and detailed information on the waste and samples for analysis);
- Provide the transporter with the transportation document and copy of the safety data sheets for each type of hazardous waste being transported; and
- Comply with the hazardous waste transportation instructions provided in the transportation document.

The hazardous waste generator shall comply with the following for keeping of records and reports:

- Keep one copy of each transport document it has generated pending receipt of the signed copy from the facility designated in the document. It shall also keep the signed copy for at least 5 years as of the date of receipt of the waste by that facility;

- Retain copies of the results of all tests and analysis performed on the hazardous waste as well as copies of all pertinent reports, correspondence and documents for at least five years from the last date of handling of such waste;
- Submit to the PME an annual report on all hazardous waste generated during the year. Copies of such reports shall be retained for at least five years from the date of completion;
- Submit on demand to the PME or the agencies designated by it, all documents, records and reports related to the waste; and
- Hazardous Waste Transporters and Hazardous Waste Management Facilities are required to have both a valid identification code and a work permit from the PME.

Non-Hazardous Solid Waste Management

The administration buildings and offices on-site are likely to generate quantities of non-hazardous waste streams including waste paper, cardboard, plastic packaging that have the potential to be segregated for recycling. Therefore suitable waste receptacles will need to be provided at central locations on-site for the segregation of waste streams for recycling and residual general waste. The segregated waste will be transferred to the central storage area on-site for non-hazardous waste which will consist of dedicated containers for recyclable waste and general waste. The storage area for non-hazardous waste will be located on an impermeable hard-standing surface and located under cover.

Maintenance Works and Plant Process Waste

The waste generated from maintenance works and plant operations are likely to be minimal but may include waste oils, fuels, chemicals, and filters which may have associated hazardous properties. Therefore, a bunded compound for hazardous waste will be provided on-site for potentially hazardous waste materials including waste fuels, oils, chemicals and filters generated during the plant operations and maintenance works.

This compound will be located on an impermeable surface and under cover to prevent any discharge or spillages to the surrounding environment. The storage area will need to be clearly labelled and staff will receive appropriate training and be informed of the types of waste materials to be stored in this compound area through a site specific OEMP to be prepared by the appointed O&M Company.

Hazardous waste streams will be collected by a locally registered waste contractor and transferred to the hazardous waste landfill site for appropriate disposal. All paperwork and records of hazardous waste management activities on-site will need to be maintained as part of the OEMP including records of off-site disposal to landfill for monitoring purposes.

Management of Operational Liquid Waste

The following design specifications are considered sufficient to mitigate any potential impacts relating to the generation of liquid waste during the operational phase:

- All sanitary waste streams generated during the operation of the Project will be diverted to a waste treatment plant for waste stream solids separation, disinfection, biological and chemical treatment;
- It is proposed that the effluent generated by the sanitary waste treatment activities will be potable and suitable to supplement the grey water raw water source;
- All solids will be held in a holding sump and removed from the Project site by truck, by an appropriately licensed waste contractor. If the quantity of effluent produced exceeds the capacity of the holding tank, then the additional flows will be directed to the plant's wastewater drainage pond for evaporation;
- All oily water and wastes draining from the GT building, fuel unloading aprons, fuel unloading pump house, fuel forwarding pump house, gaseous fuel and any other areas where oils, fuels and greases may have the potential to be spilled or leaked will be collected in local collection sumps and then to be forwarded to the plant's oil-water separator;
- Separate systems shall be provided for collecting and treating the wastewater streams which require chemical neutralisation; and
- Wastewater from the waste neutralization system and chemically contaminated water and clean water from the oil/water separator shall be discharged to an evaporation pond after treatment.

8.7.5 Operational Phase Residual Effects

Through encouraging waste minimisation and recycling principles at the site and promoting the training of staff with regards to on-site waste management practices, this will increase staff awareness and limit the amount of material disposed of to the local landfill sites in Riyadh. Through the implementation of the above good practice waste management measures, it is anticipated that there will be an overall **negligible** residual effect.

8.7.6 Operational Phase Cumulative Effects

Cumulative impacts are likely considering the existing and proposed development of adjacent sites for power generation purposes. The existing IPP-11 and proposed PP-12 will cumulatively increase pressure upon the existing waste facilities within the local area.

Whilst waste generation estimates for the existing IPP-11 facility are available, no estimates are currently available for the Project itself or other proposed adjacent plants and it is therefore not possible to quantify this potential cumulative impact. However, it is considered that the implementation of best practice measures, as set out above, will reduce cumulative impacts as far as practicable.

8.8 Summary & Conclusions

Overall, with good environmental practices followed, and the management plans detailed above instigated, the project should not create any undue pressures on the existing waste management facilities in the surrounding region.

Although it is anticipated that the quantities of hazardous and non-hazardous waste streams generated by the Riyadh PP-13 plant will be **negligible**, it is essential that the approach to waste management at the site highlighted above is rigidly adopted.

9 Soils, Geology and Contamination

9.1 Introduction

This chapter considers the soil and geological conditions on site together with an appreciation of contamination issues. The aim is to identify any potential soil and groundwater impacts associated with the development of the PP-13 facility.

The assessment considers potential contamination issues associated with both the construction and operational phases of the development and provides appropriate pollution control best practice measures. These measures are summarised below and set out in full in **Chapter 17 – Framework Construction Environmental Management Plan** and **Chapter 18 – Framework Operational Environmental Management Plan.**

9.2 Relevant Standards and Legislation

9.2.1 National Legislation and Standards

The General Environmental Regulations (2001/2006[23]) specifies the following requirements in regards to protecting soil and groundwater from environmental harm:

- Article 13.2:

'To preserve the soil and land and limit is deterioration or contamination'.

- Article 13.2.1:

'To take all precautions required to prevent and control contamination and degradation of soil and land, remediate degraded and contaminated soil and use best available means and technologies for this purpose in accordance with the standards and criteria'.

In addition, the Environmental Protection Standards (2014) set out ambient water quality standards which are applicable to coastal waters, surface water and groundwater and are therefore applicable in the assessment of potential impacts upon the groundwater locally within the vicinity of the Project site. These ambient water quality standards are set out in **Figure 9-1** below.

[23] Presidency of Meteorology and the Environment (2001/2006): General Environmental Regulations and Rules for Implementation in the Kingdom of Saudi Arabia.

Table 9-1: Ambient water quality standards for groundwater

Parameter	Unit	Limit
Temperature	°C	N/A
pH	pH unit	ABD
Salinity	%	ABD
Total dissolved solids	mg/l	ABD
Total suspended solids	mg/l	ABD
Turbidity	NTU	ABD
Dissolved oxygen (DO)	mg/l	N/A
Chemical Indicators and Nutrients		
BOD	mg/l	N/A
COD	mg/l	N/A
Oil and grease	mg/l	0
TKN	mg/l	ABD
TOC	mg/l	ABD
Phosphorous (total)	mg/l	0.03
Phosphorous PO_4^-P	mg/l	ABD
Ammonia (free as NH_3)	mg/l	0.3
Chloride (as Cl)	mg/l	ABD
Calcium ($CaCO_3$)	mg/l	ABD
Inorganic nitrogen (as nitrite and nitrate)	mg/l	30
Sodium	mg/l	150
Sulphate	mg/l	250 (guide) ABD
Sulphide	mg/l	0.002
Total petroleum hydrocarbon	mg/l	0.2
Heavy Metals		
Aluminium	mg/l	0.2
Arsenic	mg/l	0.005
Barium	mg/l	1
Cadmium	mg/l	0.005
Chromium (total)	mg/l	0.1
Chromium (hexavalent)	mg/l	0.005
Cobalt	mg/l	0.05
Copper	mg/l	0.05**
Iron	mg/l	0.2
Lead	mg/l	0.005
Manganese	mg/l	0.1
Mercury	mg/l	0.001
Nickel	mg/l	0.02

Parameter	Unit	Limit
Silver	mg/l	0.1
Zinc	mg/l	0.02
Organics and Inorganics		
Aldrin	mg/l	2.2×10^{-6}
Benzene	mg/l	0.005
Carbon tetrachloride	mg/l	0.005
Chlordane	mg/l	0.002
Chlorine (residual)	mg/l	<0.0
Chlorinated hydrocarbons (Total)	mg/l	0.001
Chloroform	mg/l	N/A
Cyanide (free)	mg/l	0.001
DDT (and metabolites)	mg/l	1.7×10^{-5}
Dieldrin	mg/l	4×10^{-6}
TCDD – Dioxin	mg/l	3×10^{-8}
Endrin	mg/l	0.001
Fluoride	mg/l	0.2
Furans	mg/l	1×10^{-6}
Helptachlor	mg/l	0.0004
Hexachlorobenzene	mg/l	0.007
Lindane	mg/l	0.0002
Mirex	mg/l	1×10^{-6}
MtBE	mg/l	0.02
Pentachlorophenol	mg/l	0.0005
PAH	mg/l	0.0002
PCBs (total)	mg/l	1.9×10^{-6}
Phenols (total)	mg/l	0.005
Total pesticides	mg/l	0.005
Toxaphene*	mg/l	0.002
2,4,5 TP (Silvex)	mg/l	0.05
1,1,1 Trichloroethane*	mg/l	0.001
Toluene	mg/l	0.002
Vinyl chloride	mg/l	0.001
Xylenes	mg/l	0.005
Microbial		
Cyanobacteria	mg/l	5000
E Coli	Count/100ml	<10
Intestinal enterococci	Count/100ml	<5

** Specified as a monthly average.*

*** May be variable as a result of background concentrations.*

9.2.2 IFC Standards and International Best Practice

Sector-specific guidance documents on pollution prevention good practices produced by the IFC are relevant, which includes:

- IFC 'EHS Guidelines for Thermal Power Plants' (2008); and
- IFC 'Environmental Health and Safety (EHS) Guidelines: Contaminated Land' (2007).

This assessment also considers the likely impacts upon soils and geology as a result of Project activities in relation to the updated IFC Performance Standards; namely:

- Performance Standard 3: Resource Efficiency and Pollution Prevention.

For reference, the International Finance Corporation (IFC[24]) defines land as being contaminated when 'it contains hazardous materials or oil concentrations above background or naturally occurring levels'. Further, 'contaminated lands may involve surficial soils or subsurface soils that, through leaching and transport may affect groundwater, surface water, and adjacent sites'.

Additional sector-specific guidance documents on pollution prevention best practice guidance developed by the UK Government and others have been used to inform the assessment, where relevant. These include:

- Integrated Pollution Prevention and Control (IPPC) Technical Guidance Note S3 1.01 'Combustion Processes Supplementary Guidance Note';
- The Environment Agency (UK) Pollution Prevention Guideline 6 (PPG6) Working at Construction and Demolition Sites (2003);
- The Environment Agency (UK) Pollution Prevention Guideline 11 (PPG11) Preventing Pollution on Industrial Sites (2003);
- The Environment Agency (UK) Pollution Prevention Guideline 21 (PPG21) Pollution Incident Response Planning (2003); and
- Environmental Protection Agency (US) Office of Compliance (1997) 'Sector Notebook project - Profile of Fossil Fuel Electric Power Generation Industry'.

9.3 Methodology

The methodology used to conduct this assessment is described below:

9.3.1 Desktop Information Review

A review of available information was made in order to provide a background to the geological and hydrogeological (groundwater) conditions within the region and the study site.

[24] International Finance Corporation (April 30th 2007): Environmental, Health, and Safety (EHS) Guidelines – General EHS Guidelines (p.54).

The following sources of information were reviewed:

- WSP Environment and Energy (November 2009) Riyadh Independent Power Plant Environmental Scoping Report (GDF Suez Energy & Aljomaih Holding Co. Ltd);
- WSP Environment and Energy (June 2010) Riyadh Independent Power Plant Social and Environmental Assessment (SEA) Report (GDF Suez Energy & Aljomaih Holding Co. Ltd); and
- WSP Environment and Energy (March 2013) Riyadh PP-13 Combined Cycle Power Plant – Preliminary Environmental Assessment and EIA Terms of Reference Report (Saudi Electricity Company).

9.3.2 Site Visit

A Phase I (non-intrusive) Assessment was undertaken to provide an initial appreciation of existing ground conditions and contamination status of the site. The Phase I Assessment comprised visiting certain areas of the site and making a visual assessment to determine the presence of any existing potential soil or groundwater contamination on-site or in the surrounding area.

Current guidance in Western Europe and the USA advocates the use of a conceptual risk assessment model to establish the potential links between a hazardous source and a sensitive receptor via an exposure pathway, as illustrated by **Table 9-1** below.

The concept behind this approach is that, without each of the three fundamental elements (source, pathway, and receptor) there can be no potential contamination risk. Thus, the presence of a contamination hazard at a particular site does not necessarily imply the existence of associated risks.

This conceptual model may be illustrated as follows:

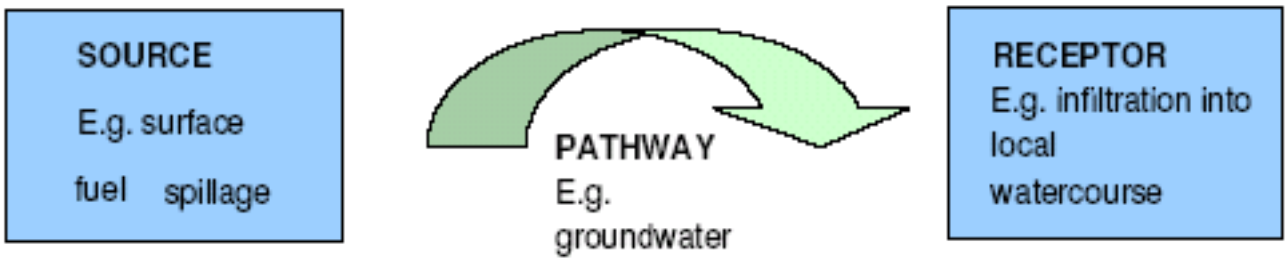


Figure 9-1: Contamination risk assessment

The IFC[25] is also instructive in providing a useful definition of 'exposure pathway(s)'; as 'A combination of the route of migration of the contaminant from its point of release (e.g. leaching into potable groundwater) and exposure routes (e.g. ingestion, transdermal absorption), which would allow receptor(s) to come into actual contact with contaminants.'

[25] IFC (2007): Environmental, Health, and Safety (EHS) Guidelines: General EHS Guidelines (p.54).

In view of the project, migration of pollutants could occur during periods of rain when the surface water could wash any contamination across the site or percolate throughout the soil affecting potentially the groundwater quality.

9.4 Existing Baseline Conditions

The site is situated on gravel/sand plain at an altitude of approximately 690 metres above sea level. It is understood that the wider site area comprises quaternary deposits with strata between 15-50 metres thick with alternating layers of sand, clay and sandy silt. These layers are followed at a deeper level by limestone, marl and sandstone[26]

The site itself is entirely flat and largely devoid of any landscape character or visual amenity, as depicted in **Figure 9-2** and **Figure 9-3** below. A ridge can be seen approximately 8km north and northeast of the site and dunes are present to the southwest.



Figure 9-2 General Project site relief



Figure 9-3 Further Project site representation

The site lies within the area known as the Arab Formation limestone which is underlain by the Jubaila formation; both are carbonate rock of marine origin and of upper Jurassic age. Arab formation is brown to tan in colour, composed of massive layers or thick layers, fractures limestone, with some marly and dolomitic intercalation.

The residual soil varies from silty sand to silty clay sand with limestone gravel of various sizes. The Arab Formation extends down to about 20 to 40 meters which is then underlined by a more compact Jubaila Formation limestone rock. This is generally composed of strong, horizontally bedded, light brown to creamy pale or grey dolomite limestone with dark grey inclusions.

[26] Riyadh Geotechnique & Foundations Co (January 2013) A Revised Report on Geotechnical Investigation at the Site of Combined Cycle Power Plant No. 12 (Contract No. 10721026).

9.4.1 Local Seismicity

The impingement of the Arabian and Eurasian continental plate is the primary cause of seismic activity in the overall region. The plate boundary is known as the Zegros Zone and is historically known to be seismically active.

According to the guidelines of the Ministry of Municipality and Rural Affairs of Saudi Arabia, the 'Seismic Zone Number' of the region is 0, which signifies a zone of the least seismic hazard.

9.4.2 Surface Water

There are no permanent surface water source present on the site and, due to the relatively flat topography of the subject site, no obvious drainage channels were identified during the site reconnaissance within the site area itself.

9.4.3 Groundwater

The results of any geotechnical and/or hydrogeological and hydrological surveys were not available at the time of writing. However, a previous assessment[27] of the Riyadh IPP-11 site notes that geotechnical investigations undertaken in 2009 revealed a sub-surface groundwater level of approximately 400 meters, in addition a groundwater well was identified to be operated during the site reconnaissance undertaken in December 2014, where the groundwater is reportedly diverted for dust suppression control system and for towards the excavation works for ongoing construction of PP12.

On a regional level, it is understood that an aquifer recharge area is situated in the wider vicinity (at +/- 40kms) of the site environs, as depicted (approximately) in **Figure 9-4** below.

[27] WSP Environment and Energy (June 2010): Riyadh Independent Power Plant Social and Environmental Assessment (SEA) Report (GDF Suez Energy & Aljomaih Holding Co. Ltd



Figure 9-4: Approximate location of aquifer recharge area

9.5 Sensitive Receptors and Potential Sources of Contamination

As stated earlier, the aquifer is reported to be 400m below ground level, and no permanent surface water has been identified.

Aside from the current IPP-11 facility and the associated construction activities of the PP-12 facility, no other anthropogenic activities were reported on the subject site and its vicinity.

A number of areas in the vicinity of the site (primarily to the north) are currently used for agricultural endeavours and camel ranching. During the construction phase, future site workers as well as other individuals who might work in the vicinity of the site may be adversely affected by the presence of any contaminants, if present.

In addition, the project area is understood to have been previously used as an equipment storage and staging area, together with offices. Whilst all above-ground facilities have been removed, it is thought that additional underground facilities may have been abandoned in-situ. The Construction Contractor would to be fully responsible for the safe removal of such abandoned infrastructure, if present. There may, therefore, be a low risk of existing ground contamination, either from existing leakage, or from contamination events associated with construction works and the operational phase of the project.

9.6 Assessment of Construction and Operational Impacts

9.6.1 Construction Phase Impacts

There is the potential for controlled and uncontrolled emissions associated with the construction of the Riyadh PP-13 facility, and operations to affect subsurface and surface water following rain events. Although the potential for contamination is not likely to be permanent, there is a measurable risk. The primary source for potential contamination is considered to be surface water runoff. This may result in a **moderate** negative impact prior to the implementation of appropriate mitigation measures.

It is not thought likely that the underground water and aquifer recharge area located approximately 40kms due east of the proposed facility will be affected, particularly in light of the deep groundwater levels. However, the results of any geotechnical and hydrological studies should be borne in mind and this judgement revisited in the future should it be required. We have therefore not provided an assessment for this element.

Aqueous effluents including sanitary wastewater from temporary construction facilities, washing down, dust damping activities and concrete work may lead to the contamination of soil and potentially surface water. This impact is likely to be temporary in nature and will only be applicable during the construction phase. Prior to mitigation, it is considered that the impact will be **minor to moderate negative** prior to the implementation of appropriate mitigation measures.

The remainder of the potential impacts are associated with the management of waste and hazardous materials. These impacts will generally be associated with poor storage or handling arrangements of these materials resulting in chronic or acute spillages of contaminants to land.

During construction, there is a potential for construction workers to come into contact with contaminated soils and hazardous materials, following an accidental release of pollutants onto the ground. It is therefore important that appropriate measures are taken to protect construction contractors during site clearance, excavation and general construction activities. It is considered that this may result in a **minor negative impact** prior to mitigation.

The improper storage and use of other hazardous materials during the construction phase such as solvents, cleaning fluids, fuels and oils may lead to spillages and leaks that may result in ground and/or surface water contamination. The above issues may result in a **moderate negative** impact prior to the implementation of appropriate mitigation measures.

9.6.2 Operation Phase Impacts

In terms of the regulatory requirements, PME's General Environmental Regulations (GER 2001/2006) state the following:

- Article 13.2: Preserve the soil and land and limit is deterioration or contamination; and,

- Article 13.2.1: To take all precautions required to prevent and control contamination and degradation of soil and land, remediate degraded and contaminated soil and use best available means and technologies for this purpose in accordance with the standards and criteria.

During the operation of the plant, the key contamination issues are associated with potential leaks and spills associated with the plant operations and storage of hazardous materials on-site. The materials with potential to cause contamination include: fuels and oils (such as associated with the maintenance and repair of equipment); lubricants (such as those associated with plant equipment maintenance and repair) and chemicals.

Prior to mitigation measures being implemented, the use and storage of materials on site with hazardous properties and the potential to cause contamination is likely to result in a **moderate negative** impact. However, adequate handling and storage arrangements complemented by appropriate procedural control measures would diminish such an impact substantially.

9.7 Mitigation Measures, Residual and Cumulative Effects

9.7.1 Construction Phase Mitigation Measures

Any identified contamination areas and hazardous waste (e.g. chemical/fuel drums), which may be encountered during excavation works or following an accidental release of contaminants onto the ground, will need to be appropriately removed and diverted to a licensed hazardous waste landfill site prior the development of the area.

There will be no discharge or overflow of sanitary waste on site. Modular wastewater storage tanks will be introduced to the site in order to provide adequate containment facilities for the construction workforce.

Hazardous materials such as fuel oils and chemicals used during the construction phase that have the potential to cause contamination will be managed through the CEMP (thought to be the responsibility of the Construction Contractor). This CEMP would provide detailed Environmental Control Plans for construction workers and personnel and sub-contractors including personnel safety, site conduct, security, storage of hazardous material and emergency preparedness.

The key control measures incorporated into the CEMP to promote on-site environmental good practice during the construction process in relation to the storage of fuels, chemicals and oils on-site must include:

- Substitution of any hazardous substances with safer alternatives;
- Changing work methods in order to prevent the production or release of potentially contaminative materials;
- Enclosing the process or handling system as far as reasonably practicable;
- Using a potentially hazardous material away from high risk areas;

- Limiting the quantities of hazardous substances during the construction process to reduce the risk of spillages;
- Ensuring that all substances are stored in suitable, undamaged, containers that are clearly marked with the type, nature and content of the material. This will ensure that all staff are aware of the material and its properties;
- Appropriate storm water management procedures to ensure that contaminants are not mobilised into the wider environment;
- Where practicable, retaining substances during the construction process in a central controlled storage compound in accordance with World Bank Group guidance, and appropriate risk assessment based on the material safety data sheet provided by manufacturer (the Control of Substances Hazardous to Health [COSHH Regulations 2002] which provides a similar framework in the UK);
- The storage area should: prevent damage to containers by any means; prevent the unauthorized use of material (e.g. responsible person to sign materials in and out of the compound); can contain any spillage from materials / substances (by the use of an impermeable surface and walls); and, separate any materials that may become a hazard if combined;
- Returning any unused materials, spent containers, contaminated clothing, rags and tools to the central compound for appropriate disposal;
- As part of the CEMP, emergency clean-up procedures will need to be in place in the event of any potential spillages; and,
- Staff and personnel will need to be briefed through toolbox talks and training on the control of substances and informing them of all control measures and location of spill response equipment on-site.

In addition the CEMP will also contain control measures to be adopted during the construction stage to minimise potential impacts associated with leaks and spills from on-site activities. Such measures will include the following:

- All plant should be regularly maintained and appropriate drip-trays should be located below mobile plant such as generators;
- Washout from concrete mixing plant or from cleaning ready-mix concrete lorries is contaminated with cement and therefore is highly alkaline. This should not be allowed to enter any watercourse/drainage channel and should be re-used on site where possible; and,
- All vehicle/plant re-fuelling should be closely supervised and appropriate spill trays utilised where appropriate.

The on-going evolution of the site CEMP will need to be agreed with the Client, the EPC contractor, and with PME in order to ensure that any potential environmental and health and safety issues are adequately managed. This will ensure good working procedures are followed and will decrease the potential risk of pollution incidents occurring. In addition, appropriate precautions will be implemented to prevent construction

workers from having contact with potentially contaminated soils. Construction workers will be required to wear appropriate personal protective clothing and be subject to adequate training / awareness.

9.7.2 Construction Phase Residual Effects

The adoption of good on-site working and storage practices and the implementation of suitable control measures and on-site training and emergency preparedness will ensure that the potential contamination is avoided.

The implementation of a detailed CEMP for the construction phase of the development is imperative in order to ensure that appropriate measures are implemented to minimise any potential risks from contamination to the workforce and the environment during the construction phase. Once these measures are followed, the assessment is of a **minor negative** residual effect.

9.7.3 Construction Phase Cumulative Impacts

The potential for cumulative effects to occur, as a result of the construction phase, is **negligible**. Type I cumulative effects – i.e. impacts associated with other construction related impacts - are not expected. Furthermore, Type II cumulative effects are not considered to be an issue in relation to soil and groundwater contamination as it is assumed that the IPP-11 plant and is operated in a manner which does not result in for example groundwater contamination; and similarly that good practice measures are implemented within the site of the PP-12 facility currently under construction.

9.7.4 Operational Phase Mitigation Measures

The key measures for preventing contamination during the operational phase will be designed into the project. This includes appropriate designs in relation to the following:

- Appropriate containment systems around storage tanks (e.g. fuels, oils etc.);
- Leak detection facilities;
- Fire prevention measures; and
- Appropriate storm water management systems.

An OEMP will also be developed which will contain the key operating procedures that are to be implemented for the project to prevent contamination of the ground and surface water. Such measures will include:

- Hazardous chemicals and materials to be appropriately stored on-site in secure, bunded compounds and located on an impervious surface. The storage areas will need to be clearly labelled with material safety data sheets (MSDS) maintained as part of the on-site record keeping.
- Details and properties for each material should be clearly detailed which include its nature (poisonous, corrosive, flammable), prohibitions on its disposal (dumpster, drain, sewer) and the recommended disposal method (recycle, sewer, burn, storage, landfill). A signed checklist should be developed for users

of hazardous materials detailing amount taken, amount used, amount returned and disposal of spent material.

Other measures in relation to personnel safety, housekeeping and security, on-site awareness training and emergency preparedness policies are also essential. Such measures will form part of the OEMP with the overall aim of avoiding incidences which may lead to potential contamination issues. Such measures will include, *inter alia*:

- To protect and promote health and safety issues to all staff and personnel on-site;
- To minimise exposure to potential hazards and safety issues and reduction in risk from injury and health risk;
- To minimise impacts on the environment from the plant activities taking into account the necessary balance between economic efficiency, energy requirements and environmental protection;
- Promote good practice measures in terms of health and safety to comply, as a minimum, with KSA law and policy requirements;
- Provide appropriate security measures to ensure that any potential issues that may result in contamination are avoided;
- Promote appropriate safety zoning to the hazards that may be present and to ensure that any spillages or incidents are avoided;
- Provide emergency response procedures to any potential incidents to ensure that contamination incidents are controlled if they occur;
- Provision of written standard operating procedures for all processes and appropriate document control;
- Provision of awareness training for all employees including management, office staff and technical staff on pollution prevention and control techniques and best practices;
- The establishment of daily checklists for plant and office areas to confirm cleanliness and adherence to proper storage and security. Specific employees should be assigned specific inspection responsibilities and given the authority to remedy any problems found;
- Continuous monitoring and reporting of the plants' performance should be undertaken in order to establish baseline conditions and whether conditions are improving or deteriorating; and,
- Regular reviews of emergency response procedures should be undertaken, including a contingency plan for spills, leaks, weather extremes etc.

9.7.5 Operational Phase Residual Effects

It is anticipated that the detailed OEMP for the site will dictate good on-site working practices the risk of pollution incidents will be minimised resulting in a **minor negative** residual effect.

9.7.6 Operational Phase Cumulative Effects

It is anticipated that the risk of cumulative impacts during the operational phase is low. Best practice measures implemented as part of the OEMP will reduce the risk of contamination events occurring at the PP-13 facility. It is also anticipated that similar best practice control measures are already in place at existing IPP-11 facilities

9.8 Summary & Conclusions

A Phase II investigation is not considered necessary for the proposed project at this stage as no localised contamination was identified during the site reconnaissance. However, it is highly recommended that any contaminated materials, including soils, are considered as hazardous waste and disposed of in a licensed landfill site prior to site preparation works by an appropriately licensed contractor. Notwithstanding the above, intrusive investigations will need to be enacted if additional significant pollutant sources or contaminations are identified prior to or during the site preparation works.

In addition, during the construction and operational phases of the project, there is a potential for workers and visitors to come into contact with contaminated land and hazardous or semi-hazardous wastes, as well as the potential for leaks and spills to adversely affect the wider environment. The CEMP and OEMP must be implemented to manage these risks and to reduce the likelihood of any future negative environmental and social impacts.

9.9 References

- NASA Johnson Space Centre, Office of Earth Sciences: http://eol.jsc.nasa.gov/handbooks/arabianpages/mainframe.htm
- Saudi Geological Survey: National Centre for Earthquakes and Volcanoes - Earthquake Seismology (www.sgs.org.sa/English/NaturalHazards/Pages/Earthquakes.aspx)
- Saudi Electricity Company: PP-13 Riyadh Combined Cycle Power Plant – Schedule B, Attachment III'.
- IFC (2008): Environmental, Health, and Safety Guidelines for Thermal Power Plants.
- IFC (2007): Environmental, Health and Safety (EHS) General Guidelines.
- Presidency of Meteorology and Environment (2001/2006): General Environmental Regulations and Rules for Implementation in the Kingdom of Saudi Arabia.
- Integrated Pollution Prevention and Control (IPPC) Technical Guidance Note S3 1.01 'Combustion Processes Supplementary Guidance Note';
- The Environment Agency (UK) Pollution Prevention Guideline 6 (PPG6) Working at Construction and Demolition Sites (2003);
- The Environment Agency (UK) Pollution Prevention Guideline 11 (PPG11) Preventing Pollution on Industrial Sites (2003);
- The Environment Agency (UK) Pollution Prevention Guideline 21 (PPG21) Pollution Incident Response Planning (2003); and
- Environmental Protection Agency (US) Office of Compliance (1997) 'Sector Notebook project - Profile of Fossil Fuel Electric Power Generation Industry'.

10 Water Resources and Wastewater

10.1 Introduction

This Chapter discusses the baseline information relating to water resources and wastewater at the Project Site and in the surrounding area. In particular, it considers the sources of water and the effective management of waste water streams during construction and operation.

Where significant impacts are identified, appropriate avoidance and mitigation measures are provided, which are summarised below and set out in full in **Chapter 17 – Framework Construction Environmental Management Plan** and **Chapter 18 – Framework Operational Environmental Management Plan**.

10.2 Relevant Standards and Legislation

In addition to the relevant guidance set out below, this assessment has been undertaken with respect to the sector specific guidance provided within the IFC Environmental Health and Safety Guidelines for Water and Sanitation (2007) and Thermal Power (2008).

10.2.1 Wastewater Standards

The IFC Guidelines for Thermal Power Plants (2008) provide environmental guidance for effluents from power plants, including thermal discharges, wastewater effluents and sanitary wastewater. Furthermore, relevant standards exist within KSA for discharges e.g. PME 2014 standards, which include discharge standards to marine waters and to municipal collection systems. Standards for the re-use of waste waters have also been developed by the Ministry of Agriculture and Water (1989).

The PME stipulate a series of standards for direct discharge, as specified within the Industrial and Municipal Wastewater Discharges Standards (2014). Of potential relevance are discharge standards to Municipal collecting systems, although it is understood that the majority of wastewater streams will be treated on site or removed by tanker for treatment and disposal at a wastewater treatment plant. In the event that any discharges to a municipal system are made, all wastewater effluents will be required to comply with the standards identified within **Chapter** 3 **– Environmental Legislation and Standards**.

10.2.2 Minimum Functional Specifications

Construction Phase Project Elements

It will be the responsibility of the EPC Contractor to provide all water to the Project Site during the construction period. This water would include potable water (for drinking, washing and other general uses) together with non-potable water (for construction processes, dust suppression etc.). At this stage it is assumed that such water will be tankered onto to the Project Site from IPP-11 or Riyadh Municipality Water Supply. Riyadh is

supplied with drinking water from both desalinated sea water and treated groundwater sources. The Saudi Arabian Standards Organisation has defined water quality standards for bottled and non-bottled drinking water (Saudi Standard No. 409). Non-potable water in Riyadh is typically sourced directly from a well.

No details are currently available in relation to wastewater handling, storage or treatment during the construction phase. It is assumed that all wastewater streams generated during the construction phase will be temporarily stored on site for removal by wastewater tankers by a PME licensed contractor to one of the Riyadh Wastewater treatment facilities. There will be no direct discharge of wastewater on site during the construction phase.

Operational Phase Project Elements

Water Supply System

Raw water for PP-13 will be sourced from a branch take-off from the grey water pipeline supplying the raw water to the adjacent IPP-11 and will be stored in an underground concrete tank specifically sized to provide a volume of seven days to cover the plant water usage.

Service water will comprise treated water which will be stored in a steel storage tank.

Potable Water

Potable water will be provided to the site by tankers, presumably also sourced from Riyadh Municipality Water Supply and will be stored in potable water storage tanks made of constructed of steel. The service and potable water systems will provide a backup supply to the firewater system in addition to providing a water source for shower stations and eyewash stations.

Demineraliser Tank

A common demineraliser tank will be constructed to serve the whole facility, including reverse osmosis and ion exchange, regeneration equipment and power supplies, chemical systems, water supply connections and wastewater discharge lines.

The demineraliser plant will provide sufficient capacity to provide blow down requirement, make-up, water wash, liquid fuel (ASL) treatment and others requirements considering 1.5% blow down plus a 20% design margin. The plant will be operational for 16 hours daily and water quality will be sufficient for use in the steam turbine, HRSG, ACC and steam circuit requirements.

Demineralised water will be stored in two carbon steel tanks.

Sanitary Waste Treatment

All sanitary waste streams generated during the operation of the Project will be diverted to a waste treatment plant for waste stream solids separation, disinfection, biological and chemical treatment.

It is proposed that the effluent generated by the sanitary waste treatment activities will be potable and suitable to supplement the grey water raw water source. All solids will be held in a holding sump and removed from the Project site by truck, by an appropriately licensed waste contractor. If the quantity of effluent produced exceeds the capacity of the holding tank, then the additional flows will be directed to the plant's wastewater drainage pond for evaporation.

Evaporation Pond

All water discharges generated on site from waste treatment systems will be diverted to an evaporation pond located within the Project site.

Oily Wastewater

All oily water and wastes draining from the GT building, fuel unloading aprons, fuel unloading pump house, fuel forwarding pump house, gaseous fuel and any other areas where oils, fuels and greases may have the potential to be spilled or leaked will be collected in local collection sumps and then to be forwarded by gravity or force main via 2 x 100% pumps to the plant's oil-water separator. The oil-water separator separated oil shall be batch pumped to an independent 1000 m^3 storage tank for temporary holding until it is removed from the Project site.

Separate systems shall be provided for collecting and treating the wastewater streams which require chemical neutralization.

Wastewater from the waste neutralization system and chemically contaminated water and clean water from the oil/water separator shall be discharged to the evaporation pond after treatment.

Waters and oils collected from transformer moats shall be individually equipped with manually operated discharge valves, before disposal through the plant main oil/water separator via 2 x 100% pumps.

Stormwater Drainage

Surface drainage will be enabled through the provision of sloping areas to provide drainage towards ditches located along the adjacent roads. Roof drainage on building structures will be grade sloped towards drainage ditches. All storm water will be diverted to a separate storm water collection facility.

10.3 Methodology

An overview of the existing conditions on site is presented below based on information provided by the Client and a site walkover undertaken in February 2013 and December 2014. The key sources of information are listed within the references section at the end of the chapter.

An assessment of potential impacts has been made for the construction and operation phases of the project using the project planning and project design information available. For details of the relevant waste water quality standards and guidelines please refer to **Section 3.3.4: Wastewater Quality Standards**.

10.4 Existing Baseline Conditions

10.4.1 Overview of Water and Wastewater in Saudi Arabia

Given Saudi Arabia's desert climate, rapidly growing population, large agricultural requirements, and recent substantial infrastructure and industrial development, the supply of water is a significant challenge.

Saudi Arabia is fourth in the world in average water use per citizen. It is estimated that 70% of the Kingdom's water requirements are provided for by desalination. Indeed, at present, Saudi Arabia is the largest producer of desalinated water in the world accounting for 30% of total world capacity. A 2,300-mile pipe distribution network supplies potable water to major urban and industrial centres, with approximately 70% of the desalinated water subsequently used for agricultural purposes, 25% for drinking water, and 5% for industrial use.

The remaining 30% of current water needs are supplied by groundwater abstraction. Given the low precipitation, the groundwater in many of the country's aquifers has taken centuries to accumulate and cannot recharge at the same rate as current rates of abstraction. In parts of the country reliant on groundwater it has been estimated that there may be less than twenty years remaining reserves of non-renewable resources at current rates of usage.

Less than one half (47%) of the current population of the Kingdom has a connection to a piped water supply. The shortfall is made up of supplies delivered in trucks and containers, which may be considerably more expensive than an equivalent amount delivered by pipe, or from private wells. There is a national tariff for water supply to the public, which has been in force since 1994. Before that all water was provided free of charge. The tariff applies everywhere in the Kingdom, regardless of the cost of production and delivery.

10.4.2 Existing Site Conditions

No surface freshwater features or any water or wastewater infrastructure were identified during the site reconnaissance undertaken by WSP in February 2013, however a groundwater well was identified to be operated in order to provide water for dust suppression systems and excavation works.

10.5 Sensitive Receptors

The key sensitive receptors relating to water resources and wastewater are listed and discussed below:

- Project staff
  - Construction and operational staff are the most sensitive receptors as they will require a continuous supply of safe drinking and washing water throughout the construction and operation period. There is also the possibility of staff coming in contact with non-potable water. Due to the potential for significant health and safety issues associated with water supply, staff are considered to be a highly sensitive receptors.

- Land and Groundwater
  - The land within and surrounding the project site is a potential receptor to the release (accidental or otherwise) of wastewater. Although there are no surface freshwater features or any water or wastewater infrastructure present on site, the groundwater level is not known and therefore must be considered as potentially sensitive. Potential impacts upon groundwater are considered in full in **Chapter 9 – Soils, Geology and Contamination.**
- Water Resources
  - The use of large quantities of water for power generation has the potential to compete with other important water uses such as agricultural irrigation or drinking water sources. As mentioned above, the supply of adequate water for various uses (irrigation, drinking, sanitation etc.) in Saudi Arabia is a significant challenge therefore water resources are considered to be of medium sensitivity to impacts.

10.6 Assessment of Construction and Operational Impacts

10.6.1 Construction Phase Impacts

Storm water run-off and Flooding of the Project Site

Construction activities such as any ground excavation and piling for building foundations will result in ground compaction and ultimately less water being allowed to infiltrate into the ground. Therefore, in the event of a storm, the volume and the rate of surface water run-off will be increased, which may pose a localised flood risk. As indicated previously, the months in which rainfall occurs in central Saudi Arabia are generally November to April and the average amount of rainfall per year is relatively low. However, it is understood that when rainfall occurs this can be very heavy and can result in rapid flushing of surfaces and high levels of surface runoff in a short time period.

Increasing the volume and rate of surface water run-off at certain times of the year, as a result of an increase in the impermeable areas across the Project site and altering ground levels within the site will affect local drainage patterns and may result in temporary 'ponding' of water in certain parts of the site during the construction phase at times of rainfall. The groundwork's should be carefully phased to ensure that surface (or flood) water conveyance is maintained.

Without mitigation it is anticipated that the construction works would exacerbate the risk of flooding at certain times of the year by increasing the amount of impermeable surface area on the site and due to other activities, such as ground compaction, storage of materials and building works. Therefore, temporary changes to the drainage regime as a result of construction, including the increase in the volume and rate of surface water run-off, are likely to result in a direct, temporary, **minor negative** impact on the drainage regime, prior to the implementation of mitigation measures. However, it must also be noted that periods of heavy rainfall are rare

and the Project Site is not located within a known flood risk area and therefore the overall risk of significant changes to the drainage regime is not significant.

Potential impacts associated with surface water run-off and contamination is dealt with comprehensively in **Chapter 9 – Soils, Geology and Contamination**.

Generation of Sanitary Wastewater from On-site facilities

During the construction phase temporary accommodation will be provided although the exact location of such accommodation and associated estimates of expected staff numbers are not currently known. It is understood that it is possible that temporary accommodation for PP-13 employees will be located in the adjacent site which is currently occupied by PP-12 construction workers.

The sanitary wastewater produced during construction will be stored within a septic tank on site and be regularly collected by sewage tankers for disposal at a Riyadh Municipality wastewater treatment plant. The impacts of sanitary wastewater would relate to the capacity of existing treatment facilities. Although significant amounts of sanitary wastewater are likely to be produced, it is considered highly unlikely that the treatment capacities at the existing treatment facilities in Riyadh would be exceeded. The effect is therefore predicted to be a direct, short term, **minor negative** impact prior to implementation of mitigation.

The potential exists for contamination of the soil and groundwater in the event of any accidental spillages or leaks associated with collection, storage and handling. These are considered in full in **Chapter 9 – Soils, Geology and Contamination**.

Potential for Contaminated Waters to be Released to the Environment

Wastewater produced by pre-commissioning works from chemical cleaning etc. may result in contamination of the soil and groundwater if appropriate collection, storage and disposal controls are not correctly implemented.

Wastewater produced by pre-commissioning works from chemical cleaning etc. will be collected in a drain pit prior to disposal by tankers by a PME licensed contractor. Alternatively, wastewater streams may be discharged to a temporary evaporation pond for neutralisation.

The generation of wastewater streams during the construction phase is a direct, temporary **minor negative** impact prior to the implementation of mitigation measures.

Potential impacts associated with releases of contaminated waters to the environment are dealt with comprehensively in **Chapter 9 – Soils, Geology and Contamination**.

Storm Water Run-Off and Contamination from the Construction Site

There is the potential for controlled and uncontrolled emissions associated with the construction of the PP-13 facility which could result in contamination of groundwater. The primary source for potential contamination is considered to be existing soil contamination, which if present could be mobilised through site construction activities and surface water runoff during the infrequent periods of rainfall. Following the Phase I Site

Walkover Survey, it has been determined that the likelihood of contamination on site is minimal and this is impact is therefore considered to be of **negligible** significance.

10.6.2 Operational Phase Impacts

Generation and Disposal of Oily and Chemical Wastewater

Oily and chemical wastewater and waste oil will be generated from industrial processes and are considered to be hazardous liquid wastes. Appropriate facilities are proposed e.g. oil-water separator to remove any oil which will then be stored in a temporary underground tank prior to removal from the Project site for disposal as a hazardous waste by a licensed contractor. Other process wastewater, including chemical wastewater will be discharged to an evaporation pond following on site treatment.

The potential exists for contamination of the soil and groundwater in the event of any accidental spillages or leaks associated with collection, storage and handling of chemical and oily wastewater streams. These are considered in full in **Chapter 8 – Waste and Hazardous Materials** and **Chapter 9 – Soils, Geology and Contamination**.

Generation of Treated Sanitary Wastewater Effluent

All sanitary wastewater streams from each element of the Project will be collected and directed to a sanitary waste treatment plant for waste stream solids separation, disinfection, and biological and chemical treatment. This will allow removal of biological organic matter and suspended solids. Following treatment, solids will be removed from the Project site by an appropriately licenced waste contractor and sanitary wastewater will be utilised to supplement the grey water sourced from the pipeline supplying the adjacent IPP-11 facility to provide additional raw water capacity for the Project.

The potential exists for contamination of the soil and groundwater in the event of any accidental spillages or leaks associated with collection, storage and collection. These are considered in full **in Chapter 9 – Soils, Geology and Contamination**.

Increased Pressure on Local Water Resources

The use of large quantities of water for power generation has the potential to compete with other important water uses such as agricultural irrigation or drinking water sources.

The source of raw water will be the grey water pipeline currently supplying raw water to IPP-11. The use of grey water for this purpose is, in itself, a major mitigating factor when assessing the impact of the project on Riyadh's already stressed water resources. In addition, as described above, sanitary wastewater streams will also be treated on site for reuse as raw water within the facility, thus supplementing the source obtained from the adjacent grey water pipeline feeding IPP-11.

It should however be noted that treated wastewater is an important resource, particularly for agricultural irrigation, and the increase in its use to meet the needs of the project may have a direct, permanent, **minor negative** impact on this resource in the local region, prior to mitigation.

It is understood that potable water will be delivered by tanker to the Project site. No further details are available regarding the source or quantities required for this water stream and therefore it is not possible to accurately assess the potential impacts related to potable water consumption. However, it is considered that usage of potable water in relation to the Project site will result in a negative impact upon local and national potable water supplies.

Storm Water Generation and Management

Alteration of ground levels and the introduction of additional areas of impermeable hard standing will have a permanent effect on local drainage patterns. In addition, the storm water generated and captured from the Project Site is likely to contain small quantities of contaminants, such as hydrocarbons and suspended solids.

Impacts associated with surface water run-off and contamination are fully assessed within **Chapter 9 – Soils, Geology and Contamination**.

As the terrestrial environment surrounding the site is not considered to be highly sensitive and there are no flood sensitive receptors in the immediate vicinity, the potential impact associated with storm water is considered to be of **minor negative** significance, particularly if run-off enters the marine environment.

10.7 Mitigation Measures, Residual and Cumulative Effects

10.7.1 Construction Phase Mitigation Measures

An overarching recommendation is that a facility-specific construction environmental management plan (CEMP) is developed by the EPC Contractor prior to any construction.

Provision of Potable and Other Water

The EPC contractor will be responsible for the provision of adequate supplies of potable and other water for use during the construction phase. It is important that appropriate sources of water are used and that water minimisation measures are implemented and fully conveyed to all construction staff.

Potable water should not be used for any other purpose than drinking water and, if required, for washing facilities. Signs should be clearly placed next to sinks and in bathrooms encouraging staff to minimise the amount of water used. If possible, push taps which automatically cut-off water should be used in preference to turning taps.

Storm Water Run-Off and Erosion from the Construction Site

To protect the environment from flooding during heavy downpours, a localised run-off management system will be employed by the EPC Contractor. This should comprise temporary surface water run-off facilities, which in addition to containing contaminants will provide on-site attenuation for surface water flows, thereby reducing the flood risk.

It is recommended that the EPC Contractor undertakes a detailed topographic survey and drainage pattern analysis to determine the existing conditions on site and estimate storm water collection at the Site and surrounding area. Information which could be considered in further assessments includes:

- Slope information;
- Drainage pattern interpreted from high resolution satellite imagery or field surveys;
- Historic information regarding rainfall patterns;
- Investigation of storm water runoff and direction;
- Demarcation of catchment area within watershed.

Mitigation measures with respect to surface water run-off and contamination are dealt with comprehensively in **Chapter 9 – Soils, Geology and Contamination**.

Generation of Sanitary Wastewater from On-Site Facilities

It is assumed that all sanitary wastewater produced during the construction phase will be gravity fed to an underground septic tank for storage prior to regular collections by sewage tankers for disposal by a licensed contractor. The waste contractor should supply the following documentary evidence (Chain of Custody records):

- Treatment facilities and methods; and
- Method/s of disposal.

Mitigation measures with respect to the potential for the contamination of the soil and groundwater in the event of any accidental spillages or leaks associated with collection, storage and collection are dealt with comprehensively in **Chapter 9 – Soils, Geology and Contamination**.

Potential for Contaminated Waters to be Released to the Environment

Adequate infrastructure should be installed on the construction site for the collection and storage of all contaminated wastewaters generated during the construction phase e.g. plant washdown water or chemical wastewater streams. The wastewater must then be collected by a suitably qualified and PME approved hazardous liquid waste contractor. Duty of care records should be maintained for all potentially contaminated wastewater throughout the construction phase. Alternatively, these wastewater streams may be discharged to a temporary evaporation pond for neutralisation.

Mitigation measures to prevent releases of contaminated waters to the environment are dealt with comprehensively in **Chapter 9 – Soils, Geology and Contamination**.

10.7.2 Construction Phase Residual Effects

Provision of Potable and Other Water

It is assumed that adequate amounts of potable and other sources of water will be supplied by the EPC contractor. However, it is important that measures to reduce the requirements for water, both potable and non-potable water should be implemented. This has the potential to reduce the impacts upon water resources to **negligible** levels.

Storm Water Run-Off and Erosion from the Construction Site

Following implementation of the proposed mitigation measures, the residual impacts associated with storm water run-off will be **negligible.**

Generation of Sanitary Wastewater from On-Site Facilities

Providing that all best practice measures are implemented in relation to sanitary waste collection and storage and that an appropriate Chain of Consent system is implemented for wastewater removed from the site by an appropriately licensed contractor in the correct manner, the residual impacts are predicted to be **negligible**.

Residual impacts associated with the potential for contamination of the soil and groundwater in the event of any accidental spillages or leaks associated with collection, storage and handling are considered in full in **Chapter 9 – Soils, Geology and Contamination**.

Potential for Contaminated Waters to be released to the Environment

The residual impacts associated with releases of contaminated waters to the environment are dealt with comprehensively in **Chapter 9 – Soils, Geology and Contamination**.

10.7.3 Construction Phase Cumulative Effects

The potential for cumulative effects to occur during the construction period is relatively limited. The supply of water, for potable and other construction purposes, is likely to be a small fraction of the total amounts required by SEC for this and other adjacent facilities and therefore the cumulative effect is considered to be **negligible**.

The potential for cumulative effects associated with storm water management is also limited as it is assumed that SEC have existing storm water management systems in place, together with measures to prevent, or limit, the contamination of storm waters.

10.7.4 Operational Phase Mitigation Measures

Generation and Disposal of Oily Wastewater

The key mitigation measure to implement is to ensure that waste oil is collected by an approved contractor for recycling at a waste oil refinery rather than disposal. If it is not practical to recycle the waste oil it must be stored on site and collected for disposal by a PME accredited hazardous waste contractor.

Generation and Disposal of Chemical Wastewater

Chemical wastewater will be discharged to an evaporation pond following on site treatment.

Generation of Treated Sanitary Wastewater Effluent

The sanitary wastewater from the Riyadh PP-13 facility will be treated on-site to meet the water quality standards of PME (**Table 3-6**, **Chapter 3**) and national wastewater reuse standards (**Table 3-7**, **Chapter 3**). The national wastewater reuse standards specifically address the use of treated sanitary wastewater for landscape irrigation, although it is not currently understood if this is the intention for sanitary wastewater streams within PP-13 since the treated effluent will be utilised to supplement service water provisions for the plant.

Since it is likely that any landscaping incorporated within the facility will be ornamental only and access should be restricted, it is justified that the criteria for secondary treated sewage should apply. Irrigation with secondary treated water should be via drip or sub-surface application to avoid any health risks associated with aerosols from sprinkler systems. If access to any of the irrigated areas is foreseen, the wastewater will be treated to meet the pollution levels for tertiary treatment.

The use of treated wastewater for irrigation represents a beneficial reuse of a waste product from the facility. However, it will be necessary to implement adequate quality control measures to ensure that no impacts upon the environment or health and safety are realised. The United States Environmental Protection Agency (USEPA) Guidelines for Water Reuse (2004) provide guidance on the safe reuse of wastewater for irrigation. It is recommended that these guidelines, or a suitable recognised alternative, are adhered to when implementing this element of the project.

Sewage sludge will also be generated from the sanitary wastewater treatment process. The impact of sanitary wastewater sludge can be mitigated by ensuring that a large quantity of the sludge is reused for beneficial purposes, such as fertilizer. The option of having the sludge collected by a fertilizer company should be considered in preference to sending the sludge to landfill.

Increased Pressure on Local Water Resources

The Project will implement a key mitigation measure specified by the IFC for water conservation, specifically:

- The on-site treatment and re-use of sanitary wastewater.

In addition to this it is also recommended that potable water reduction measures be implemented in the final design such as water efficient faucets, urinals, showerheads and toilets.

Storm Water Generation and Management

Run off and storm water will be collected via sloping areas towards drainage ditches; specifically along roadsides. In addition, roof drainage will be graded to slope towards drainage ditches. Concrete trenches will steel grating and concrete pipes may supplement onsite drainage of areas where necessary. Storm water will be diverted to a separate storm water collection facility.

Sludge or other solid wastes arising from storm water catchments or collection and treatment systems may contain elevated levels of pollutants and should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long term sustainability of water and land resources.

10.7.5 Operational Phase Residual Effects

Generation and Disposal of Oily Wastewaters

The residual impacts associated with the potential for releases of contaminated waters to the environment are dealt with comprehensively in **Chapter 9 – Soils, Geology and Contamination**.

Generation and Disposal of Chemical Wastewaters

The residual impacts associated with the potential for releases of contaminated waters to the environment are dealt with comprehensively in **Chapter 9 – Soils, Geology and Contamination**.

Generation of Treated Sanitary Wastewater Effluent

The residual impacts associated with the potential for releases of contaminated waters to the environment are dealt with comprehensively in **Chapter 9 – Soils, Geology and Contamination**.

Increased Pressure on Local Water Resources

With the implementation of proposed mitigation measures the residual impact associated with increased pressure on local water resources is estimated to be of **negligible** significance, particularly since raw water requirements will be met by the treated sanitary wastewater effluents generated on site.

Storm Water Generation and Management

With the implementation of the proposed mitigation measures the residual impact associated with storm water generation and management is estimated to be of **negligible** significance.

The residual impacts associated with surface water run-off and contaminations are fully assessed within **Chapter 9 – Soils, Geology and Contamination**.

10.7.6 Operational Phase Cumulative Effects

There is the potential for cumulative effects to occur during the operational period associated with the water demand required to supply both the existing IPP-11, under construction PP-12 and the PP-13 facility. Together, the cumulative effects could be significant. This significance cannot however be predicted and it is the responsibility of SEC to ensure the sustainability of water sourced for use within these facilities in the long term.

The potential for cumulative effects associated with storm water management is also limited as it is assumed that SEC have existing storm water management systems in place, which would be supplemented by appropriate controls at the PP-13 facility.

10.8 Summary and Conclusions

The construction impacts that have been identified are those that, with good on site and off site environmental management practices, can be relatively easily avoided or mitigated. Following their implementation the residual impacts are considered to be of **negligible negative** significance and therefore are considered acceptable.

The residual operational impacts related to the Project Site are considered to be of **neutral** to **negligible negative** significance with the implementation of the mitigation measures stated above and are therefore considered acceptable.

Recommendations and mitigation detailed within this assessment are designed to ensure compliance with IFC Environmental Health and Safety Guidelines for Water and Sanitation (2007).

Finally, and as determined within this section, a comprehensive construction environmental management plan (CEMP) and operational environmental management plan (OEMP) are required for the facility.

10.9 References

- IFC (2008) Environmental, Health, and Safety Guidelines for Thermal Power Plants.
- IFC (2007) Environmental, Health and Safety Guidelines for Water and Sanitation.
- IFC (2007) Environmental, Health and Safety (EHS) General Guidelines.
- United States Environmental Protection Agency (USEPA) (2004) *Guidelines for Water Reuse*. U.S. Agency for International Development.
- Ministry of Agriculture and Water (1989): Waste Water Re-use Standards.
- Presidency of Meteorology and Environment (2001/2006): General Environmental Regulations and Rules for Implementation in the Kingdom of Saudi Arabia.

11 Terrestrial Ecology

11.1 Introduction

This chapter assesses the status of the existing terrestrial ecology of the proposed site and, where relevant, presents the applicable approaches to mitigate or minimise any potential negative impacts associated with the PP-13 development.

Where significant impacts are identified appropriate avoidance and mitigation measures are provided, which are summarised below and set out in full in **Chapter 17 – Framework Construction Environmental Management Plan** and **Chapter 18 – Framework Operational Environmental Management Plan**.

11.2 Relevant Standards and Legislation

11.2.1 International Standards

The IFC's Performance Standard 6[28]: Biodiversity Conservation and Sustainable Management of Living Natural Resources (January 1st 2012) should be applied to projects:

- located in modified, natural, and critical habitats;
- that potentially impact on or are dependent on ecosystem services over which the client has direct management control or significant influence; or
- that includes the production of living natural resources (e.g. agriculture, animal husbandry, fisheries, and forestry).

Performance Standard 6[29] requires the following:

> *'The risks and impacts identification process…should consider direct and indirect project-related impacts on biodiversity and ecosystem services and identify any significant residual impacts. This process will consider relevant threats to biodiversity and ecosystem services, especially focusing on habitat loss, degradation and fragmentation, invasive alien species, overexploitation, hydrological changes, nutrient loading, and pollution'.*

As a matter of priority, the client should seek to avoid impacts on biodiversity and ecosystem services. When avoidance of impacts is not possible, '*measures to minimize impacts and restore biodiversity and ecosystem services should be implemented*'.

[28] International Finance Corporation (January 1st 2012): IFC Performance Standards on Environmental and Social Sustainability.

[29] Ibid.

11.2.2 National Standards

There are no specific requirements within the Kingdom that protect terrestrial ecology and biodiversity. However, since terrestrial flora and fauna form part of the definition of '*the Environment*[30]', they should be afforded adequate protection from unnecessary damage and deterioration.

11.3 Methodology

This assessment has been undertaken with due consideration of Performance Standard 6 (Biodiversity Conservation and Sustainable Management of Living Natural Resources) of the IFC Performance Standards on Social and Environmental Sustainability (January, 2012).

The terrestrial ecology assessment comprised a desktop review of existing, accessible information relating to the site and its surrounding environs, and was supported by a rapid terrestrial ecology survey.

11.3.1 Desktop Information Review

A review of available information was made in order to provide a background to the terrestrial ecology conditions within the region and the study site. The following sources of information were reviewed:

- Performance Standard 6 (Biodiversity Conservation and Sustainable Management of Living Natural Resources) of the IFC Performance Standards on Social and Environmental Sustainability;
- WSP Environment and Energy (November 2009) Riyadh Independent Power Plant Environmental Scoping Report (GDF Suez Energy & Aljomaih Holding Co. Ltd);
- WSP Environment and Energy (June 2010): Riyadh Independent Power Plant Social and Environmental Assessment (SEA) Report (GDF Suez Energy & Aljomaih Holding Co. Ltd); and,
- Relevant KSA terrestrial ecology related papers and websites.

11.3.2 Site Survey

A site visit and walk-over survey was undertaken in February 2013 and December 2014 to identify any habitats as well as flora and fauna species present.

The site was surveyed based on the rapid ecological survey method to determine the following:

- The main habitats at the Project site together with dominant species of flora; and
- The presence or potential presence of species of fauna.

[30] Presidency of Meteorology and the Environment (2001/2006): General Environmental Regulations and Rules for Implementation in the Kingdom of Saudi Arabia.

More detailed ecological surveys such as invertebrate surveys, mammal trapping and avifauna surveys were not undertaken given the disturbed conditions of the Project site, which is situated adjacent to the existing IPP-11 facility and PP-12 plant under construction.

11.4 Existing Baseline Conditions

11.4.1 Climate

Daily maximum temperatures average 47°C in July and August, reaching peaks of 51°C. The daily minimum average is 12°C in January and February, although frosts have been recorded. Daily extremes of temperature can be considerable.

Rainfall records in the central part of KSA, particularly in the Riyadh region, indicate that rainfall decreases from North to South and from West to East, averaging between 100 to 85 mm per annum. In general the mean annual rainfall averages less than 100 mm, most of it occurring in the period from December to March and serving substantially for the development of ephemeral vegetation[31].

11.4.2 Habitat

The Word Wide Fund for Nature[32] classifies the area in which the site is located as Arabian Desert and East Sahero- Arabian Xeric Shrublands. This is the largest ecoregion of the Arabian Peninsula, stretching from the Yemeni border to the Arabian Gulf and from Oman to Jordan and Iraq. Within this area lies a vast wilderness of sand, '*a desert within a desert so enormous and so desolate that it is regionally known as the Rub'al-Khali, or the Empty Quarter*' (Thesiger, 1959[33]). It is probably the biggest continuous body of sand anywhere in the world, with an area of over 500,000 km^2 (approximately, the size of France (Mandaville, 1986[34])).

The flora of KSA comprises some 2,243 species in 837 genera (Thomas, 2010[35]). The areas along the north-western and south-western regions are densely vegetated and contain the highest number of species. Approximately 70% of the country's floristic elements are reported to be from these areas (Thomas, 2010[36]). About 100 flora species have been listed as endangered or of vulnerable status.

The National Commission for Wildlife Conservation and Development assisted by its two prominent research centres, the King Khalid Wildlife Research Centre and the National Wildlife Research Centre run a chain of

[31] Juneidi, M. and D.L. Huss (1978): Rangeland Resources of the Gulf and Arabian Peninsula Countries and their Managerial Problems and Needs (Cairo, Egypt: FAO, RNEA).

[32] World Wildlife Fund (WWF): www.worldwildlife.org

[33] Thesiger, W (1959): Arabian Sands (Penguin Books, London, England).

[34] Mandaville, J.P. (1986): Plant Life in the Rub'al-Khali (the Empty Quarter), South-Central Arabia (Proceedings of the Royal Society of Edinburgh, 89B:147-157).

[35] Thomas, J. (2010): Flora of Saudi Arabia (Department of Botany and Microbiology, College of Science, King Saud University (www.plantdiversityofsaudiarabia.info).

[36] Ibid.

fifteen wildlife reserves comprising about 3% of the country land area where conservation of certain wildlife species is a major priority. Gazelle and oryx have been successfully re-introduced after motorized hunting parties had virtually exterminated them by the early 1970's. At the Uruq Bani Ma'arid protected area, white (or Arabian) oryx (*Oryx leucoryx*) again roam the sands, as do sand gazelle (*Gazella subgutturosa*) and mountain gazelle (*G. gazella*). Capra ibex nubiana survived the exterminations that befell the oryx and gazelle and are officially protected in 3 sites. Both Oryx leucoryx and Capra ibex nubiana are included on the IUCN Red List as endangered (IUCN 2001). Other mammals which occur in KSA include the Arabian wolf (*Canis lupus arabs*), Cape hare (*Lepus capensis*), striped hyaena (*Hyaena hyaena*), sand cat (*Felis margarita*), red fox (*Vulpes vulpes*) and caracal (*Caracal caracal*).

This is a desert ecoregion which holds relatively little biodiversity. The primary biomes in this region are deserts and xeric shrublands. Many species, such as the striped hyena, jackal and honey badger have become extinct in this area due to hunting, human encroachment and habitat destruction. Other species have been successfully re-introduced, such as the endangered white oryx and the sand gazelle, and are protected at a number of reserves. Overgrazing by livestock, off-road driving, and human destruction of habitat are the main threats to this desert ecoregion.

As a result of its geological history, the country shares its flora with Africa in the west, Asia in the northeast, east and southeast and with the Mediterranean region in the northwest and the north. In global geographical terms, the vegetation of KSA (in general) belongs to the Arabian sub-zone of the Saharo-Sindian phyto-geographical zone[37]. However, the south-western and most of the western coastal plains fall under the Somalia-Masai phyto-geographical region[38].

11.5 Sensitive Receptors

The visit to the proposed Riyadh PP-13 facility took place on Tuesday 26th of February 2013 and 22nd December 2014. The site itself is located on the western side of the Tuwaiq Escarpment, an 800 km long, narrow limestone plateau. Comprised entirely of a flat sand and gravel plain, the ecology observed on the site was very sparse and unremarkable. The site was found to be of a generally very flat relief as shown in **Figure 11-1:** and **Figure 11-2:** below. Access was not possible to the entirety of this site but judging from the views afforded, which are further illustrated in **Figure 11-3:** and **Figure 11-4**:; the site has been previously graded and is of negligible ecological value.

[37] Zohary, M. (1973): Geobotanical Foundation of the Middle East. (2 vols.) (Stuttgart, Germany: Gutav Fischer Verlag).

[38] Chaudhary, S.A. (ed.) (1999). Flora of the Kingdom of Saudi Arabia (vol. 1). Riyadh: Ministry of Agriculture and Water



Figure 11-1: Looking east towards IPP-11



Figure 11-2: Looking north-west from site



Figure 11-3: Looking north



Figure 11-4: Typical site relief

As can clearly be seen, the site is almost completely devoid of extant vegetation. In a similar vein, no tracks, droppings, or similar evidence was found of terrestrial fauna during the surveys. One species of bird, a tree sparrow, was identified in 2013 and none in 2014, but no other avian species were noted to be present during the site visits. However, it is thought likely that the existing irrigated landscaped areas in the direct environs of the site are likely to provide refuges for both flora and fauna and the extension of such areas should be encouraged (see below).

The nearest protected area (for nature conservation) is that of the Jabal Tuwayq Nature Reserve, as depicted in **Figure 11-5** below. Whilst noteworthy, the Jabal Tuwayq Nature Reserve is situated on the opposite side of the busy Highway 505 and approximately 19.5km from the proposed PP-13 site.



Figure 11-5: Location of Jabal Tuwayq nature reserve

11.6 Assessment of Construction and Operational Impacts

11.6.1 Construction Phase Impacts

Given the minimal importance of the site in terrestrial ecology terms, construction impacts are thought to be minimal. However, typical adverse impacts may arise from the following:

- site clearance and grading resulting in habitat loss;
- removal of the top layer of sand due to levelling and grading of the site may reduce the seed bank, reducing the potential for re-colonisation;
- wastes and hazardous materials generated from the construction phase have a potential to pollute the natural environment if not adequately managed;
- there is a potential for damage to the vegetation of adjacent areas and lay-down areas during the construction stage; and
- dewatering activities may reduce the groundwater level outside of the site boundary. This may affect the ability of local species to source water from this resource or it may increase the salinity of the groundwater itself.

The construction phase impacts are deemed to be of **negligible significance** without the implementation of mitigation measures.

11.6.2 Operational Phase Impacts

During the Operational phase, positive and negative impacts may include:

- There are possible positive impacts associated with any site landscaping as it may could promote significant growth of plants which will in turn provide a habitat for invertebrates and birds, potentially increasing the overall biodiversity of the site; and
- Exotic weed and pest control may be desired by the operator; however these activities may represent a threat to any indigenous favourable species that are growing naturally and which provide ecological value to the area.

The operational phase impacts (i.e. landscaping) are deemed to be of **minor, positive significance** without the implementation of mitigation measures.

11.7 Mitigation Measures, Residual and Cumulative Effects

11.7.1 Construction Phase Mitigation Measures

The principal mitigation measures during the construction phase are as follows:

- Where significant site levelling and re-grading is expected, the productive top surface layer should be removed separately and either spread back within the site once the re-grading has been completed, or spread on the adjacent environment. This will give seeds that exist in the top surface layer a chance to germinate.
- Wastes from construction must be adequately managed in terms of a waste management regime so that the waste does not end up in the terrestrial environment. An adequately enforced waste management plan will also serve to reduce the attraction of pest species such as rats and flies to the site.
- During construction, unnecessary movement of machinery around the site should be avoided where possible. Dedicated transport access ways should be designated to avoid damage to the existing natural vegetation. Construction activities should be limited to the proposed site and measures should be taken to avoid damage to adjacent areas.
- Vehicles carrying potentially toxic, friable materials such fly ash, should be covered at all times so that these materials are not accidentally deposited into the natural environment, causing harm to flora and fauna. Littering from construction vehicles must be prohibited.

11.7.2 Construction Phase Residual Effects

The residual effect of the construction works is considered to be of **negligible** significance.

11.7.3 Construction Phase Cumulative Effects

No cumulative effects are predicted.

11.7.4 Operational Phase Mitigation Measures

There is the potential to include areas of site landscaping as it could promote significant growth of plants which will in turn provide a habitat for invertebrates and birds, potentially increasing the overall biodiversity of the site.

11.7.5 Operational Phase Residual Effects

Following mitigation from operational impacts, the residual impacts are likely to remain as **negligible.**

11.7.6 Operational Phase Cumulative Effects

No cumulative effects are predicted.

11.8 Summary & Conclusions

The ecological assessment has identified that the Project site is of low ecological value, and includes disturbed habitats largely devoid of fauna and flora. These habitats are considered to be modified habitats in accordance with IFC guidance and therefore the impacts during both construction and operation are considered to be negligible.

There is however the opportunity for the provision of landscaped areas which would increase the ecological value of the site.

11.9 References

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12 Socio-Economic Issues

12.1 Introduction

This chapter of the ESIA considers the potential socio-economic impacts (both positive and negative) of the proposed Riyadh PP-13 development on its environs during both the construction and operational phases. Where appropriate, mitigation measures and residual effects have been included and assessed respectively.

The Interorganisational Committee on Guidelines and Principles for Social Assessment (1994; updated 2003)[39] provides a broad definition of a Social Impact Assessment as:

'*the systematic…appraisal of the impacts on the day to day quality of life for people and communities when the environment is affected by development*.'

This chapter highlights the methodology used to conduct this study and is followed by a brief examination of Saudi Arabia's macro socio-economic situation. From this, the baseline conditions of the proposed site and the surrounding area are presented followed by an assessment of the social and economic effects of the proposed Riyadh PP-13 development.

Where significant impacts are identified, appropriate avoidance and mitigation measures are provided, which are summarised below and set out in full in **Chapter 17 – Framework Construction Environmental Management Plan** and **Chapter 18 – Framework Operational Environmental Management Plan**.

12.2 Relevant Standards and Legislation

12.2.1 International Standards

The International Finance Corporation (IFC, part of the World Bank Group) 'performance standards' place a significant emphasis on ensuring that the likely social and economic impacts of a project are identified and minimised and that this is clearly demonstrated within the EIA documentation. The specific IFC Performance Standards appropriate to this assessment are:

- Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts;
- Performance Standard 2: Labour and Working Conditions;
- Performance Standard 4: Community Health, Safety and Security;
- Performance Standard 5: Land Acquisition and Involuntary Resettlement;

[39] US National Oceanic and Atmospheric Administration (1994; updated 2003): Guidelines and Principles for Social Impact Assessment (Impact Assessment (12) (Summer)) pp. 107-152).

- Performance Standard 7: Indigenous Peoples; and,
- Performance Standard 8: Cultural Heritage.

Performance Standard 1 requires that a project proponent should identify the range of stakeholders that may be interested in their actions and consider how external communications might facilitate a dialog with all stakeholders. Furthermore, Performance Standard 1 states that *"The client will develop and implement a Stakeholder Engagement Plan that is scaled to the Project risks and impacts and development stage, and be tailored to the characteristics and interests of the Affected Communities"*.

Performance Standard 2 (Labour and Working Conditions) in particular, determines the standard of care that must be taken with regards to workers during the construction and operational phase of the proposed facility. SEC and the appointed project company must ensure that the objectives are achieved and promote the fair treatment of workers and safe and healthy working conditions.

Performance Standard 4 places an emphasis on the avoidance or minimisation of impacts upon community health, safety, and security that may arise from a proposed project.

IFC's EHS Guidelines for Thermal Power Plant (2008) also address industry-specific impacts on the social and economic aspects of the site and surrounding context, specifically:

- Occupational Health and Safety; and,
- Community Health and Safety.

12.2.2 National Standards

The Labour Law (by Royal Decree No. M/51, 2005) defines the regulation of employment, labour relations, worker contracts and work place conditions in the Kingdom.

The law contains provisions intended to protect the interests of both employers and employees with the aim of establishing a stable, equitable and sustainable work environment. This law will therefore provide a minimum legal basis for the engagement of the PP-13 workforce, the working conditions and worker housing. The law also specifically addresses such issues as protection against occupational hazards; major industrial accidents and work injuries; and health and social services.

The law will apply to the construction and operational workforce as well as applying to both the project company staff and all contractors.

12.3 Methodology

An assessment of the development's social and economic impacts has been conducted using a range of research techniques. The objective of this section is to identify the baseline social and economic characteristics of both the site and the surrounding local area (approximately 50km radius of the site).

This baseline review focused upon the area's demographics, infrastructure (roads, transportation and communication levels) potable water and sanitation facilities, education and healthcare services, economic activity, social organisation, land ownership patterns, and land use patterns.

However, due to the inherent difficulties in assessing the significance of socio-economic issues, it is inevitable that there will be a degree of subjectivity in assessing the nature of the impacts described. Nevertheless, this chapter has described the principal impacts on the local social and economic climate in terms of whether the impact and residual effects are positive or negative; permanent (long-term) or temporary (short-term); and major, moderate, minor, or negligible.

12.3.1 Desk Study

A desktop study review has been undertaken for the proposed Project and the key information has been incorporated into the social and economic assessment and decision making process.

Information sources considered as part of the desk study include, *inter alia*:

- CIA – The World Factbook website: https://www.cia.gov/library/publications/the-world-factbook/;
- GDF Suez Energy & Aljomaih Holding Co. Ltd (2009): Riyadh IPP 11 - Environmental Scoping Report (WSP Environment & Energy);
- GDF Suez Energy & Aljomaih Holding Co. Ltd (2010): Riyadh IPP 11 – Social and Environmental Assessment Report (WSP Environment & Energy);
- World Bank's web-site: http://www.worldbank.org/;
- International Financial Corporation's website: http://www.ifc.org;
- UNESCO Institute for Statistics: http://www.uis.unesco.org; and;
- The International Labour Organisation (ILO) website: http://www.ilo.org.

12.4 Existing Baseline Conditions

12.4.1 Introduction

The Kingdom of Saudi Arabia as we know it today came into being in the early part of the 20th Century. Under the Basic Ruling Law, the King is the ultimate source of authority for the executive, judicial and organisational powers of the State. The King appoints the Council of Ministers, which he also leads as Prime Minister. Saudi Arabia's political and judicial apparatus is bound to Islamic principles, with the sharia (Islamic law) the basis for all legislation.

12.4.2 Population and Demography

Saudi Arabia is the largest country in the Arabian Peninsula covering an area of 2.15 million square kilometres. Its population was estimated to be 26.54 million in 2012, including 5.6 million non-nationals[40].

From 1981 to 2001, the population grew from 9.9 million to 21.4 million, a total increase of 54%, averaging out at a per annum increase of about 3.67%. The UN[41] has estimated that the rate of population growth in Saudi Arabia in the years 1975-1999 was at an even higher rate of 4.2%, making it one of the highest in the world.

There are several causes for this tremendous population growth. The first being the reduction in infant death rates over the past 20 years. From 65 deaths per 1000 live births in 1980, Saudi Arabia had dropped to 19 per 1000 by 1999, and 15.61 per 1000 in 2012. However, whilst this is one of the lowest in the Arab world, and less than half the regional average, KSA ranks 111 out 223 countries in the world[42]. Likewise, life expectancy in Saudi Arabia, which was 61 in 1980, had risen to 72 by 1999 and 74.35 in 2012[43].

The population is comprised of approximately 75% Saudi citizens and 25% non-Saudi residents. Of these, 4.7 million people live in the capital Riyadh. The age structure of the kingdoms population was estimated in 2014 to be (4):

- 0-14 years: 27.6% (male 3,869,961/female 3,681,616);
- 15-24 years: 19.3% (male 2,832,538/female 2,458,339);
- 25-54 years: 45.4% (male 7,086,004/female 5,323,373);
- 55-64 years: 3.2% (male 674,571/female 555,136); and
- 65 years and over: 3.1% (male 444,302/female 420,146).

Riyadh Region has a population of 6,777,146, 69% of whom are Saudi nationals (2010 census data).

12.4.3 Health Care

The increased life expectancy of both infants and the elderly has been largely due to the Saudi Government's investment in the health care system. In 2009[44], the Kingdom spent 5% of GDP on health expenditure and healthcare provisions within KSA have been widely cited by the World Health Organisation (WHO) as being an exemplar model for the development of healthcare infrastructure within third world countries.

[40] US Central Intelligence Agency (2013): www.cia.gov/library/publications/the-world-factbook/geos/sa.html

[41] United Nations Department of Economic and Social Affairs (June 2010): Resource Abundance – A Curse or a Blessing?'

[42] US Central Intelligence Agency (2013): www.cia.gov/library/publications/the-world-factbook/geos/sa.html

[43] Ibid

[44] Ibid

12.4.4 Education

Saudi Arabia's educational policy aims to ensure that education becomes more efficient, to meet the religious, economic and social needs of the country and to eradicate illiteracy.

General education in the Kingdom consists of kindergarten, six years of primary school and three years each of intermediate and high school. The Ministry of Education sets overall standards for the country's educational system and also oversees special education for the handicapped. Early in 2003 the General Presidency for Girls' Education was dissolved and its functions taken over by the Ministry, to administer the girls' schools and colleges, supervise kindergartens and nursery schools and sponsor literacy programs for females. The first government school for girls was built in 1964; by the end of the 1990s there were girls' schools in every part of the Kingdom. Of the nearly 5 million students enrolled in Saudi schools for the academic years 2003-04, it is thought about half of these were female.

In addition to the dramatic quantitative growth of the educational system since the introduction of the First Development Plan in 1970, there has also been an improvement in the quality of education. One measure of this emphasis is that while the number of students in the educational system increased six-fold between the 1970s and the 1990s, the number of full-time teachers grew more than nine-fold. The Kingdom's ratio of 15 students to every teacher is one of the lowest in the world. The government, however, continues to work to improve educational standards. This has been achieved by raising the quality of teacher training programs, improving standards for evaluation of students and increasing the use of educational technology. One aspect of this is the introduction of computer science at the secondary level. In 2000, an ambitious school computer project was named after Deputy Prime Minister and Commander of the National Guard Crown Prince Abdullah. In addition, the administration of the educational system has also been enhanced by delegating greater authority to the Regional Boards.

12.4.5 Employment and Labour Market

In 2012, it was estimated that Saudi Arabia had a total work force of 8 million[45], albeit, approximately 80% of the workforce was comprised of non-nationals[46]. Despite having a high unemployment rate, especially amongst the younger generations (estimates for the Kingdom range between 14% and 25%), employment in the Kingdom can be divided into the following sectors:

- Government 40%;
- Industry, construction and oil 25%;
- Services 30%; and,
- Agriculture 5%.

[45] US Central Intelligence Agency (2013): www.cia.gov/library/publications/the-world-factbook/geos/sa.html

[46] Ibid

Saudi Arabia has enacted a policy known colloquially as 'Saudiisation' the goal of which is to increase employment of Saudi citizens by replacing 60% of the estimated 5.6 million foreign workers in the country. To do this, the Saudi government has stopped issuing work visas for certain jobs and has moved to increase the training of Saudi nationals and has minimum requirements for the hiring of Saudi nationals by private companies.

The labour market of Saudi Arabia is subject to significant challenges, with considerable unemployment and skills shortage in key sectors. Official records estimate unemployment of Saudi males as 10.7%[47] (2012, est.) however, numerous sources recognise this as a significant underestimate, with some placing unemployment as high as 25%. This is particularly acute in the large youth population, which generally lacks the education and technical skills the private sector needs.

12.4.6 Economic Overview

Saudi Arabia has an oil based economy with strong government controls over major economic activities. The petroleum sector accounts for roughly 75% of budget revenues, 45% of Gross Domestic Product (GDP), and 90% of export earnings. About 40 % of GDP comes from the private sector. Saudi Arabia has the largest reserves of petroleum in the world (26% of proven reserves). Saudi Arabia's GDP was estimated in 2012 to be $657 billion, with a real GDP growth of 6% on the previous year[48].

In spite of the recent surge in its oil income, Saudi Arabia continues to face long term economic challenges including high rates of unemployment, as highlighted above. It has a rapidly growing population, around 1.523% (2012, est.) a year[49], which verifies the government's consequent need for increased public spending. Saudi Arabia's young population has increased, while oil export revenues have sharply decreased. Saudi Arabia has also moved towards subsidy cuts, tax increases and financial sector reforms.

While the government is expanding the country's oil and gas industry, it is also diversifying the economy into non-oil sectors, including manufacturing and services. Although the state retains a dominant role in the economy, the government is seeking to encourage the development of the private sector, particularly in areas such as utilities and services.

Since 1970, economic development in Saudi Arabia has been organised through five-year development plans, which establishes infrastructure development targets and an overall framework for public spending. The primary objective of this plan is to increase the Saudi employment through economic growth, new investments education, and the development of national capabilities and skills.

[47] US Central Intelligence Agency (2013): www.cia.gov/library/publications/the-world-factbook/geos/sa.html

[48] Ibid

[49] Ibid

12.4.7 Social Development

In the context of the Arab world, the welfare of Saudi Arabia's citizens ranks reasonably highly. The 2011 United Nations Human Development Index (HDI) gives Saudi Arabia a score of 0.777, placing it within the High Human Development category and above the average level for the Arab States data grouping. Graphical analysis of the change in HDI in the Kingdom over the past 30 years also indicates that the growth of the HDI in Saudi Arabia has outstripped the average rate for the Arab world.

12.4.8 The Proposed PP-13 Development

The proposed Riyadh PP-13 plant will not only increase the volume of available power in the region but will also create a large number of employment opportunities in the town of Dhurma (estimated population 15,000), the neighbouring town of Muzahmiyya (estimated population 24,000) and other smaller settlements within the Al-Batin valley area. This is particularly pertinent within Dhurma since it is recognised that there has been a significant migration of the local community to Riyadh where there are more job opportunities. The proposed facility would therefore represent a positive employment option which may draw prospective residents back to the region.

The project is buffered from causing major direct impacts on surrounding receptors due to the site being relatively isolated. The proposed site is located 114km to the west of Riyadh city in a wide valley known as Al Batin. The Project site is 20km away from the Saudi Aramco Gas Pumping Station No. 5 and the main road (No. 505), which is a two lane highway approximately 8m in width. This road connects Dhurma with Marat. The closest large town is Dhurma which is approximately 58km to the southeast. Dhruma has a population of approximately 15,000 residents, whilst the larger town of Muzahmiyya, located approximately 75km southeast from the Project site supports a population of 24,000 inhabitants.

The closest formal land uses appears to be an active farm comprising of a number of fields and silos approximately 13km away and a mining operation approximately 16km away.

12.5 Sensitive Receptors

A number of key sensitive receptors have been identified (in terms of the socio-economic assessment) as described earlier in this report. These are considered to be the most sensitive receptors within the potential zone of influence of the Project. Specifically, **Table 12-1** below described the following sensitive receptors in terms of socio-economic impacts.

Table 12-1: Key socio economic sensitive receptors

Receptor	Potential Construction Impacts	Potential Operational Impacts
PP-13 Construction workers	■ Health and safety; ■ Working conditions and welfare; ■ Exposure to air emissions from IPP-11 & PP-12.	-
Operational staff at IPP-11, PP-12 and PP-13	■ Exposure to dust and construction related emissions to air during PP-13 construction works (operational staff from IPP-11 and PP-12 only); ■ Exposure to noise emissions during PP-13 construction works (operational staff from IPP-11 and PP-12 only).	■ Health and safety; ■ Working conditions; ■ Exposure to air emissions from IPP-11, PP-12 and PP-13; ■ Exposure to noise emissions from IPP-11, PP-12 and PP-13.
Population	■ Positive socio-economic impacts through employment opportunities for Saudi nationals and skills transfer.	■ Positive socio-economic impacts through employment opportunities for Saudi nationals, skills transfer and the supply of power.

The presence of sensitive receptors in close proximity to the PP-13 site is very limited. The closest large town is Dhurma which is located approximately 50 km to the southeast.

There are no existing developments nearby and whilst agricultural activities are on-going within the area, none are situated within close proximity.

The only sensitive human receptors are, therefore, those associated with the influx of workers during both the construction and operational phases of the development.

12.6 Assessment of Construction and Operational Impacts

12.6.1 Construction Phase Impacts

Construction Worker Welfare

The main issues to be considered are associated with the labour force during the construction phase, which includes the following:

- Health and safety at work;
- Access to medical facilities where required;
- Reasonable working hours, wages and other benefits;

- Provision of suitable and safe accommodation and sanitation; and
- Access to welfare and recreation facilities.

With respect to health and safety at work, construction sites are considered to be a relatively dangerous working environment and without proper health and safety controls there is a considerable risk of serious injury or fatalities. Access to medical facilities is also crucial with respect to accidents and illness either in the workplace or outside. In the absence of mitigation measures, the potential impacts are therefore considered to be of **major negative** significance.

Other working conditions such as reasonable working hours, wages and other benefits are considered to be good working practices and should be employed at all times. In the absence of mitigation measures, this has the potential to be an impact of **moderate negative** significance.

In addition, a large number of labourers may be housed temporarily on or near the site. It must be ensured that the labour and working conditions are of an acceptable standard. Housing must be adequately designed with adequate sanitary and safety facilities such as fire suppressants. Issues such as retrenchment policies must be clearly defined prior to work beginning.

Noise and Dust Nuisance

The close proximity of the construction activities to these receptors could result in impacts such as increased noise and dust levels.

The noise assessment within **Chapter 7 – Noise and Vibration** has determined that the noise impacts associated with construction activities are predicted to be negligible since noise levels are well below the L_{Aeq} 80 dB(A) criterion applicable to day, evening and night periods and therefore construction noise is predicted to comply with the nominated noise limits.

The assessment undertaken within **Chapter 6 – Air Quality** has determined that impacts upon existing workers within the adjacent areas will be temporary and **negligible** as a result of dust and other air quality effects during the construction phase.

Impact on Local Business

The influx of professional workers into the area, whilst expected to the relatively low, will generate economic opportunities and rewards for the local population of nearby Dhurma, enhancing social and economic development. This is deemed to be a **minor positive** impact.

Additional impacts may be associated with local employment created during the construction phase. Taken in consideration, the high level of unemployment in the Kingdom, any additional creations for jobs and for Saudi nationals is likely to prove beneficial for the local economy.

The construction of the proposed facility will create direct and indirect opportunities for various support service providers including guards, cleaners, catering and other site management, prior to mitigation to be a **minor positive** impact on a short term basis.

Social Issues

As above, the proposed facility will introduce a certain number of professional workers (including expatriates) to the local area. However, in addition to the potential benefits that this may represent, this influx may also result in social and cultural tensions, albeit this is deemed unlikely and thus thought to be a **minor negative** impact on a short term basis.

12.6.2 Operational Phase Impacts

Operational Worker Welfare

One of the key issues is ensuring that operational staff and contractors are protected from workplace incidents and illness through appropriate health and safety systems both during normal operation and other tasks such as maintenance and repair. Appropriate safety systems such as fire protection and emergency procedures will also be required. The potential health and safety impacts are considered to be of **moderate negative** significance in the absence of suitable control measures.

Noise Nuisance upon Sensitive Receptors

The results of the noise modelling assessment indicate that no exceedances of IFC or PME noise standards are expected and therefore impacts during operation are expected to be **negligible.**

The proposed facility has the potential, prior to mitigation, to be deemed unwelcome to nearby local farming and ranching operations in the local areas due to increased noise, emissions, traffic and increased level of activity in the area. However, owing to the dearth of development, dwellings or other activities within the vicinity of the proposed site, this can be assessed to be a **minor negative impact**.

Air Quality Impacts on Human Health

A full assessment of air quality impacts associated with the operation of the Project has been undertaken within **Chapter 6 – Air Quality**.

Modelling of the Riyadh PP-13 Power Plant emissions in conjunction with the two power plants (IPP-11 and PP-12) showed that under normal operating conditions, no exceedances of the respective PME AQSs or IFC Guidelines were predicted for the pollutants considered and all concentrations were well below the standards.

Additionally, the assessment has also identified that in the highly unlikely event that all three power plants were required to operate under emergency or abnormal conditions, the area where exceedances were predicted would still be considered a dispersion zone in accordance with the provisions of the PME National Environmental Standard and further mitigation measures would therefore not be required to address these operational conditions.

Impacts on Local Businesses and Social Issues

As intimated above, the influx of professional workers, labourers, and other staff members into the area will generate economic opportunities and rewards for the local population of Dhurma, enhancing social and economic development. This is deemed to be a **minor positive impact** on a long-term basis.

Indirect opportunities for various support service providers including guards, cleaners, catering and other site management will provide employment and a further source of income for these services giving a **minor to moderate positive** impact.

The employment of local workers on such a project of national importance with the requisite training which will be included within their contracts will improve their capabilities and skill. This will also result in improving their employability should they move on from the project. This is deemed to be a **negligible to minor positive** impact.

The additional employees required for the operation of the proposed facility will put additional pressure on local services which is deemed to be a **negligible negative** impact.

Similar to the construction phase, a potentially positive economic impact will result from any local employment created by the operational phase of the project. Whilst the likely nature of these impacts, and the effect of expatriate workers, is largely unchanged from the construction phase, they are likely to be amplified by the greater time-scales involved in the operation of the site.

In addition, the Project will result in the increased reliability of, and increased capacity for electricity provision for residents and businesses within Dhurma and surrounding areas.

The relatively small workforce required during the operational phase means that potential impacts are likely to be less significant. However, all relevant labour and working condition laws and guidelines must still be adhered to during this phase.

12.7 Mitigation Measures and Residual Effects

12.7.1 Construction Phase Mitigation Measures

Construction Worker Welfare

Construction activities undertaken for the proposed PP-13 facility will be managed in such a way as to minimise construction impacts through the Construction Environmental Management Plan (CEMP; to be developed by the EPC) throughout the construction phase. The CEMP will also identify methods by which these concerns may be addressed. Such measures are to include:

- The development of a Health and Safety and Environmental Policy would provide detailed health and safety guidelines for staff, personnel and sub-contractors, including personal safety, site conduct, security, site safety zoning and emergency procedures.

- In common with Performance Standard 2, on site medical facilities must be made available throughout the construction phase for the use of workers. Trained health and safety and first aid personnel must be identified to workers as part of their training schedule.
- Suitably qualified personnel must be chosen for potentially hazardous activities such as for the installation and testing of specialist electrical equipment.
- Appropriate action must be taken for outbreaks of illnesses amongst workers, minimising the transmission as far as is possible.
- The EPC contractor must establish a Human Resources Policy which will be communicated to employees with information including, but not limited to, their rights under national labour and employment laws, salary, and other associated information, such as medical care and insurance. The Human Resources Policy will ensure an approach of non-discrimination is followed with equal opportunities for all. No child labour or forced labour will be used for the proposed facility.
- In common with Performance Standard 1 (Section 23), the establishment of a 'grievance mechanism' for workers and local residents, will involve the identification of a local environmental co-ordinator, identified by the EPC within the management structure, to identify and log all concerns. This contact information will be provided to the public via appropriate transparent measures and a placard left on the perimeter of the site with further details of contact arrangements. The resultant procedure to address these concerns will be made clear to the complainant and a set process followed, as identified within the CEMP, and within a suitably prompt period.
- Throughout the construction and operation of the proposed facility, a long term training programme should be implemented to ensure adequate training and qualification of all staff employed within the PP and its associated facilities. The aim of this programme would be to ensure that personnel acquire and maintain the combination of knowledge and demonstrated skills as required to safely and adequately fulfil their responsibilities. The objective of the long term training plan will be to ensure that the facility is operated safely and efficiently, while also guaranteeing the long term economic success of the project; and,
- In common with Performance Standard 4, all components of, and infrastructure associated with, the project will be constructed in accordance with industry best practice and by qualified engineers. The site will be fenced to avoid any danger to the public.

Noise and Dust Nuisance

Chapter 7 – Noise and Vibration sets out a series of controls to reduce the noise impacts during construction which will reduce the impacts of noise during construction.

Chapter 6 – Air Quality sets out a series of measures which will be implemented during the construction phase to ensure that the generation of dust is minimised as far as possible.

12.7.2 Construction Phase Residual Impacts

With the implementation of the CEMP it is considered that health and safety risks for construction site workers, particularly the risks of serious injury, illness or fatalities are significantly reduced and therefore the residual significance is predicted to be **minor negative** significance.

With the implementation of the mitigation measures set out above it is predicted that the residual impacts upon construction staff in relation to their working conditions and welfare will be **negligible** significance.

In terms of the nuisance to the IPP-11 Operational Staff, it is predicted that the residual effects associated with noise will be of **negligible** significance and the residual effects associated with air quality and, more specifically, dust impacts will be of **negligible** significance.

Nuisance to nearby residents of the camps due to increased dust, noise, emissions, traffic and increased levels of activity will be kept to a minimum with the use of construction corridors and low-noise producing equipment, where possible. These mitigation measures will be identified and implemented through a CEMP. These mitigation measures will be identified and implemented through a CEMP. Following the implementation of such techniques, the impact is deemed to be a **negligible** impact on a short-term basis, although concerns from residents will be iterative. As such, the CEMP must be viewed as an 'organic' document which will require constant updating in view of new concerns coming to light, and allowing the addressing of such concerns.

The residual effects of the construction of the Plant on the local businesses will be a **minor positive** effect.

The residual effects related to potential social issues relating to the presence of a construction workforce will be **negligible**.

The residual impacts of indirect employment opportunities and influx of professional workers during the construction are both of **minor positive** significance.

12.7.3 Construction Phase Cumulative Effects

Cumulative Type 1 socio-economic impacts may occur in terms of nuisance from increased noise, vibration, air pollution issues and congestion from construction traffic, e.g. for nearby mobile camel farming activities and residents of Dhurma. Prior to the implementation of mitigation measures (see **Section 12.7.1**), these cumulative impacts are considered to represent an impact of **negligible** significance given the lack of sensitive receptors in the local area.

There is the potential for positive Type 2 cumulative effects associated with the generation of economic activity through direct employment and materials, equipment and service providers, which is likely to result in an impact of **minor positive** significance.

12.7.4 Operational Phase Mitigation Measures

It is recommended that the following measures are adopted during the operational phase of the Project, ideally within an Operational Environmental Management Plan (OEMP), a framework for which is provided in **Chapter 18 – Framework Operational Environmental Management Plan.**

Operational Worker Welfare

- To provide the employees with a safe and risk free environment, it is recommended that a comprehensive EHS plan is developed and implemented. This framework, in line with Performance Standard 2, will address measures for accident prevention, identification, mitigation and management of hazards (including physical, chemical, and radiological hazards), training of workers and reporting of accidents and incidents;
- Occupational noise standards need to be maintained as part of the Health and Safety of the employees at the facility. It is therefore important that noise levels in working areas are limited to less than 85 dB(A) at 1m from any noise generating equipment. It is further recommended that a full occupational noise survey is undertaken in the interests of the health and safety of the site employees;
- In accordance with Performance Standard 2, the Project should develop and implement a human resource policy outlining the management approach towards working conditions, entitlement to wages and any benefits and terms of employment. This policy must be disseminated and accessible for all employees, clearly defining the employees' legal rights and the management's statement on child labour, forced labour and on non-discrimination and equal opportunities. This policy will also provide the mechanism through which employees can express and register their concerns and the system through which these grievances will be addressed;
- Expatriate staff must be provided with an induction course (as part of their training), which will highlight local customs, cultures and living conditions in KSA. The objective of this course will be to familiarise the expatriate staff with knowledge of their host country and provide an understanding and respect for other cultures. The aim will be to reduce, prevent and mitigate against social and cultural tensions and potential hostility between workers and the residents of surrounding communities;
- The provision of facilities for workers, such as kitchen facilities, dining areas, washrooms, and a mosque, will minimise the placing of undue pressure on existing local services;
- Where feasible, staff will be of local origin where suitably qualified applicants are available. This will ensure a degree of balance between the use of non-Saudi Arabian workers and locally employed personnel during the operational phase, and limit the impact on the local economy;
- In common with Performance Standard 4, all components of and infrastructure associated with the Project will be operated in accordance with industry best practice by qualified staff; and
- In line with IFC Performance Standard 1, it is also recommended that a grievance mechanism is established for local residents, giving them a platform to raise any concerns.

Noise Nuisance

No significant noise nuisance upon nearby sensitive receptors is expected and no additional mitigation measures are required.

However, it is important to note that there are also occupational noise standards that need to be maintained as part of the Health and Safety of the employees at the facility. It is therefore important that noise levels in working areas are limited to less than 85 dB(A) at 1m from any noise generating equipment.

Air Quality Impacts on Human Health

It is recommended that control measures are considered to minimise NO_x emissions under abnormal operating conditions (using back-up fuels), in accordance with best practice principles. Although such conditions would only occur at infrequent intervals, it is not acceptable that operational workers are exposed to NOx emissions levels which exceed the ambient air quality standards. Therefore, it is recommended that ambient air quality monitoring is undertaken continuously on site during all operating conditions, the results of which will be reviewed regularly to ensure compliance with PME/WHO standards and ensure that workers present within the Project site, and adjacent power plants are not adversely affected.

All plant on-site will be regularly maintained to ensure optimal efficiency and ensure, as far as practicable, all equipment is in good working order at all times.

Impacts on Local Businesses

As the impacts are considered to be positive there is no requirement for any mitigation measures to be implemented.

12.7.5 Operational Phase Residual Impacts

With the implementation of the proposed mitigation it is considered that health and safety risks for operational workers are significantly reduced and therefore the residual impacts are predicted to be **minor negative** significance.

The residual impacts of air quality upon human health both within the Project site and at sensitive receptors are expected to be **negligible** to **minor negative** (in the case of unlikely exceedances of NOx under certain meteorological conditions and emergency/abnormal operation).

The residual impacts of noise both within the Project site and at sensitive receptors are expected to be **negligible**.

The residual impacts of indirect employment opportunities, the influx of professional workers, wealth creation and secured power supply for the region during the operational phase are all of **moderate, positive significance**.

The impact on the local residents of temporary camps associated with the proposed facility operations, and following the implementation of an OEMP, (see the framework OEMP included within this ESIA), is deemed to be of **negligible impact**.

Any concerns will be addressed by the grievance protocol. This is deemed to result in a **negligible negative** impact.

Additional pressure placed on local services by employees and service providers is deemed to be a **negligible negative** impact.

12.7.6 Operational Phase Cumulative Effects

It is not considered that there will be any Type 1 significant cumulative effects during the operational phase of the Project.

Type 2 impacts are likely given that the area will eventually contain three operational power plants, which may exacerbate the potential impacts identified above, both positive and negative.

12.8 Summary and Conclusions

It is generally thought that the development of the PP-13 facility will have a positive impact on the local economy, particularly in terms of local job creation, and if the mitigation measures detailed above, and within the framework OEMP delivered as part of this ESIA are followed. In addition, it will be the responsibility of the EPC contractor to develop a comprehensive Environmental Management Plan specific to the construction and operation of the PP-13 facility.

The positive impact on the local economy is particularly pertinent to Dhurma since it is recognised that there has been a significant migration of the local community to Riyadh where there are more job opportunities. The proposed facility would, therefore, represent a positive employment option which may draw prospective residents back to the region.

Key economic benefits that are thought likely to be derived from the proposed facility include, inter alia:

- The creation of temporary and permanent jobs during the construction and operational phases of the proposed development;
- The potential for labour and procurement contracts to be let locally during the construction phase and the capital cost of the redevelopment; and,
- The potential for indirect increased local spending from the incoming workforce.

One risk items does remain however, which relates to the potential exposure of operational workers to elevated levels of NOx during operation under abnormal conditions when utilising back-up fuels. A programme of monitoring and mitigation (if required) should be developed to ensure that during such periods, workers are not exposed to dangerous NOx levels.

12.9 References

- CIA – The World Factbook website: https://www.cia.gov/library/publications/the-world-factbook/
- *FC/EBRD (undated): Workers' Accommodation: Processes and Standards – A Guidance Note.*
- International Financial Corporation's website: http://www.ifc.org.
- International Finance Corporation - World Bank Group (2006). *'International Finance Corporation's Performance Standards on Social & Environmental Sustainability*'. IFC.
- International Finance Corporation – World Bank Group and The European Bank for Reconstruction and Development (2009) *'Guidance Note: Workers Accommodation: Processes and Standards'*. IFC – EBRD.
- UNESCO Institute for Statistics; http://www.uis.unesco.org/.
- The International Labour Organisation (ILO): http://www.ilo.org/.
- The Interorganisational Committee on Guidelines and Principles for Social Assessment (1994): '*Guidelines and Principles for Social Impact Assessment*' (Impact Assessment (12) (Summer) pp.107-152.
- The Interorganisational Committee on Guidelines and Principles for Social Assessment *(1994): Guidelines and Principles for Social Impact Assessment (Impact Assessment (12) (Summer) pp.107-152).*
- World Bank's web-site: http://www.worldbank.org/.
- WSP Environment & Energy (Middle East) Ltd. (December 2009) '*Riyadh IPP: Environmental Scoping Report, GDF Suez Energy & Aljomaih Holding Co. Ltd.'* WSP Environment & Energy (Middle East) Ltd.

13 Cultural, Heritage and Archaeology

13.1 Introduction

This chapter of the ESIA examines the key cultural heritage and archaeological issues associated with the Riyadh PP-13 development, both within and surrounding the site, and during construction and operational activities.

The significance of the proposed Project on the local archaeology and cultural heritage has been assessed. Where significant impacts are identified appropriate avoidance and mitigation measures are provided, which are summarised below and set out in full in **Chapter 17 – Framework Construction Environmental Management Plan** and **Chapter 18 – Framework Operational Environmental Management Plan**.

13.2 Relevant Standards and Legislation

13.2.1 International Standards

The IFC Performance Standard 8: Cultural Heritage recognises the importance of cultural heritage for current and future generations. Consistent with the Convention Concerning the Protection of the World Cultural and Natural Heritage[50], this Performance Standard aims to ensure that clients protect cultural heritage in the course of their project activities. The main objectives of this standard are:

- "To protect cultural heritage from the adverse impacts of project activities and support its preservation; and
- To promote the equitable sharing of benefits from the use of cultural heritage".

13.2.2 National Standards

There are no specific requirements set out in the PME General Environmental Regulations (2001/2006) or within PME's revised standards (Ref. Presidency of Meteorology and the Environment (2012): Kingdom of Saudi Arabia National Environmental Guidance) that protect cultural heritage and archaeology artefacts.

13.3 Methodology

The assessment has been made with due consideration of Performance Standard 8 (Cultural Heritage) of the International Finance Corporation's (IFC) Performance Standards on Social and Environmental Sustainability.

[50] United Nations Educational, Scientific and Cultural Organisation (1972): Convention Concerning the Protection of the World Cultural and Natural Heritage.

This is in accordance with the revised Equator Principles' requirement for Category B developments in non-OECD countries.

Archaeological and cultural (historical) remains are fragile and finite resources that require careful management and sympathetic conservation/preservation practices. For the purpose of this ESIA, such resources may be defined as:

- Archaeological remains, both above and below ground;
- Historic buildings and sites (including burial grounds);
- Historic areas (including towns and villages, in whole or in part); and,
- Other structures of archaeological and/or cultural/historical merit.

As Morris and Therivel (2007)[51] state: '*The range of archaeological evidence reflects the diversity of human experience: the need for water, food and shelter, the use of changing technologies, and the religious, cultural and political needs of society*.'

A desk-based assessment has been undertaken to inform this assessment. Desk-based archaeological assessments can be defined as a programme of assessment of the known or potential archaeological resources within a specified area or site on land, within the inter-tidal zone, or underwater. It consists of a collection of existing written, graphic, photographic and electronic information in order to ascertain the likely character, extent, quality and worth of the known, or potential, archaeological and cultural resources in a local, national, regional and international context, as appropriate.

In addition to the desk-based assessment, a site walkover was undertaken in February 2013 in order to record current site land-use and topography, and to assess any potential above ground archaeology and cultural heritage resources and features at the site and the immediate vicinity.

13.4 Existing Baseline Conditions

13.4.1 Kingdom of Saudi Arabia

Our awareness of the archaeological landscape of the Kingdom of Saudi Arabia has changed greatly during the last two decades. As a result of intensive surveys, excavations and investigations conducted by Saudi archaeologists, thousands of sites have been recorded across the country.

Historic preservation is extremely important to the Kingdom with numerous restoration projects having been undertaken to safeguard the Kingdom's architectural heritage, including restoring historic building and neighbourhoods.

[51] Morris, P and Therivel, R (2007): Methods of Environmental Impact Assessment

These projects are typically undertaken by the Department of Museums and Antiquities, which excavates catalogues and preserves pre-historic and historic sites. In 2003, the department was transferred from the Ministry of Education to the Supreme Commission for Tourism (SCT), which was established in 2000. This department is now referred to as the Saudi Commission for Tourism and Antiquities.

One major restoration project took place at Dariyah, the ancestral home of the Al-Saud family and the capital of the First Saudi State. Other projects include the ancient sites of Fau, Madain Saleh, Al-Ula, Tayma, Duma and along the Darb Zubaydah, the pilgrimage road to Makkah.

As the birthplace of Islam, the Kingdom places a special emphasis on preserving its Islamic archaeological heritage. A large number of mosques around the Kingdom have been meticulously restored, including the Holy Mosque in Makkah, the Prophet's Mosque in Madinah and mosques built by the first caliphs after the death of the Prophet Muhammad.

The Saudi Arabian government is also in the process of restoring historic neighbourhoods. Restoration work has been undertaken in the old Qasr Al-Hokm area in Riyadh, as well as the ancient quarters of Jeddah, Hail, and other Saudi cities. This restoration work was showcased during the 1999 celebrations marking the hijrah centennial of the taking of the Masmak Fortress in 1902.

13.4.2 The Project Site

It is understood that Dhurma, the nearest town to the project, was first recorded in the 7th century and was then known as Qarma or Garma. At this time, the settlement was a small village and considered important as a significant gateway to the region of Wadi Hanifah and was subject to significant clashes and military campaigns. Following an unsettled history, the town is now relatively small, with a large majority of the population having moved to Riyadh.

No specific cultural heritage or archaeological information relating to the immediate environs of the Project site is available and it has not been possible to undertake consultation with the relevant authorities. However, a site survey undertaken in February 2013 and December 2014 indicated that there is no above ground evidence of former communities at this location or features or artefacts of cultural or archaeological sensitivity.

13.5 Sensitive Receptors

Given that the proposed site is located in a barren flat gravel/sand plain adjacent to an area already developed for power generation purposes, and due to the lack of any above ground features it not thought that any sensitive receptors exist either within the project site or within the adjacent environs.

13.6 Assessment of Construction and Operational Impacts

13.6.1 Potential Impacts (Construction and Operational)

Given that the proposed site is located in a barren flat gravel/sand plain, and due to the lack of any above ground features it is thought unlikely that any archaeological and/or cultural remains and artefacts exist on the site.

A desk-study and site-visit have been carried out but have not identified any potential risks associated with the development of the facility and any perceived impacts on or for archaeological and cultural resources. Any potential impacts are therefore thought to be of **negligible significance** for both the construction and operational phases of the development.

13.6.2 Mitigation Measures, Residual and Cumulative Effects

The findings of the desk-study and site visit indicate that no cultural or archaeological artefacts or remains exist either inside or within close proximity to the proposed development site and, therefore, the potential for uncovering archaeological and/or cultural resources is thought to be very low. There is therefore little requirement for the employment of mitigation measures at this juncture.

Notwithstanding the above, should such remains be discovered at any time during the commissioning, construction, operational, and decommissioning phases of the proposed Project, it is beholden of the EPC and its sub-contractors to cease all works and to contact the relevant authorities, immediately. It should also be noted that the earthworks phase of a project is generally the most significant in terms of archaeological finds. Indeed, an 'archaeological watching brief' should be carried out during the relevant stages of the development, such as during the site preparation. It is therefore recommended that construction staff are instructed by the EPC to be aware of the critical importance of contacting the Site Manager should they uncover any artefacts or anthropogenic finds.

The intention of the archaeological watching brief would be to record and remove any finds of archaeological and cultural significance. It is envisaged that the watching brief would include the following requirements:

- Any chance finds or suspected evidence of archaeological and/or historical materials must be immediately reported by any of the construction workers, or other parties involved in the construction phase, and all works should be stopped immediately, and until further notice; and,
- Relevant departments, such as the Ministry of Education (Deputy Ministry of Archaeology and Museums), Riyadh, should be contacted and a representative be requested to assess any find within 72 hours of discovery to determine the next steps. Contact details for Riyadh Museum for History and Archaeology are as follows:
  - King Saud Street, Al-Bathaa, Riyadh, Tel: +966 1 419 1210;

Any unexpected finds of cultural or archaeological value should not be removed unless the following options apply:

- There are no feasible alternatives, financially or technically, to removal;
- The benefits represented by the Project outweigh the perceived benefit of preservation of the archaeological find;
- Should any removal take place, Best Available Techniques should be employed;
- Work in areas adjacent to the archaeological find area may continue, consistent with the detailed design, unless additional finds are found or suspected.

In addition, a CEMP will be developed by the appointed EPC for this Project and will include an 'Environmental Control Plan' which details the approaches that must be taken and the practices that must be adhered to by contractors and sub-contractors should archaeological and cultural artefacts and remains be discovered during any time of the Project's development. It is beholden of all parties to familiarise themselves with such Environmental Control Plans (which should be developed for all environmental aspects) and to secure adherence to them.

13.7 Summary and Conclusions

Given that the proposed site is located in a barren flat gravel/sand plain, and due to the lack of any above ground features it is thought unlikely that any archaeological and/or cultural remains and artefacts exist on the site. Notwithstanding this, should any potential artefacts and/or resources be discovered at any time, now or in the future, it is beholden on all responsible parties to ensure that works are curtailed immediately and experts consulted. Additionally, it is recommended that an 'archaeological watching brief' is undertaken during the relevant stages of the development, such as during site preparation.

13.8 References

- International Finance Corporation - World Bank Group (2006). '*International Finance Corporation's Performance Standards on Social & Environmental Sustainability* – Performance Standard 8: Cultural Heritage'. IFC.
- Morris, P. & Therivel, R. (2001) '*Methods of Environmental Impact Assessment'* 2nd. Ed. Spon Press.
- Saudi Commission for Tourism & Antiquities website: www.scta.gov.sa/

14 Landscape and Visual

14.1 Introduction

This chapter determines the significance of the Project in terms of visual impact by defining the character of the existing landscape and locating potentially significant viewpoints. The purpose of this chapter is to describe, determine and assess the existing character and visual resources of the Project site and its immediate surroundings.

The chapter also evaluates the likely visual impacts of the development on the landscape during the construction and operational phases and where appropriate, pertinent mitigation measures are proposed.

Where significant impacts are identified appropriate avoidance and mitigation measures are provided, which are summarised below and set out in full in **Chapter 17 – Framework Construction Environmental Management Plan** and **Chapter 18 – Framework Operational Environmental Management Plan**.

14.2 Relevant Standards and Legislation

In the absence of specific national legislation or guidance relating to landscape and visual amenity, this assessment has been undertaken in accordance with accepted international best practice, such as information detailed within the 'Guidelines for Landscape & Visual Impact Assessment'[52], produced from a combined venture between the UK's Institute of Environmental Management and Assessment, the Landscape Institute; and Morris and Therivel[53].

14.3 Methodology

Although landscape impacts and visual impacts are interrelated, it is instructive to briefly explain the difference between 'landscape' and 'visual' impacts:

- 'Landscape' refers to the appearance of the land (its shape and colour for example). It is not just a visual resource but is also shaped by a number of factors, such as the topography, geology and ecology of the area and any existing development or land uses. Generally, landscape impacts are changes that affect the character and quality of a landscape, due primarily to development.
- 'Visual' impacts relate solely to changes in the available view or views of the landscape, and, importantly, the effect of such changes on viewpoints used and/or valued by people.

[52] The Landscape Institute and the Institute of Environmental Management and Assessment (2002) '*Guidelines for Landscape & Visual Impact Assessment*'. 2nd Ed. Spon. Press.

[53] Morris, P. & Therivel, R. (2001) '*Methods of Environmental Impact Assessment*' 2nd. Ed. Spon. Press.

The methodology used follows and incorporates accepted international best practice, such as information detailed within the 'Guidelines for Landscape & Visual Impact Assessment'[54], produced from a combined venture between the UK's Institute of Environmental Management and Assessment, the Landscape Institute; and Morris and Therivel[55].

Despite the lack of landscape or visual amenity associated with the Project site, desk-based and *in-situ* field studies have been undertaken to assess any landscape and visual impacts in accordance with international best practice. The assessment methodology consisted of the following:

- A desk-based review of existing information including available development documents and aerial photographs was undertaken to determine the existing landscape features and landscape character;
- In order to provide a comprehensive assessment of the landscape and visual implications of the project, and despite a lack of sensitive receptors or visual resources in the area, a viewpoint based assessment has been undertaken. Therefore, following the desk-based review the Project Site and surrounding areas were surveyed in February 2013 and December 2014 during which conditions were clear. A review of the landscape character of the existing sites and significant viewpoints were noted and photographed; and
- Viewpoints taken at key points within and adjacent to the Project site are presented below within **Section 14.4.1** to illustrate the existing landscape and features surrounding the site. For each of these, the key features of the existing views were described, and impacts of the project summarised.

14.4 Existing Baseline Conditions

14.4.1 Landscape Character

The proposed PP-13 site is located approximately 110 km to the west of the city of Riyadh in a wide valley known as Al-Batin. The surrounding landscape features a gravel/sand plain at an altitude of approximately 690 metres above sea level and is entirely flat being devoid of any landscape character or visual amenity. A ridge can be observed approximately 7 km to the north and northeast of the Project site while dunes are present to the southwest.

The local area is characterised by a very flat topography, and with the exception of a small number of now abandoned agricultural buildings, is devoid of other significant features. The proposed Project site lies within the immediate vicinity of the IPP-11 facility and approximately 800 metres east from the PP12, which is currently under construction and scheduled to become operational in 2015, with both these facilities and associated laydown areas dominating the local landscape character.

[54] The Landscape Institute and the Institute of Environmental Management and Assessment (2002) '*Guidelines for Landscape & Visual Impact Assessment*'. 2nd Ed. Spon. Press.

[55] Morris, P. & Therivel, R. (2001) '*Methods of Environmental Impact Assessment*' 2nd. Ed. Spon. Press.

The site itself is accessed by a purpose built sealed road which branches off Highway 505, which is located approximately 20 km east from the Project site. The overall site currently comprises the operational IPP-11 facility, the PP-12 facility which is under construction, laydown areas and substations are mainly located respectively along the northern and southern section of the overall development area.

WSP notes that the digitised images provided by Google Earth Pro was antecedent to the site reconnaissance and reveals that the project site was supporting laydown areas in 2014, certainly associated with the earlier construction phases of the PP-12 facility. Since then, the overall project footprint area has been graded and compacted, and previous laydown areas re-located.

Given the isolated location of the Project site, combined with the lack of landscape features or visual amenity, and featuring only a few, remote settlements, together with the general flat relief of the land, the site is considered to be of low sensitivity in landscape and visual terms. **Figure 14-1** illustrates the location of the Project site in the context of the local area and adjacent land uses.

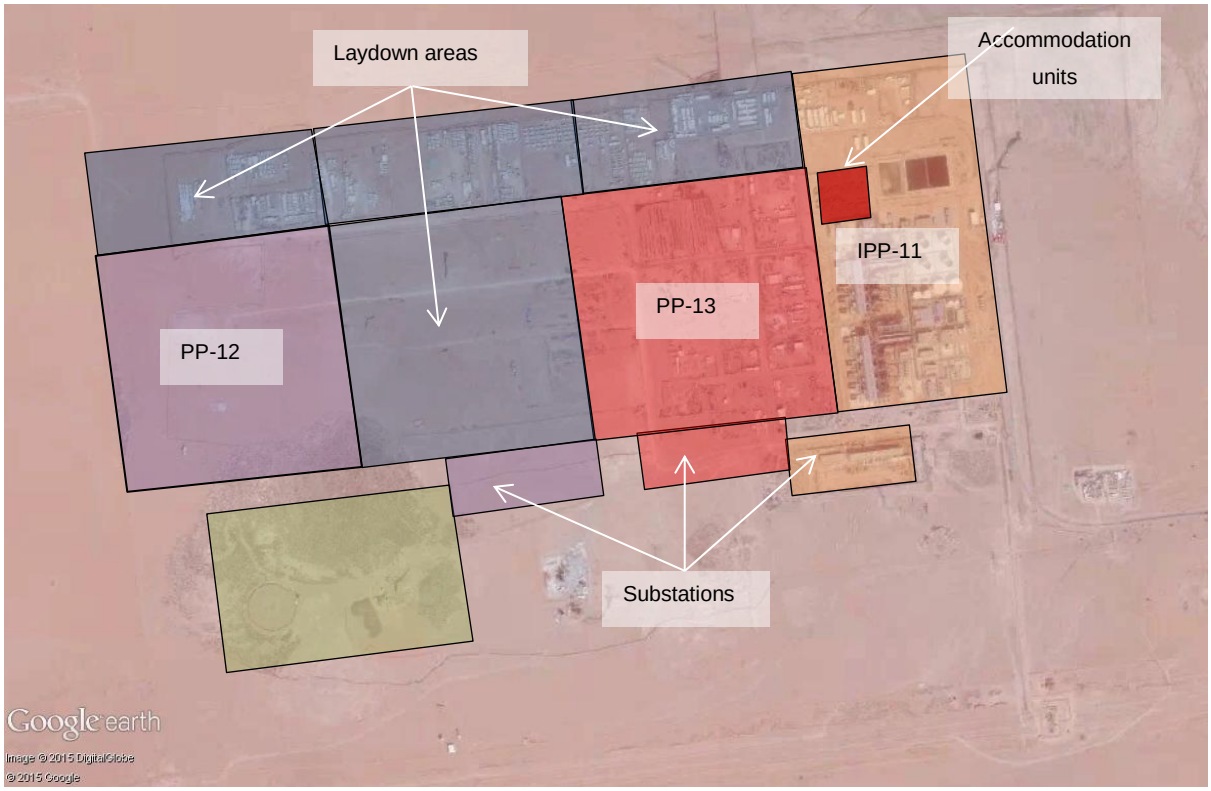


Figure 14-1 The Project site in the context of the local area



Figure 14-2: WP 1375, PP-11 accommodation units associated with the IP-11 facility



Figure 14-3: WP 1375, view towards IPP-11 from the accommodation units



Figure 14-4: WP 1375, view towards PP-12 and PP-13 project site from the accommodation units



Figure 14-5: WP 1375, view towards IPP-11 laydown area from the accommodation units

Figure 14-2 to Figure 14-5 illustrates the generally flat, featureless landscape character within the vicinity of the Project site, interspersed only by industrial activity associated with the adjacent IPP-11 facility.

14.4.2 Landscape Value

Given the isolated nature of the Project site, combined with the general lack of landscape features within the exception of the adjacent power facilities, and associated infrastructure, the Project site and surrounding area are considered to be of low aesthetic value in landscape and visual terms.

14.5 Sensitive Receptors

Sensitive receptors associated with the new PP-13 facility has been identified as the residents of the permanent accommodation units of the IPP-11, where the nearest residential villas are adjacent to the southeast corner of the PP-13 project footprint area. Additional potential sensitive receptors would include residential dwellings with a clear view over a particular landscape or site; and viewpoints within an area of particular natural beauty or high aesthetic value such as a historic settlement. Examples of non-sensitive receptors would include an industrial facility situated within an area dominated by an industrial landscape.

However, it is clear from a review of the viewpoints that the project site and surrounding area represent no aesthetic amenity in terms of landscape or visual character, and while sensitive receptors have been identified on the IPP-11 project footprint area, the overall development is within an established industrial landscape.

14.6 Assessment of Construction and Operational Impacts

14.6.1 Construction Phase Impacts

Visual impacts during the construction phase would mainly be associated with the presence of mobile equipment, including cranes, excavators, bulldozers etc. However construction equipment are likely to have a temporary impact of **negligible significance** on the existing permanent residential accommodation units associated with the IPP-11 facility.

14.6.2 Operational Phase Impacts

Schedule B[56] identifying required project specifications, dictates that a minimum stack-height of 60m is required, with the exact height to be determined in line with PME requirements. In combination with the requirements of KSA regulations for such stacks to be painted red and white and to include a continuously operating flashing red light, the stack will be visible from a quite considerable distance. However, in light of the generally isolated nature of the area and the industrial landscape of the overall development, the potential operational visual impact of the proposed PP-13 will be of **negligible significance**.

[56] *Saudi Electricity Company: PP-13 Riyadh Combined Cycle Power Plant – Schedule B, Attachment III'.*

14.7 Mitigation Measures, Residual and Cumulative Effects

14.7.1 Construction Phase Mitigation Measures

It is not considered that any specific mitigation measures will be required during the construction phase.

14.7.2 Construction Phase Residual Effects

Given the temporary nature of the construction operations and the site location, the residual effects will be temporary and of **negligible significance.**

14.7.3 Construction Phase Cumulative Impacts

Given the remote nature of the Project site, and its designation as an area for industrial purposes, no cumulative impacts are predicted.

14.7.4 Operational Phase Mitigation Measures

The surrounding area is a remote and isolated desert landscape. It is considered that the visual impact on the areas will be of **negligible significance** and no mitigation will be required.

Incorporation of landscaping would result in a small improvement to the visual perception of this administrative area, and the residential accommodation units associated with the IPP-11 facility.

14.7.5 Operational Phase Residual Effects

Given the nature of the locality, it is anticipated that the overall residual impact will be of permanent but **negligible significance**.

14.7.6 Operational Phase Cumulative Impacts

Given the remote nature of the Project site, and its designation as an area for industrial purposes, no cumulative impacts are predicted.

14.8 Summary and Conclusions

The proposed PP-13 site is located in a remote and isolated desert landscape, which represents little or no visual amenity. In addition, while sensitive receptors have been identified on the IPP-11 project footprint area, the overall development is within an established industrial landscape.

14.9 References

- The Landscape Institute and the Institute of Environmental Management and Assessment (2002) '*Guidelines for Landscape & Visual Impact Assessment*'. 2nd Ed. Spon Press.
- Morris, P. & Therivel, R. (2001) '*Methods of Environmental Impact Assessment'* 2nd. Ed. Spon Press.

15 Traffic and Transportation

15.1 Introduction

This chapter considers and assesses the potential effects from traffic movements associated with the proposed PP-13 facility. It identifies mitigation measures, the implementation of which may avoid or minimise social and environmental impacts attributable to the transportation elements of the construction and operational phases of the proposed Project.

Where significant impacts are identified appropriate avoidance and mitigation measures are provided, which are summarised below and set out in full in **Chapter 17 – Framework Construction Environmental Management Plan** and **Chapter 18 – Framework Operational Environmental Management Plan**.

15.2 Relevant Standards and Legislation

In the absence of specific relevant legislation relating to traffic and transportation, note will be made of recommendations presented within the IFC General EHS Guidelines: Community Health and Safety (2007), in addition to guidance published by the Institution of Highways and Transportation[57].

The Guidelines on Traffic Impact Assessment[58] requires that a Transport Assessment (TA) is undertaken if it is deemed that a proposed development is likely to result in a 10% increase in traffic. Currently, no baseline or future traffic data is available relating to either the construction or operational phases of the development and it is therefore not possible to determine if this threshold will be exceeded. Furthermore, there are no specific requirements for a TA to be undertaken within Schedule B[59] prepared by SEC. Instead, this assessment will be based on available information and in consideration of transport assessment best practice. Typically, a TA would incorporate several elements, such as:

- Whether the development involves the relocation of an existing use;
- The potential traffic generation from the site;
- Whether the local highway network will require modification;
- Whether adjacent links or junctions will become overloaded;
- Whether there are significant phases to the development;
- Information on pedestrian, cycle and other road user movements;

[57] Institution of Highways and Transportation (1994) *Guidelines for Traffic Impact Assessment*. London. IHT

[58] Ibid.

[59] *Saudi Electricity Company: PP-13 Riyadh Combined Cycle Power Plant – Schedule B, Attachment III'.*

- Site development constraints; and
- Secondary measurements such as for noise and air quality.

The above points have been borne in mind whilst undertaking the transportation element of the ESIA, albeit given the location of the proposed Project, several of the above are not deemed to be applicable.

Morris and Therivel (2007) note that: '*transport is seen as a key factor in the approval, design and likely success of prospective new developments. Developments require good access…as well as the need for optimum servicing arrangements, all of which will affect the surrounding transport and highway network*.'

15.3 Methodology

A site visit was undertaken in February 2013 and December 2014 which provided a first-hand experience of the local road network and other modes of transport which will be relevant to the construction and operational phases of the PP-13 development.

Additional information sources were consulted to gain further information on the existing transport framework within the KSA, and included:

- The Presidency of Meteorology and Environment website (www.pme.gov.sa);
- Ministry of Transport website (http://www.mot.gov.sa);
- Saudi Arabia Ministry of Culture & Information web site (www.saudinf.net); and
- Saudi Public Transport Co. (SAPTCO) web-site (www.saptco.com.sa).

15.4 Existing Baseline Conditions

15.4.1 Introduction

Saudi Arabia's substantial socio-economic growth in recent years has prompted a parallel expansion in the Kingdom's transportation sector, including road, air, rail and ports. A brief summary of the existing road network in Saudi Arabia is provided below.

15.4.2 Road Network

The massive increase in traffic that has resulted from the Kingdom's industrial and commercial development has led to upgrading of many of the inter-city roads to expressways, with up to eight lanes for traffic. Some of the more important inter-city highways are;

- Dammam – Abu Hadriya – Ras Tanura Highway (257 kms);
- Khaybar – Al Ola Highway (175 kms);

- Makkah – Madinah Al Munawarah Highway (421 kms);
- Riyadh – Dammam Highway (383 kms);
- Riyadh – Sedir – al Qasim Highway (317 kms);
- Riyadh – Taif Highway (750 kms); and
- Taif – Abha-Gizan Highway (750 kms).

A number of cities now have modern ring-roads which serve to reduce congestion and pollution issues in the city centres. A further development is the construction of networks of over- and under-passes within the cities which again serve to facilitate driving in city centres[60].

15.4.3 Existing Site Conditions

The PP-13 site is situated approximately 20km from the Dhurma-Marat Highway (Road No. 505), which is a two lane highway approximately 8m in width. The closest large town is Dhurma which is approximately located 50 km to the southeast of the Project site. The Project site is accessed via a purpose built two lane highway which leads directly to the PP-13 site and adjacent plots from Highway 505.

15.5 Sensitive Receptors

Due to the isolated nature of the Project site, the main sensitive receptor is considered to be the adjacent IPP-11 and future PP-12, in addition to Road No. 505. In addition, the local road network in and surrounding Dhurma may also represent a sensitive receptor, both as a result of commuting workers and transport of construction materials and wastes to and from the site, respectively. This receptor has been assessed as Low in terms of sensitivity, in accordance with the Assessment Criteria set out in **Chapter** 5 **– Impact Assessment Methodology**.

15.6 Assessment of Construction and Operational Impacts

15.6.1 Construction Phase Impacts

The transportation of materials to and from the site during the construction phase together with the removal of waste will represent an increase over normal traffic levels on the local roads. Given the relative isolation of the Project site, and in the absence of mitigation measures, this is expected to result in a temporary impact of **minor negative** significance, particularly upon the adjacent IPP-11 and future PP-12.

The majority of the workers (contractors and sub-contractors) will be housed in the vicinity of the site. In view of this approach, it is thought that the transportation of workers will be of **negligible** impact.

[60] Ministry of Transport. Available online at: www.mot.gov.sa. [Accessed 27 May 2013].

A significant increase in heavy vehicle movements could affect the ground due to compaction, potentially damaging underground services and/or damage and affect the quality of the existing road network. Prior to the implementation of mitigation measures, this issue is expected to result in a **minor negative** impact.

Impacts such as any perceived increase in air pollutants from construction vehicular movements; and noise pollution impacts are detailed within **Chapter** 6 **– Air Quality** and **Chapter** 7 **– Noise and Vibration**, respectively.

15.6.2 Operational Phase Impacts

The total number of operation and maintenance staff is currently not known. However, given the local road capacity, and otherwise remote nature of the surrounding environs, the impact associated with personnel travelling to and from the site during the operational phase of the power plant has been assessed as a being a **negligible** impact.

During the operational phase, fuel, oils, materials and waste will require transportation on and off site. The back-up fuel, ASL will brought to the site by road tanker. Sludge from the sludge holding tank associated with each STG and solid sanitary wastes will be removed by road tanker. The increased number of vehicles utilising the local roads and highways may result in an increase in road traffic accidents. However, the probability of accidents is considered to be very low, assuming that road traffic regulations and speed limits are adhered to and therefore this issue has been assessed as a **minor negative** impact.

15.7 Mitigation Measures, Residual and Cumulative Effects

Traffic-related mitigation measures generally include off-site highway works (such as to reduce driver delay), and measures to reduce community effects in Dhurma and focus on mitigating the environmental impacts of changes in transport activities. Thus, they are largely covered within other chapters of this report but are summarised below in **Table 15-1**.

Table 15-1: General environmental mitigation measures in relation to transport infrastructure

Main Environmental Impact	Mitigation Measure
Air Pollution	■ Traffic management (reduced and/or improved traffic flow; speed restrictions) ■ Minimising of construction traffic
Noise Pollution	■ Appropriate road surfacing e.g. porous asphalt ■ Noise barriers e.g. absorptive/vegetative
Water Pollution	■ Improved run-off ■ Interception of any/all pollutants
Terrestrial Ecology	■ Avoid or translocate species
Visual and Amenity	■ Promotion/restriction of views

General Traffic Safety Guidance is set out within the IFC General EHS Guidelines: Community Health and Safety and is applicable throughout all phases of the proposed Riyadh IPP. Specifically, the guidelines require that traffic safety is considered and promoted by project personnel during travel to and within the project site as well as during the operation of Project equipment on private or public roads. Safety measures are required to ensure that traffic related injuries are prevented and controlled, both in terms of Project workers and the public.

The guidelines recommend that a Road Safety Initiative relative to the scope and location of the Project should be implemented to ensure that best practice transport safety practices are in place throughout all phases of the Project. These measures include the following:

- Emphasising safety aspects among drivers;
- Improving driving skills and requiring licensing of drivers;
- Adopting limits for trip duration and arranging driver rosters to avoid overtiredness;
- Avoiding dangerous routes and times of day to reduce the risk of accidents;
- Use of speed control devices (governors) on trucks, and remote monitoring of driver actions; and
- Regular maintenance of vehicles and use of manufacturer approved parts to minimize potentially serious accidents caused by equipment malfunction or premature failure.

Where the project may contribute to a significant increase in traffic along existing roads, or where road transport is a significant component of a project, recommended measures include:

- Minimising pedestrian interaction with construction vehicles;
- Collaboration with local communities and responsible authorities to improve signage, visibility and overall safety of roads, particularly along stretches located near schools or other locations where children may be present;
- Collaborating with local communities on education about traffic and pedestrian safety (e.g. school education campaigns);
- Coordination with emergency responders to ensure that appropriate first aid is provided in the event of accidents;
- Using locally sourced materials, whenever possible, to minimise transport distances. Locating associated facilities such as worker camps close to project sites and arranging worker bus transport to minimizing external traffic; and
- Employing safe traffic control measures, including road signs and flag persons to warn of dangerous conditions.

- It is recommended that these mitigation measures are considered, and where appropriate, included within the Traffic Plan prepared for the project. In addition, the following site-specific mitigation measures should be implemented:

15.7.1 Construction Phase Mitigation Measures

- The access road constructed and used for the Project will be designed to incorporate sufficient width and load. And maintained in an appropriate condition to ensure safe use;
- In designing and managing all temporary road layouts and signage associated with the Project infrastructure and consequent utilisation of local road networks, adherence should be made to specifications set out within the Ministry of Communications 'Workzone Traffic Control Handbook' (MOC,1995);
- Construction materials and/or plant delivered by road should be scheduled in order to avoid peak hours in the area. Special attention will be made of slow-moving vehicles carrying heavy equipment/loads; which will be transported at times where the traffic on Road No. 505 is at its lowest levels;
- Waste collection will be scheduled to minimise journeys at peak times;
- A scheme will be prepared for traffic management on site during construction. This includes details of routes, signage, parking and a speed limit of 25km/h;
- Where possible, in order to minimise congestion at key entrances to the site, the Project proponent should ensure that separate entrances are nominated for different purposes. Thus, an entrance should be designed for the PP construction workforce and associated personnel; an entrance for site-clearance and construction vehicles, and heavy equipment; and an entrance for waste removal (including hazardous waste) etc.;
- The transportation of any waste that could represent a hazard to the environment will be undertaken according to an agreed procedure to minimise the risk of accidental spillage and in common with best practice; and
- As the workers will be housed on site, this will significantly reduce the number of vehicle movements required during the construction phase; and
- Adherence to guidance set out within the IFC General EHS Guidelines: Community health and safety, relating to the on-site and off-site transportation of waste is recommended. These guidelines require that transportation of waste should be undertaken so as to prevent or minimise spills, releases, and exposures to employees and the public. All waste containers designated for off-site shipment should be secured and labelled with the contents and associated hazards, be properly loaded on the transport vehicles prior to leaving the site, and be accompanied by a shipping paper that describes the load and its associated hazards.

15.7.2 Construction Phase Residual Effects

It is anticipated that the residual effects resulting from the transport of construction staff, material and equipment and removal of waste to and from the Site on the local transport infrastructure, will be **negligible** following the implementation of mitigation measures.

15.7.3 Construction Phase Cumulative Effects

No sensitive receptors are present which would be significantly impacted by Type 1 cumulative impacts (e.g. the combination of increases in traffic as a result of construction vehicles, together with the correlating increase in dust generation, wastewater and noise).

There is however the potential for Type 2 impacts to occur when the normal operational traffic associated with the existing IPP-11 and PP-12 construction site is combined with traffic generated during the construction phase of PP-13. This is considered to be a **minor negative** impact.

15.7.4 Operational Phase Mitigation Measures

Whilst a reasonably significant number of vehicle movements may be predicted as a result of the operation phase of the Project, it is considered that the very isolated nature of the Project Site and high capacity of Highway 505 ensures that no significant impacts will occur on the local highway network; however the following key preventative measures will be implemented:

- Where possible, operational traffic should be scheduled during off-peak traffic times;
- Waste collection will be scheduled to minimise journeys at peak times;
- The transportation of any waste that could represent a hazard to the environment will be undertaken according to legal requirements to minimise the risk of accidental spillage or accidents; and
- A designated Traffic Coordinator will be assigned to the Project and will be required to prepare and implement a Traffic Plan. The Traffic Plan will be informed by a Traffic Survey which will include physical examination of the routes, carriers and support activities that could impact the movement of materials and equipment.

15.7.5 Operational Phase Residual Effects

It is predicted that the residual effects on traffic resulting from commuting of workers to the Project Site will be **negligible.**

As a result of the measures proposed, the residual impact of the Project relating to increases in traffic and pressure upon the transport infrastructure are predicted to be of **negligible** significance.

15.7.6 Operational Phase Cumulative Effects

Type 2 cumulative impacts would occur as a result of the operation of IPP-11, PP-12 and PP-13. These are however predicted to be **negligible** as it is unlikely that the PP-13 would provide a significant increase in road traffic over and above existing traffic generated from operation at the site. Cumulative impacts resulting from noise, air and socio-economic factors are possible; although it is not possible to quantify these potential impacts in the absence of traffic data relating to PP-12 and PP-13.

15.8 Summary and Conclusions

Due to the isolated nature of the Project Site, and in the absence of traffic data, a review of potential traffic impacts has been made and best practice mitigation measures presented. With a relatively low increase in traffic due to the construction and operation of the Project, combined with the existing capacity of Highway 505, the impact of traffic and transportation is considered to be of **negligible** to **minor negative** significance.

15.9 References

- Institution of Highways and Transportation (1994) *Guidelines for Traffic Impact Assessment*. London. IHT.
- IFC (2007) General EHS Guidelines: Community Health and Safety.

16 Impact Assessment and Analysis Summary

16.1 Introduction

The following chapter provides a tabularised impact assessment and analysis summary of the environmental and social impacts related to the Riyadh IPP project. Each impact is identified, described and an assessment of its significance is made based on recognised criteria. This chapter should be read in conjunction with the Assessment Method outlined in **Chapter** 5 **– Impact Assessment Methodology**.

The impacts are evaluated before and after the implementation of appropriate and cost effective mitigation measures. Residual and cumulative impacts are described where appropriate.

16.2 Key

The following tables provide a quick reference guide to the symbols and colour coding in the impact assessment tables.

Table 16-1: The impact nature, associated colour coding and symbol

Symbol	+	=	-
Impact Nature	Positive	Neutral	Negative

Table 16-2: Colour coded symbols for impact significance & residual impact significance

Significance	Definition
Positive Impact	An Impact that is considered to represent an improvement on the baseline or introduces a new desirable factor.
Negligible Impact	Magnitude of change comparable to natural variation.
Minor Impact	Detectable but not significant.
Moderate Impact	Significant; amenable to mitigation; should be mitigated where practicable.
Major Impact	Significant; amenable to mitigation; must be mitigated.
Critical Impact	Intolerable; not amenable to mitigation; alternatives must be identified – Project Stopper.

Table 16-3: Environmental impacts summary table

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Air Quality				
Construction Phase	Dust from construction activities: activities on site can cause dust (PM_{10}) to be emitted to the atmosphere. If transported beyond the site boundary, dust can have an adverse impact upon air quality.	-	■ Best practice methods for construction sites will be employed to ensure dust emissions and plant exhaust emissions are minimised to an extent where adverse impacts beyond the boundary of the site would be minimal.	-
Construction Phase	Release of emissions (including PM_{10}) to air from construction traffic: construction traffic will contribute to existing traffic using local road network, resulting in potential localised & short-term impacts upon ambient air quality.	-	■ Minimising emissions from construction vehicles and plant through regular servicing and maintenance; ■ Controlling dust arising through management of vehicle movements and speeds	-

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Operational Phase	NO_x, SO_2, CO and PM_{10} emissions from IPP-11, PP-12 and PP-13 have been assessed using dispersion modelling for nine scenarios for a range of operating conditions. The modelling predicted no exceedances of Saudi or World Bank AQS under normal operating conditions and exceedances only under worst case meteorological conditions when all three plants are operating on back up fuel; even under these circumstances, no exceedances were identified at any off-site sensitive receptors locations. Please refer to **Chapter 6 – Air Quality** for full details relating to operational impacts.	-	■ Consideration needs to be given to measures to control NOx emissions during abnormal (back-up fuel) operation. ■ A programme of mitigation will be developed to prevent the exposure of operational workers to elevated levels of NOx during operation on back-up fuels. This will include a programme of continuous ambient air quality monitoring. ■ All plant on-site will be regularly maintained to ensure optimal efficiency and ensure, as far as practicable, all equipment is in good working order at all times. ■ Continuous monitoring of the emissions from each stack for levels of NO_x, SO_2, CO will take place.	--

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Operational	NO_x, SO_2, CO and PM_{10} emissions from IPP-11, PP-12 and PP-13 have been assessed using dispersion modelling for nine scenarios for a range of operating conditions. The modelling predicted exceedances of Saudi or World Bank AQS under worst case meteorological conditions when all three plants are operating on back up fuel at the point of maximum impact. Please refer to **Chapter 6 – Air Quality** for full details relating to operational impacts.	-	■ Consideration needs to be given to measures to control NOx emissions during abnormal (back-up fuel) operation. ■ A programme of mitigation will be developed to prevent the exposure of operational workers to elevated levels of NOx during operation on back-up fuels. This will include a programme of continuous ambient air quality monitoring. ■ All plant on-site will be regularly maintained to ensure optimal efficiency and ensure, as far as practicable, all equipment is in good working order at all times. ■ Continuous monitoring of the emissions from each stack for levels of NO_x, SO_2, CO will take place.	--
Noise and Vibration				

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Construction Phase	Temporary increase in noise levels as a result of site preparation/ground works, concreting operations and general site activities.	-	■ Best practice noise and vibration control measures are to be used to limit the noise exposure of the construction workers. ■ Construction workers accommodation should be located as far as possible from the active construction site – i.e. north of the allocated area. Ideally the laydown area will be located between the construction site and labour accommodation in order to act as a buffer for noise impacts. ■ A programme of construction noise and vibration monitoring must be undertaken throughout the construction phases and especially during phases likely to generate high levels of vibration at sensitive buildings. ■ Electrically powered plant should be preferred, where practicable, to mechanically powered alternatives. All mechanically powered plant should also be fitted with suitable silencers	-
Construction Phase	Temporary impacts upon labour accommodation associated with piling activities within 110m	-	■ Best practice noise and vibration control measures are to be used to limit the noise exposure of the construction workers. ■ Construction workers accommodation should be located as far as possible from the active construction site – i.e. north of the allocated area. Ideally the laydown area will be located between the construction site and labour accommodation in order to act as a buffer for noise impacts.	-

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Operational Phase	Noise levels at the northern boundary adjacent to the premises for worker accommodation are expected to fall below 50dB(A) which complies with the PME noise criteria.	-	■ Given the isolation of the site and the very small probability that any residential development is likely to occur near the site, this is not regarded to be a significant impact. ■ Despite the above, International Best Practice recommends that equipment must be restricted to specific values by a combination of purchase specifications for potentially noisy equipment, noise insulation in areas that require it, proper ear protection in those areas which naturally have high decibel ranges associated with them, and, once construction is complete, full noise attenuation walls will be in evidence.	-
Waste and Hazardous Materials				
Construction Phase	No impacts predicted relating to increased pressure on local landfill and other local waste facilities due to the disposal of (potentially contaminated) excavated land from the Project site.	-	■ It is expected that excavated materials could be re-used or spread within the project site area, which would not require mitigation. If however contamination is suspected or identified, this material must be disposed of to a suitably licensed facility.	-
Construction Phase	Generation of raw material waste from the construction of buildings and plant infrastructure which may require off-site disposal. Additionally, waste generation will be increased due to the high number of construction workers to be employed at the Project site.	-	■ Within the CEMP, recommendations have been set out detailing requirements for the identification of the types and quantities of waste that can be minimised or effectively segregated for recycling/re-use and the materials that require disposal to landfill. ■ Encouraging waste minimisation practices during the construction process and segregating waste streams for re-use and recycling.	-

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Construction Phase	The poor storage of construction materials on-site may result in the potential wastage of large volumes of raw materials.	-	■ Good working practices are encouraged on-site within the CEMP, particularly in relation to the storage and disposal of waste materials. ■ All on-site workers should be aware of the location of storage areas and the requirements of such areas. Good working practices will also be encouraged as a means of minimising waste	-
Construction Phase	The potential impact from the off-site movement and disposal of waste, either to an appropriate landfill site or to a recycling centre, may result in increased traffic movements.	-	■ Efficient planning of material deliveries to the site by local contractors and subcontractors; ■ Effective handling and storage of delivered materials to prevent loss or damage through exposure to the weather, mud and on-site vehicles; ■ According to “Duty of Care” best practices all consignments of waste for disposal should be recorded, and the type, destination and name of the carrier should be specified; ■ The transport of wastes from the site should be scheduled to minimise journeys during peak traffic times. The minimisation of collection frequency is also important; however this will depend on storage space availability at the development construction site.	-

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Operational Phase	The generation of waste streams during the operational phase of the development.	-	■ Ensuring compliance with national and international best practice guidance; ■ Encouraging opportunities to minimise waste; ■ Providing good on-site storage practices; ■ Providing suitable waste receptacles for the segregation of waste streams for recycling and general waste for disposal to landfill; ■ Provision of adequate storage facilities and transport arrangements for any hazardous waste streams generated; ■ Dedicated personnel responsible for waste management issues	-

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Operational Phase	Generation and disposal of hazardous wastes produced from maintenance works and plant processes.	-	▪ Waste management practices to include control rules and procedures as indicated within the GER Appendix 4, including storage, treatment and disposal facilities and methods.	-
Soils, Geology and Contamination				
Construction Phase	Controlled/uncontrolled emissions associated with construction of PP-13, primarily the contamination from surface run-off to affect subsurface and surface water following rain events.	-	▪ Adhere to CEMP instructions to ensure good working practises are followed, thereby decreasing the risk of pollution incidents occurring.	-

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Construction Phase	Aqueous effluents including sanitary wastewater from temporary construction facilities, washing down, dust damping activities and concrete work may lead to the contamination of soil and potentially surface water.	-	■ There will be no discharge or overflow of sanitary waste on site. Modular wastewater storage tanks will be introduced to the site to provide adequate containment facilities for the construction workforce. ■ Adhere to CEMP instructions to ensure good working practises are followed, thereby decreasing the risk of pollution incidents occurring.	-

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Construction Phase	During construction, there is a potential for construction workers to come into contact with contaminated soils (sand) and hazardous materials at the site.	-	■ All identified contamination areas and hazardous waste (e.g.: chemical/fuel drums) will need to be appropriately removed and diverted to a licensed hazardous waste landfill site prior the development of the area. ■ There will be no discharge or overflow of sanitary waste on site. Modular wastewater storage tanks will be introduced to the site to provide adequate containment facilities for the construction workforce. ■ The key control measures incorporated into the CEMP to promote on-site environmental good practice during the construction process in relation to the storage of fuels, chemicals and oils on-site and relating to potential leaks and spills from on-site activities. ■ Ongoing evolution of the CEMP to ensure that all potential environmental and health and safety issues are adequately managed.	-

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Construction Phase	The improper storage and use of other hazardous materials may lead to spillages and leaks resulting in soil and/or surface water contamination.	-	▪ Hazardous materials such as fuel oils and chemicals used during the construction phase that have the potential to cause contamination will be managed through the CEMP (thought to be the responsibility of the EPC contractor). This CEMP would provide detailed Environmental Control Plans for construction workers and personnel and sub-contractors including personnel safety, site conduct, security, storage of hazardous material and emergency preparedness.	-

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Operational Phase	During operation of the plant the key contamination issues are associated with potential leaks and spills associated with the plant operations and storage of hazardous materials on-site. Such materials include: fuels, oils, lubricants and chemicals, e.g. hydrochloric acid.	-	■ Implementation of key operating procedures set out within the OEMP ■ Hazardous chemicals and materials will be appropriately stored on-site in a secure, bunded compound on an impervious surface. ■ Storage areas will be clearly labelled with material safety data sheets (MSDS) maintained as part of the on-site record keeping. ■ Please refer to **Chapter 9 – Soil, Geology and Contamination** and/or **Chapter 18 – Framework OEMP** for a detailed list of mitigation measures.	-
Terrestrial Ecology				

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Construction Phase	Site clearance and grading will impact on certain habitats present within the site. Potential contamination, general human activity and sand erosion may all contribute to the disturbance of flora and fauna present on site.	-	■ Where significant site levelling and re-grading is expected, the productive top surface layer should be removed separately and either spread back within the site once the re-grading has been completed, or spread on the adjacent environment. ■ Wastes from construction must be adequately managed in terms of a waste management regime so that the waste does not end up in the terrestrial environment. ■ During construction, unnecessary movement of machinery around the site should be avoided where possible. ■ Vehicles carrying potentially toxic, friable materials such fly ash, should be covered at all times so that these materials are not accidentally deposited into the natural environment, causing harm to flora and fauna. ■	-
Operational Phase	Any site landscaping may promote significant growth of plants which will in turn provide a habitat for invertebrates and birds, potentially increasing the overall biodiversity of the site.	-	■ There is the potential to include areas of site landscaping as it could promote significant growth of plants which will in turn provide a habitat for invertebrates and birds, potentially increasing the overall biodiversity of the site	-

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Water Resources and Wastewater				
Construction Phase	Increased volume and rate of storm water run-off and erosion could cause changes to the drainage regime, resulting in on-site flooding and ponding within the Project site.	-	■ To protect the environment from flooding a localised run-off management system will be employed by the Contractor. This should comprise temporary surface water run-off facilities, which in addition to containing contaminants will provide on-site attenuation for surface water flows thereby reducing flood risk.	-
Construction Phase	Sanitary wastewater generated onsite during construction activities	-	■ Best practice measures for the management of sanitary liquid wastes generated during the construction phase are provided within the CEMP. ■ Sanitary wastewater will be stored within an underground septic tank onsite. This wastewater will be regularly collected by sewage tankers for disposal at a Riyadh Municipality wastewater treatment plant.	-
Construction Phase	Potential for contaminated waters to be released to the environment, resulting in contamination of soil and groundwater	-	■ Adequate infrastructure should be installed on the construction site for the collection and storage of all contaminated wastewaters generated during the construction phase e.g. plant washdown water or chemical wastewater streams. The wastewater must then be collected by a suitably qualified and PME approved hazardous liquid waste contractor. ■ Duty of care records should be maintained for all potentially contaminated wastewater throughout the construction phase. Alternatively, these wastewater streams may be discharged to a temporary evaporation pond for neutralisation.	-

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Construction Phase	The potential for controlled and uncontrolled emissions associated with the construction of the PP-13 facility which could result in contamination of groundwater e.g. from existing soil contamination, which if present could be mobilised through site construction activities and surface water runoff during the infrequent periods of rainfall	-	■ Mitigation measures with respect to the potential for the contamination of the soil and groundwater in the event of any accidental spillages or leaks associated with collection, storage and collection are dealt with comprehensively in **Chapter 9 – Soils, Geology and Contamination**.	-
Operational Phase	Generation and disposal of oily and chemical wastewater		■ Ensure that waste oil is collected by an approved contractor for recycling at a waste oil refinery rather than disposal. If it is not practical to recycle the waste oil it must be stored on site and collected for disposal by a PME accredited hazardous waste contractor. ■ Other process wastewater, including chemical wastewater will be discharged to an evaporation pond following on site treatment.	-

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Operational Phase	Generation of Treated Sanitary Wastewater Effluent		■ Sanitary wastewater from the PP-13 facility will be treated on site to meet water quality standards of PME and national wastewater resuse standards. ■ Sewage sludge will also be generated from the sanitary wastewater treatment process. The impact of sanitary wastewater sludge can be mitigated by ensuring that a large quantity of the sludge is reused for beneficial purposes, such as fertilizer. The option of having the sludge collected by a fertilizer company should be considered in preference to sending the sludge to landfill.	-

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Operational Phase	Increased pressure on local water resources due to an increase in water demand	-	■ The facility will ensure the on-site treatment and reuse of sanitary wastewater. ■ In addition to this it is also recommended that potable water reduction measures be implemented in the final design such as water efficient faucets, urinals, showerheads and toilets.	-
Operational Phase	Alteration of ground levels and introduction of additional areas of impermeable hardstanding will result in alterations to local drainage patterns. Stormwater generated and captured may contain small quantities of contaminants.	-	■ Run off and storm water will be collected via sloping areas towards drainage ditches; specifically along roadsides. In addition, roof drainage will be graded to slope towards drainage ditches. Concrete trenches will steel grating and concrete pipes may supplement onsite drainage of areas where necessary. Storm water will be diverted to a separate storm water collection facility. ■ Sludge or other solid wastes arising from storm water catchments or collection and treatment systems may contain elevated levels of pollutants and should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long term sustainability of water and land resources.	-
Socio Economic Issues				

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Construction Phase	Construction worker welfare e.g. health and safety at work,	-	■ Construction activities undertaken for the proposed PP-13 facility will be managed in such a way as to minimise construction impacts through the Construction Environmental Management Plan (CEMP) to be developed by the EPC) and allow nearby settlements to comment on any concerns that they may have, throughout the construction phase.	-
Construction	Construction worker welfare e.g. reasonable working hours, wages and other benefits.	-	■ The EPC contractor must establish a Human Resources Policy which will be communicated to employees with information including, but not limited to, their rights under national labour and employment laws, salary, and other associated information, such as medical care and insurance. The Human Resources Policy will ensure an approach of non-discrimination is followed with equal opportunities for all. No child labour or forced labour will be used for the proposed facility	-

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Construction Phase	Public health risk (to construction workers accommodation) including noise and dust nuisance from construction activities.	-	■ Construction activities undertaken for the proposed PP-13 facility will be managed in such a way as to minimise construction impacts through the Construction Environmental Management Plan (CEMP; to be developed by the EPC) throughout the construction phase. ■ In common with Performance Standard 2, on site medical facilities must be made available throughout the construction phase for the use of workers. Trained health and safety and first aid personnel must be identified to workers as part of their training schedule. ■ Suitably qualified personnel must be chosen for potentially hazardous activities such as for the installation and testing of specialist electrical equipment. ■ Appropriate action must be taken for outbreaks of illnesses amongst workers, minimising the transmission as far as is possible.	-
Construction Phase	Noise impacts associated with construction activities within 110m of the main worksite.	-	■ **Chapter 7 – Noise and Vibration** sets out a series of controls to reduce the noise impacts during construction which will reduce the impacts of noise during construction.	-
Construction Phase	Impacts on local businesses e.g. generation of opportunities and reqards for the local population of nearby Dhurma.	+	■ No mitigation measures are considered necessary.	+

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Construction Phase	Direct and indirect opportunities for various support service providers including guards, catering etc.	+	▪ No mitigation measures are considered necessary.	+
Construction Phase	The influx of professional workers may cause some social and cultural tensions in the community.	-	▪ Ensure staff are provided with cultural sensitivity training to minimise the possibility of such tensions arising and ensure that there is a proper grievance and/or complaints system in place where members of the community may raise these type of issues with the Project Company.	-
Operational Phase	Health and safety impacts upon operational workers.	-	▪ To provide the employees with a safe and risk free environment, it is recommended that a comprehensive EHS plan is developed and implemented. This framework, in line with Performance Standard 2, will address measures for accident prevention, identification, mitigation and management of hazards (including physical, chemical, and radiological hazards), training of workers and reporting of accidents and incidents.	-

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Operational Phase	Detrimental impacts upon the nearby farming and camp operations due to increased noise, emissions, traffic and increased levels of activity.	-	■ Local farmers/residents of the camps will be able to consult directly with the plant operators, via the nominated Environmental Co-ordinator (as appointed by the EPC), and to raise any concerns and/or grievances. Such issues are to be addressed within a clearly defined procedural context.	-
Operational Phase	Air quality impacts upon human health resulting from exceedances of NOx during the highly unlikely event that all three power plants were required to operate under emergency or abnormal conditions	-	■ Ambient air quality monitoring will be undertaken continuously on site during all operating conditions, the results of which will be reviewed regularly to ensure compliance with PME/WHO standards and ensure that workers present within the Project site, and adjacent power plants are not adversely affected.	-
Operational Phase	The influx of professional workers, labourers, and other staff members into the area will generate economic opportunities and rewards for the local population of Dhurma, enhancing social and economic development.	+	■ No mitigation measures are considered necessary.	+

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Operational Phase	Indirect opportunities for various support service providers including guards, cleaners, catering and other site management will provide employment and a further source of income for these services.	+	■ No mitigation measures are considered necessary.	+
Operational Phase	Increased pressure on local services due to the presence of additional employees	-	■ No mitigation measures are considered necessary.	-
Cultural Heritage and Archaeology				
Construction & Operational Phase	Given that the proposed site is located in a barren flat gravel/sand plain, and due to the lack of any above ground features it is thought unlikely that any archaeological and/or cultural remains and artefacts exist on the site.	-	Should any potential artefacts and/or resources be ■ discovered at any time, now or in the future, it is ■ beholden on all responsible parties to ensure that ■ works are curtailed immediately and experts ■ consulted. Additionally, it is recommended that an ■ 'archaeological watching brief' is undertaken ■ during the relevant stages of the development, ■ such as during site preparation.	-
Landscape and Visual				

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Construction Phase	During the construction phase, mobile equipment, including large cranes, bulldozers, etc. will be present on the site.	-	■ It is not considered that any mitigation measures will be required.	-

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Operational Phase	The proposed PP-13 will be visible during the operational phase, a minimum stack height of 60m will be designed for considerable visibility, including a continuously flashing light.	-	▪ The surrounding area is a remote and isolated desert landscape. It is considered that the visual impact on the areas will be minimal and no mitigation will be required.	-
Traffic and Transportation				

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Construction Phase	The transportation of materials to and from the site during the construction phase together with the removal of waste will represent an increase over normal traffic levels on the local roads.	-	■ Good working practices are encouraged on-site within the CEMP.	-
Construction Phase	Transportation of workers to and from the Project site will result in an increase in traffic levels within the local road network.	-	■ As the majority of workers will be housed on site, this will significantly reduce the number of vehicle movements required during the construction phase.	-
Construction Phase	Ground compaction due to heavy vehicle movements which could damage underground services or existing road network	-	■ Temporary roads and signages will adhere to Ministry of Communications 'Workzone Traffic Control Handbook.	-
Operational Phase	The impact upon the local road network associated with personnel travelling to and from the site.	-	■ Where possible, operational traffic should be scheduled during off-peak traffic times; ■ Waste collection will be scheduled to minimise journeys at peak times; ■ A designated Traffic Coordinator will be assigned to the Project and will be required to prepare and implement a Traffic Plan. The Traffic Plan will be informed by a Traffic Survey which will include physical examination of the routes, carriers and support activities that could impact the movement of materials and equipment.	-

Project Phase	Description of Impact	Significance	Mitigation	Residual Impact
Operational Phase	Contamination/spill events during transportation on and off site of hazardous materials such as ASL and Sludge from the sludge holding tank associated with each STG and solid sanitary wastes	-	■ The transportation of any waste that could represent a hazard to the environment will be undertaken according to legal requirements to minimise the risk of accidental spillage or Accidents.	-

17 Framework Construction Environmental Management Plan

17.1 Purpose of the CEMP

This chapter proposes a framework for pollution control and best practice measures that should be adopted during the construction phase of the Riyadh PP-13 facility in order to avoid, minimise, or offset likely impacts in the areas on and surrounding the site that are attributable to the project.

It is recommended that the mitigation requirements set out within this Framework Construction Environmental Management Plan (CEMP) chapter will be included in full within any Project Environmental, and Health and Safety (EHS) Plan or CEMP established by the construction contractor and other associated standalone documents where relevant.

The updated Project EHS Plan or CEMP will therefore provide a logical extension of the EIA process and will ensure that recommendations contained within the ESIA are implemented, assuring that the Riyadh PP-13 does not deviate from the environmental and social profile that formed the basis of this document.

In a similar vein the Project EHS Plan or CEMP will serve to ensure that requirements of the General Environmental Regulations (GER, 2006) and, where relevant, the IFC Operational Standards and Guidelines are also met and serve as a clear and auditable indication as to how those requirements are implemented during the construction phase.

The primary objective of the Project EHS Plan or CEMP will be to provide a clear direction on the requirements of the construction contractor and all subcontractors in their activities: each requirement is measurable and enforceable; hence any non-compliance can be identified and addressed swiftly.

The objectives of the Project EHS Plan or CEMP are defined as follows:

- Prescribe an overall management structure with clearly defined accountabilities and responsibilities;
- Ensure an environmental management structure responsible for implementing the relevant measures within the Framework CEMP;
- Ensure adequate and relevant environmental induction training for all contractors and subcontractors (including construction workers);
- Incorporate Emergency Planning into the management system;
- Stipulate a programme of deliverables, meetings, audits, communication protocols and reporting requirements to monitor and manage the construction works;

- Define objectives and targets for environmental and social management on the construction activities (these objectives and targets will be captured in the detailed Environmental Control Plans of the full Project EHS Plan or CEMP);
- Implement Mitigation Measures and Monitoring Programmes;
- Prescribe a mechanism for recording and reporting environmental and social concerns, improvement, complaints or incidents;
- Define the communications protocols for liaison with local communities and regulatory authorities on environmental and social matters;
- Ensure compliance with all regulatory requirements of the GER 2006 and with all IFC operational standards and Guidelines, where relevant; and
- Stipulate a mechanism for periodical review for the Project EHS Plan or CEMP.

17.2 International Standards for Organisation: ISO 14001 Model

One of the most widely used environmental management systems, developed by the International Standards Organization (ISO), is the ISO14001 standard for environmental management of activities. The standard provides a logical framework within which to prepare and develop the Project Environmental Health and Safety Plan and subsequent formal EMS (if applicable). The structure of a typical EMS certified to ISO 14001 is shown in **Figure 17-1**:.

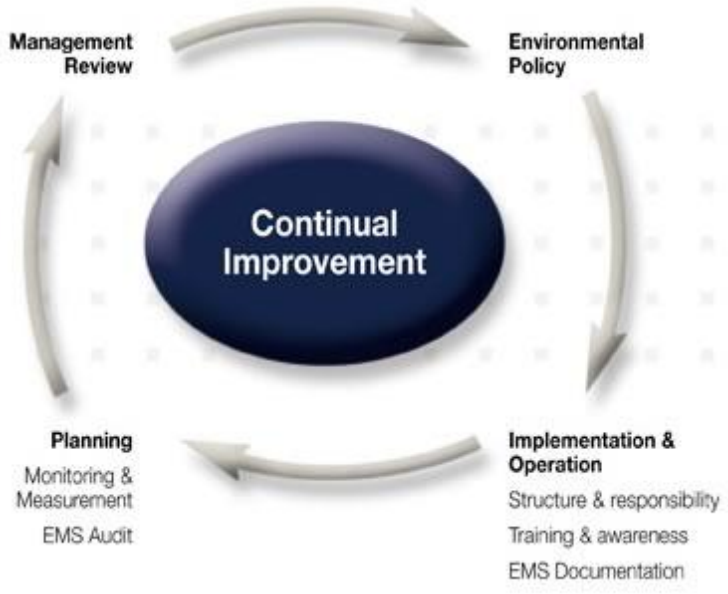


Figure 17-1: ISO 14001 Structure

17.3 CEMP Implementation

17.3.1 Resources, Roles, Responsibility

Environmental governance will be clearly set out and maintained as a stand-alone document by the Construction Project Director for the duration of the project. This structure will be agreed prior to and during the construction phases. Although individual sub-contractors may have adequate controls in place when reviewed independently, the Construction Project Director is the lead contractor for EHS in the proposed scheme and has the authority to update, replace or approve them as appropriate to ensure its responsibilities are met.

These relationships will be set out in an organisational chart which will be supported by a more detailed description of the roles and responsibilities of the organisations such as Construction Project Director, Site Manager, Site EHS Manager, Subcontractors Site EHS representatives etc. All construction teams with a significant project involvement should be consulted as part of the development process.

Clear roles and responsibilities for internal staff will also be specified for the construction phase which will include responsibility for both environmental as well as health and safety issues. The definition of roles and responsibilities is an important part of environmental governance and allows for discreet management of tasks and involvement throughout the project team.

It is everyone's responsibility to ensure that the Project EHS Plan or CEMP policies and applicable Client's procedures are adhered to.

17.3.2 Training and Induction Procedure

Competence, training and awareness are critical to the effective implementation of the Project EHS Plan or CEMP, and therefore all site personnel and visitors must attend an EHS induction course which includes environmental awareness in order to gain an understanding of the environmental aspects and associated environmental mitigation measures related to the construction phase.

An Induction and Training Procedure will be developed to cover aspects of training involving those personnel and activities likely to have a significant effect on the environment, including: Induction Training for New Site Personnel including General Site Induction, Supervisors Site EHS Training, Visitor Induction and Toolbox Talks.

In addition, the Project EHS Plan or CEMP will be updated in order to include Specialist Training for individuals with specific roles and responsibilities, including but not limited to: Chemical and fuel handling, Hot Work, Handling or organic solvents, Handling of toxic materials etc.

17.3.3 Environmental Incident Procedure

A site specific emergency procedure for all foreseeable eventualities that pose significant risks to site personnel, local communities and the environment will be developed and will need to be implemented and adequately communicated to all involved parties during the construction phase of the project. These emergency plans will be supported by planned simulated training exercises in order to test their robustness and practicability.

17.3.4 CEMP Compliance

The Project EHS Plan or CEMP will set out how the compliance of construction activities will be periodically inspected and audited through:

- Routine inspections:
  - Areas Supervisor's Weekly Inspections;
  - Site Managers Weekly EHS Tour;
  - Site EHS Managers Inspections; and
  - Routine daily Surveillance Inspections.
- EHS Audits:
  - Subcontractor Audits, undertaken within the first month of the arrival of the subcontractor, then subsequently on a 6 monthly basis;
  - EHS Road map Self-Assessment;
  - EHS Road map Verification Assessments; and
  - Internal Site Audits.
- Client and Third Party Audit.

17.3.5 Non-conformances Management Procedure

Any deviations from the Project EHS Plan or CEMP identified by site personnel or other parties through formal site inspections, audits, visual observations or other mechanisms, would need to be documented and associated corrective action and preventative action implemented by competent individuals in order to mitigate the environmental impacts and to prevent re-occurrence.

17.3.6 Complaints Management Procedure

A Complaint Procedure will be established in order to effectively address all complaints received by the project management team and construction contractor; outlining roles and responsibilities, and timeframes for investigation and resolution of complaints.

17.3.7 Environmental Review Procedure

A review of any Project EHS Plan or CEMP will be required in order to ensure that all requirements of this Framework CEMP are included and to ensure continual improvement, suitability and effectiveness of the overall management system.

17.3.8 Environmental Control Plans

Specific Environmental Control Plans (ECP) detailing mitigation measures which must be implemented during the construction phase of a project in order to minimise potential environmental and social impacts. This will include as minimum all mitigation measures identified within the ESIA.

Typically the structure of an ECP will be as follows:

1. Environmental Impacts;
2. Responsibilities;
3. IFC Guidelines;
4. Standards; and
5. Environmental or Social Issue(s):
    a. Objective;
    b. Target;
    c. Responsibilities;
    d. Mitigation measures;
    e. Monitoring Activities;
    f. Reporting; and
    g. Records Management.

17.4 Environmental Aspects and Mitigation Measures

An assessment of construction activities will be conducted to determine the significant environmental aspects and resulting impacts, taking into consideration normal, abnormal and emergency operation, together with the location of the sensitive receptors identified.

The environmental aspects will be determined and ranked based on an approved methodology, which will be consistent with the ISO 14001:2004 Standard for Environmental Management Systems and detailed within the Project EHS Plan or CEMP.

Each contractor and sub-contractor will be required to undertake their own review of the Environmental Aspect Register, which includes the potential environmental impacts of the project during the construction phase. This sets out the construction activities where mitigation measures will be implemented. They will also be required to use the same approach provided in the methodology detailed within the Project EHS Plan or CEMP to determine the significance of any new aspects and impacts resulting from a new construction activity if the methodology differs significantly from what has been assumed in advance of the appointment of the construction contractor. This will therefore identify any additional environmental aspects and impacts which would need to require additional mitigation measures.

The ESIA has identified the following aspects that require control during the construction phase:

- Air Quality;
- Noise and Vibration;
- Solid Waste Management;
- Social Aspects (including construction workers welfare and local communities);
- Soils, Geology and Contamination;
- Terrestrial Ecology Management;
- Water Resources and Wastewater;
- Traffic and Transportation;
- Landscape and Visual; and
- Cultural and Archaeology.

17.4.1 Air Quality

Mitigation Measures by construction activities

- Stockpiling of friable materials
  - Minimize stock pile heights (circa. 3m);
  - Pile surfaces will be as smooth as possible to reduce wind erosion. An irregular pile surface will create turbulence that aggravates dust;
  - When reclaiming from stockpiles, loaders will work on the lee side (sheltered side) of the pile where its activity is sheltered from the wind;
  - Stockpiled materials shall be covered with tarpaulin type materials to prevent wind blowing off dust from these areas; and
  - Good housekeeping to make sure that unnecessary stockpiled waste material does not accumulate and become airborne pollution.

- Vehicle movement
  - Vehicles and vessels carrying loose aggregate should be covered at all times;
  - Vehicles should not be overloaded while transporting sand, as this may lead to spillage and littering of roads;
  - Keep vehicles equipment as free from dust as possible; and
  - Make sure tailgates of trucks are secured properly to prevent spillage of aggregate and clean up spillages immediately;
  - Temporary site roads and any unpaved areas will be watered to avoid excessive dust. The frequency of watering will be determined by weather conditions (wind, humidity, temperature) and the erodibility of the soil;
  - Existing roads to be utilized to the maximum extent;
  - The contractors will ensure that adequate supply and storage of water is available on site for dust suppression;
  - Speed of vehicles will be restricted to 15 km/h along the temporary site roads and any unpaved areas of the site to avoid creating excessive dust;
  - Fencing of construction area to prevent external vehicle movement on site;
  - Any machinery which is intermittent in use will be shut off during periods of non-use, or if not practical to be throttled back to a minimum;
  - Washing of vehicle tyres to prevent dust emissions during movement outside the Project site; and
  - Provision of covers on vehicles transporting soil or other loose materials.
- Unpaved Roads
  - New direct access roads would be constructed providing clearly designated haul routes;
  - Existing tracks would either be compacted and/or water sprayed;
  - Designated working corridors would assist in controlling the routes for vehicle access across the site and reducing airborne dust;
  - Regular non-potable water spraying (dust suppression) of the haul roads with water sprinklers;
  - Regular inspection and, if necessary, cleaning of surrounding roads to check for dust deposits (and removal if necessary);
  - Keep speed limit to 15km/hr on site, with signs erected to this effect; and
  - Paving of roads will stop dust emissions from these surfaces, which has already been undertaken for the site access road.

- Materials handling
  - Operators must exercise caution to maintain minimum height for dropping of aggregate materials;
  - Loader operators should be trained to avoid overfilling their bucket and spilling aggregate on the carry over to the trucks; and
  - Operators must be trained to observe potential problem conditions. For example, the loader takes a cut from a pile just to see how dusty it is. If it looks like a problem, wet the pile down.
  - Grading
  - Grading of material is potentially a source of dust. It is envisaged that such operations will not generally be undertaken during periods of high wind and will be subject to stringent application of dust suppression sprays.
- Cement batching
  - On-site cement and concrete batching, where required, will be undertaken in suitable areas, with wind shielding to avoid wind-blown dry cement.
- Exposed areas
  - Plant naturally occurring (endemic), desert adapted trees and shrubs around the perimeter of the site to act as a wind and dust screen;
  - Do not remove any existing site vegetation unless absolutely necessary; and
  - Cover exposed dust generating areas with shade cloth materials until needed.
  - Climatic conditions
  - During extremely windy conditions, activities should be temporarily ceased to prevent excessive dust generation.
- Demolition
  - Dust suppression using spraying of treated water on land and buildings;
  - Water spraying will prevent dust generation due to demolition of buildings and other facilities;
  - Demolition to be avoided during high wind speeds; and
  - Screens to be provided for each demolition activity to prevent dust emissions to nearby receptors.
- Excavation
  - Spraying of water on the ground before excavation to moist the area and prevent dust emissions; and
  - Loading of materials into the trucks by excavators to be carried out from minimum height to prevent dust generation.

- Piling
  - Spraying of water on the ground before piling to moist the area and prevent dust emissions.
- Sand blasting
  - Barriers or protective screens to be installed around any sand blasting areas to avoid the dispersion of fugitive dust.
  - Sand blasting of materials, if required, to be conducted in offsite locations prior to shipment to site based on the feasibility.

Construction Vehicles and Plant Air Emissions

- Exhaust emissions from Vehicle and Machinery
  - Heavy machinery will be serviced prior to commencement of construction. Any emission filters or catalytic converters (in the case of petrol engines) will be tested for compliance with supplier's specifications. In the case of non-compliance, they will be replaced;
  - Motor vehicles and plant equipment are to be fitted with appropriate exhaust equipment to minimise emissions;
  - The contractor shall inspect the machinery, vehicles and vessels every morning for defects (indicator lights, oil leaks) and excessive emissions;
  - All vehicles and machinery including diesel power generators will be frequently maintained and serviced to manufacturer specifications with at least a major service every 6 months;
  - Clean fuel, i.e. low sulphur diesel will be used.
  - Black smoke will not be allowed from construction equipment.
  - Idling of vehicles will be avoided at site. Vehicles will be switched off when not in use.
  - Proactive liaison with the PME and local residents for any complaints;
  - All complaints pertaining to the construction vehicles and plant machinery will be recorded as well as immediate actions taken to rectify the situation;
  - Unnecessary journeys will be avoided;
  - The combustion of any waste materials including waste oils on site will not permitted under any circumstances;
  - When possible the use of mains powered electrical equipment should be used in preference to using generators to provide power; and
  - Ensure limited escape of gases during maintenance works.

Gaseous Substances

- Gaseous Hazardous Substances
  - These substances must be appropriately stored with the necessary warning signage, in accordance with the MSDS;
  - Personnel using such substances must be trained in the safe handling of such substances; and
  - Personnel must be provided with the necessary safety equipment to protect against any possible harmful emissions.

17.4.2 Noise Management

General

- It is recommended that regular noise monitoring is undertaken within close proximity of noise sensitive locations, especially if future works include activities which are known to cause significant levels of noise;
- In order to control the duration of noise and vibration from the construction activities, no noise from the works will be audible at the application site boundary of any occupied residential property outside the hours of:
  - Saturday to Wednesday 08:00 - 18:00
  - Thursday 08:00 - 13:00; Or
  - No working on Friday or Public Holidays.
- If noise exceeds the required standards the use of acoustic screens or noise attenuation measures will be implemented (refer to standards below);
- Stationery machinery such as generators must be kept in enclosed structures for noise control during the night;
- Items of plant on site operating intermittently will be shut down in the intervening periods between uses;
- Electrically powered plant should be preferred, where practicable, to mechanically powered alternatives. All mechanically powered plant should also be fitted with suitable silencers;
- Proper PPE to be provided to all personnel working in high noise areas;
- Appropriate breaks to be provided to personnel working in high noise areas;
- High noise sign boards to be placed in high noise areas such as piling, excavation, cutting, grinding, etc.

Backfilling

- Backfilling activities will be restricted to day time hours.

Excavation and material handling

- Loading of materials into the trucks by excavators to be carried out from a minimum height to prevent high noise; and
- Excavations to be restricted to day time hours.

Piling

- Piling activities to be conducted during the day time;
- Use of vibratory hammer rather than impact hammer to reduce noise levels;
- High frequency vibrator hammer to be used rather than low frequency based on the type of piling; and
- Moveable acoustic sound barrier for the hammer and piling equipment to be provided near to receptors such as accommodation and other facilities.

Cutting, bending and welding

- Cutting of steel rods and other building materials to be conducted in separate areas; and
- Machinery used for cutting to be adequate to ensure low noise generation.

Sand blasting

- Sand blasting, if required will be conducted during day time and in closed environment with temporary noise barriers.

Vehicle movement

- Speed restriction of 15 kmph to be enforced on internal roads to minimise noise from vehicle movement;
- Vehicle movement and delivery of materials will be avoided at night time (6pm to 6am) to ensure minimum disturbances to the nearby receptors;
- Vehicle deliveries will be organised in order to avoid pile of delivery trucks leading to high noise levels; and
- Deliveries will be routed so as to minimise disturbance to nearby communities. Delivery vehicles will be prohibited from waiting within or near the site with their engines running. The movement of heavy vehicles during the night will be avoided wherever practical.

Construction equipment

- Noise from vehicles, machinery and equipment used on site will not exceed the manufacturer's specifications, based on the installation of adequate noise reduction systems;
- Equipment and machinery will be regularly serviced to ensure that they are kept in good condition, with attention given to muffler maintenance and noise reduction systems;

- Noisy equipment and machinery will be replaced with less noisy alternatives or provide equipment that is specifically designed with noise inhibitors, such as generators and compressors with silencers and muffled jackhammers;
- Acoustic covers and barriers must be used on all machine engines that generate excessive noise levels;
- Any machinery will be shut off during periods of non-use or, if not practical to do so, will be throttled back to a minimum; and
- Where possible, ensure that operation times of noisy equipment, machinery and activities are carried out during daytime hours.

17.4.3 Solid Waste Management

The aim of the proposed mitigation measures during the construction phase is to ensure adherence to the waste management hierarchy of the '3 Rs': "Reduce – Reuse – Recycle", and to present procedures for the correct segregation and disposal of the waste streams. Waste streams will be collected by locally registered waste contractors and transferred to appropriately licensed waste facilities for recycling or disposal. A chain of custody relating to the waste will be implemented with the aim of ensuring the waste is handled and disposed of correctly by suitable qualified contractors.

Non Hazardous Solid Waste Management

Waste Storage

- Damage to materials from incorrect storage will be avoided;
- Loss, theft, or vandalism will be avoided through secure storage and on-site security;
- Effective segregation of waste streams will be undertaken to facilitate onsite reuse and offsite recycling where possible;
- Construction workers will be informed and trained with regards to waste minimisation throughout toolbox talks;
- Dedicated containers for segregated waste streams for reuse/recycling/disposal will be located under cover on an impermeable hardstanding surface and will be located at strategic locations in the onsite compound;
- These containers will be stored in a covered and enclosed area when practicable to provide protection from the elements and scavengers;
- Dedicated skips for any residual construction waste that requires off-site disposal will be located under cover on an impermeable hardstanding surface in a designated area. Key waste streams will include any excavated soil from building foundations and waste chemicals / oils will be located in the on-site construction compound;

- Waste storage on site will be in designated and appropriately signed area(s). Skips will be clearly labelled to specify the waste streams which can be recycled or disposed of;
- Waste that is generated during construction will be classified as hazardous or non-hazardous and stored appropriately;
- Domestic solid waste generated within workers accommodation areas will be stored in specified areas prior to removal and disposal by the specifically appointed waste management sub-contractor;
- Food waste will be collected and stored within an allocated skip and disposed of by a specifically appointed waste management sub-contractor; and
- Storage practices will be implemented across the site in order to ensure that any wastage is kept to a minimum.

Waste Minimisation and Waste Recycling

- Over ordering will be avoided;
- Ordering standard lengths rather than lengths required will be avoided;
- Ordering for delivery at an inadequate time (update programme regularly) will be avoided;
- Conventional dry recyclable materials (paper, cardboard, plastic etc.) will be either reused on site or removed by licensed contractors for recycling;
- The following dry recyclable materials will be reused or recycled; Glass, papers and cardboard, metals (other than aluminium), aluminium, organic waste and plastic could be recycled;
- Containers will be suitably marked and stored in a covered and enclosed area to ensure that the weather and/or scavengers cannot access them;
- Recyclable materials will be collected by recycling contractors registered with the PME;
- Excavated material from the construction activities will be reused for backfilling and other activities, wherever possible;
- Welding rods will be used to the maximum extent prior to disposal only certified welders will be employed for welding purposes;
- Metal waste from cutting will be reused on site to the maximum extent possible;
- Waste metal scrap will be collected in separate bins or skips and disposed to waste metal recyclers;
- Leftover concrete after casting will be reused for the construction of temporary works;
- Where possible, materials will be ordered in bulk to reduce packaging;
- Suppliers will be requested to use minimal packaging or take back packaging such as plastic drums;

- Dedicated skips for segregated waste streams for re-use/recycling will be located under cover on an impermeable hardstanding surface in the onsite construction compound(s);
- Dedicated skips for any residual construction waste that requires off-site disposal will be located under cover on an impermeable hardstanding surface. Key waste streams will include any excavated soil from building foundations and waste chemicals / oils will be located in the on-site construction compound;
- Suppliers will be required to reduce surplus packaging associated with any construction raw materials; particularly common packaging materials such as plastics (shrink wrap and bubble wrap), cardboard and wooden pallets. This will also involve improved procurement and consultation with selected suppliers regarding commitments to waste minimisation, recycling and the emphasis on continual improvements in environmental performance;
- Concrete/cement will be purchased from local ready mix works, where possible, to allow materials to be generated in close proximity to the site, thereby allowing for 'just-in-time' resource ordering and minimising transport costs associated with haulage of raw and finished or semi-finished products;
- Material deliveries will be efficiently planned in order to avoid damage to the materials and the unnecessary generation of waste;
- Coordination between local contractors and suppliers will be effective in order to avoid the excessive purchase of raw materials and to prevent the risk of materials being lost, stolen or damaged;
- Handling and storage of delivered materials will be effective in order to prevent loss or damage through exposure to the weather, mud and onsite vehicles through:
  - Ensuring well-timed deliveries to the site;
  - Providing on-site security; and
  - Installing temporary site security fencing.
- Conventional wastes (paper, cardboard, plastic etc.) will be either reused by approved firms or removed from site by licensed contractors preferably for recycling;
- Any construction waste materials will be reused where feasible, for example, timber and other scrap material representing commercial value shall be separated and stored in a segregated area prior to reuse or recycling (including selling of products to third parties);
- Damage during unloading operations will be avoided through careful handling;
- Damage to materials from incorrect storage or handling will be avoided;
- Temporarily site security fencing will be installed; and
- On-site 24h security will be provided and together with temporary site security fencing.

Waste Handling and Transport

- Damage during unloading operations will be avoided;
- Delivery to inappropriate areas of the site will be avoided;
- Acceptance of incorrect deliveries, specifications or quantities will be avoided;
- PME approved certified waste contractors will be sourced in order to regularly remove the separated waste streams;
- All relevant consignments of waste (waste manifests) for disposal or recycling will be specify: type, destination and name of the carrier. This will indicate whether the waste is to be treated, recycled or disposed of to a landfill site and discharge liability from the waste producer by ensuring that disposal activities are in accordance with local regulations;
- On site waste auditing at each stage of the construction process is required as part of the audit programme in order to develop and to allow reporting on waste management targets and to ensure that the Project EHS plan or CEMP is being adhered to;
- The segregated materials for recycling will be collected on an agreed basis with a local waste recycling contractor;
- The construction contractor will perform biannual inspection of all waste management facilities for their areas of assignment and based on this audit, contracts will be renewed or rejected;
- Industrial / domestic waste containers will be checked prior to leaving the Riyadh PP-13 site to ensure that:
  - The waste containers are clean on the outside, sealed, and not leaking;
  - The required forms for wastes and other documents required for shipment are completed and correct; and
  - Waste separation will be undertaken by staff wearing suitable PPE such as gloves and dust masks.

Waste Disposal

- All non-hazardous waste generated on site, if it is not suitable for reuse either on site or off-site, must be disposed of at a landfill site, which is licensed by PME;
- A licensed waste management contractor will be appointed for all removal of waste from site and delivery to the PME licensed landfill; and
- Collection of all non-hazardous construction waste will be undertaken at least daily.

Staff Training

- Training will be provided to educate all construction workers regarding best practice waste management practices and recycling initiatives, and to encourage more sustainable working practices. Emphasis will be placed on the waste minimisation hierarchy: “Reduce, Reuse, and Recycle”;
- All workers will be provided with a comprehensive induction awareness program outlining which wastes must be segregated in adequately labelled containers;
- Specific PPE and training will be provided; and
- PPE must be worn by employees at all times.

Hazardous Waste Management

Identification

- All identified contamination areas, generated by historical or existing incidents and hazardous waste (e.g. chemical/fuel drums) will need to be appropriately stored, removed and diverted to a licensed hazardous waste landfill site prior the development of the area.

Storage

- The construction contractor will nominate EHS representatives to manage hazardous wastes on site. These individuals will be responsible for ensuring the correct placing, construction, maintenance and housekeeping of the hazardous waste storage areas;
- Accurate record keeping of hazardous waste types and amounts will be undertaken. This will take place on a monthly basis or as new hazardous waste stream is produced. The following information shall be kept up to date for each hazardous waste stream:
  - Name and description of the hazardous waste stream;
  - Classification (e.g. code, class or division) of the hazardous waste stream;
  - Quantity of the hazardous waste stream produced per month;
  - Characteristic(s) of the hazardous waste stream(e.g. flammability, toxicity);
  - Hazardous Waste Responsibility Details; and
  - Inventory of all hazardous wastes on site, which should be updated daily. This should be available for Emergency crews in case of an event.
- Any waste fuels, oils and chemicals will be stored separately in a bunded compound situated on an impermeable surface in order to prevent any potential spillage and contamination issues prior to collection for appropriate disposal;
- Storage areas will be clearly marked and signed with regard to the quantity and hazardous characteristics of the hazardous waste streams materials stored therein;

- Hazardous wastes will be stored in a container which has sufficient strength and structural integrity to ensure that it is unlikely to burst or leak in its ordinary use;
- Any unused materials, spent containers, contaminated clothing, rags and tools will be returned to a central compound, where practicable, for appropriate disposal;
- For liquid hazardous waste streams, the waste container will be situated within a secondary containment system which will satisfy the following requirements:
  - It must have a capacity of not less than 110% of the container's storage capacity or, if there is more than one container within the system, of not less than 110% of the largest container's capacity or 25% of their aggregate capacity, whichever is the greater;
  - It must be positioned, or other steps must be taken, so as to minimise any risk of damage by impact so far as is reasonably practicable;
  - Its base and walls must be impermeable to water and oil;
  - Its base and walls must not be penetrated by any valve, pipe or other opening which is used for draining of the system; and
  - If any fill pipe, or draw off pipe, penetrates its base or any of its walls, the junction of the pipe with the base or walls must be adequately sealed to prevent hazardous wastes escaping from the system.
- Each individual drum, package or container will be clearly labelled. Internationally recognised warning signage shall be used to indicate the hazards of the individual hazardous waste materials;
- Where any drum is used for storage in conjunction with a drip tray as the secondary containment system, it is sufficient if the tray has a capacity of not less than 25% of:
  - The drum's storage capacity; or
  - If there is more than one drum used at the same time with the tray, the aggregate storage capacity of the drums.
- Incompatible hazardous wastes will be segregated and stored separately. For example, flammable liquids and other organics must be segregated from acidic and caustic materials;
- Where there is risk of a spill of hazardous wastes, a spill control, prevention, and countermeasure plan will be established as a specific component of the Site Emergency Preparedness Plan;
- Storage areas will be constructed such that any spillage or loss of containment of a particular hazardous waste type cannot spread to other material types. This is particularly important where flammable materials are involved;
- Covered plastics containers will be provided in the first aid area (for waste syringes, suturing kits and needles) and also clearly identified bagging for infectious or contaminated items;

- Containers holding hazardous wastes will be clean, in good condition, not leaking, and compatible with the waste being stored within;
- Regular inspection and maintenance of storage areas including drums, vessels, pavements and bunds will take place;
- The stated maximum capacity of waste storage areas will not be exceeded; and
- There will be vehicular and pedestrian access at all times to the whole of the waste storage area such that the transfer of containers is not reliant on the removal of impediments which may be blocking access, other than drums in the same row.

Handling

- Staff members will be assigned to manage hazardous wastes on site, to make sure that hazardous wastes are handled in the correct manner in order to reduce the risk of accidents;
- Prior to commencing work involving handling waste materials, all personnel will be familiar with the relevant hazardous properties and instructed on the relevant emergency plan;
- Personnel will wear appropriate PPE according to the type of hazardous waste they are working with;
- The use of drip trays for liquid hazardous waste will be compulsory in order to contain any spills;
- Any spillage of fuel or oils waste into the marine environment will be efficiently contained with oil booms and pumps will be readily available to pump out any spillages; and
- Emergency procedures will be put in place in case of spills.

Transportation

- Contractors responsible for transporting hazardous wastes from the site will be suitably qualified and possess a license from the PME to perform such work;
- The vehicles will be in a good condition and will be suitable for the material being conveyed;
- A transportation document will be created in order to establish a chain-of-custody, using multiple signed copies to demonstrate that the hazardous waste stream has been transported and received by the disposal facility in the correct manner (such as intact, non-leaking labelled containers, licensed transporter, correct handling);
- Employees involved in the transportation of hazardous waste will be trained regarding proper transport procedures and emergency procedures;
- Hazardous wastes will be labelled, and external signs on transport vehicles will be appended;
- Competent individual(s) will be available for emergency response on call 24 hours/day;
- Hazardous wastes will be transported outside of peak traffic hours;

- A material safety data sheet shall be filled in for each item of hazardous waste. These forms will be kept on record for at least 5 years following completion of the construction phase; and
- Any spillages during transport will be removed and disposed of in a manner decided by the PME and the Civil Defence.

17.4.4 Social Aspects

Construction Workers Welfare Management

The implementation of Project EHS Plan or CEMP will ensure that all health and safety guidelines for construction workers, personnel and sub-contractors are followed and any potential risk is mitigated and managed. The Project EHS Plan or CEMP will include detailed practices on undertaking safe work in relation to the following:

- The use of PPE will be mandatory;
- Control measures will be implemented with regards to the use and the storage of hazardous substances;
- A permit to work system for potentially hazardous work will be established;
- Control measures will be established in relation to:
  - Crane operation;
  - Working at heights;
  - Using scaffolding;
  - Using ladders and steps;
  - Barricading;
  - Electrical safety;
  - Welding, cutting and grinding;
  - Working in confined spaces;
  - Excavations; and
  - Working over and near water.
- Emergency response procedures will be developed;
- First aid procedures (including the provision of first aid kits);
- Provision of an ambulance service; and
- Disciplinary action for non-compliance.

Induction Training

- Environmental and health and safety induction awareness training will be mandatory for all personnel working on site. This induction awareness training will be provided in all cases prior to any commencement of any work on site;
- Specific employees will be assigned specific inspection responsibilities and given the authority to remedy any problems found, therefore specialist training will be according to the role and responsibilities of the personnel and education level of the workforce;
- The training will address safety, health, environmental and social matters;
- Further training will be held as required at appropriate intervals to reinforce the culture of environmental protection as per the work ethic; and
- Toolbox talks will be provided throughout the construction works to address specific issues such as dewatering, waste management, storage and transport of fuels and chemicals, etc.

Water, Washing and Toilet Facilities

- Provision will be made for employee facilities including shelter, toilets and washing facilities;
- Toilet facilities supplied by all contractors and subcontractors for the workers shall have a minimum ratio of 1 toilet per 25 workers;
- Sanitation facilities will be located within 100m from any point of work;
- All temporary / portable toilets will be secured to the ground in order to prevent them toppling due to wind or any other cause;
- Combinations of urinal and pan type units will be considered;
- These facilities will be maintained in a hygienic state and serviced regularly;
- Toilet paper and toilet hoses will be provided in sufficient quantity;
- The sanitary waste subcontractor(s) shall ensure that spillage do not occur when the toilet are cleaned or emptied and the contents are removed from the site;
- Discharge of waste from toilets into the environment and burying of waste will be strictly prohibited;
- Wash areas will be placed and constructed in such a manner so as to ensure that the surrounding areas which include groundwater and coastal water are not polluted;
- Water from kitchens, showers, sinks etc. will be discharged into a septic tank for removal from site by a specialist contractor; and
- All contaminated water, contaminated run-off or effluent will be disposed of by an appropriately licensed contractor and at a site approved by the PME.

Building Materials

- All components of and infrastructure associated with the project will be constructed in accordance with industry best practice and by qualified engineers;
- All materials used in the construction of working areas will not represent any possibility for occupational or environmental hazards; and
- All materials used will be structurally safe and will provide adequate protection against all climatic conditions. They will also be fire resistant where required and free from asbestos, CFCs or any other dangerous substance.

Flooring

- In order to prevent accidents, floors will be well maintained, not contain holes and/or present any features that may lead to slips or falls;
- All surfaces, structures and fittings will be easy to clean and maintain and not allow for the accumulation of hazardous or unhygienic compounds; and
- All floors will be fitted with non-slip coverings.

Ventilation

- Sufficient quantities of fresh air will be available within enclosed working areas and ventilation systems will be well maintained to ensure good working order;
- Vents will not measure less than 1/10 of the floor area for each work station. Empty areas per worker will measure at least 11.5m^3;
- All vents within the facility will be adequate for the activity taking place and will be in good working order;
- Adequate provision of fans will be required, with a minimum of 1 fan per 20m^2; and
- Protection from dust, smokes, gases, vapours and other harmful respirable substances will be provided. Adequate air suction systems will be installed and appropriate PPE in the form of face masks, will be provided at all times.

Heat Stress

- The ambient indoor temperature within all areas used by the employees will be maintained at an adequate level during working hours;
- Careful ratios of temperature and humidity will be calculated according to each work task in order to specify working hours per activity;

- Safe drinking water will be readily available throughout the site and the labour camp at all times. This may be in the form of bottled water, or drinking fountains, located at strategic points within all areas. Depending on the weather conditions and accommodation standards, at least 180 litres per person; and
- Provisions will be made for adequate shaded areas to allow respite from direct sunlight.

Infectious Disease Control

- The design of on-site catering facilities will be in accordance with the internationally accepted Hazard Analysis Critical Control Point (HACCP) standards in order to prevent the transmission of food-borne bacterial or viral diseases;
- The building site and the labour camps will be adequately drained to avoid the accumulation of stagnant water; and
- Appropriate action will be taken for outbreaks of illnesses amongst workers, minimising the transmission as far as is possible. These measures may involve quarantine areas.

Medical Services

- On site medical facilities and ambulance services will be made available throughout the construction phase for the use of workers;
- Trained health and safety and first aid personnel will be identified to workers as part of their training schedule;
- First Aid stations and adequate equipment will be easily reachable throughout the site; and
- Where necessary, eye wash stations and emergency showers will be installed near to areas for which emergency flushing is the recommended first aid treatment, for example in areas where hazardous liquids are used.

Terms of Employment and Working Conditions

- Human Resource representative(s) will communicate to all employees the details of their working conditions as dictated by the Saudi Labour Law 2005, and terms of employment including wages, benefit allowances, overtime payment arrangement, sickness leave allowances, paternity and vacation allowances, and internal grievance mechanism; and
- Human Resources representative(s) will ensure that subcontractors adhere to these principles.

Labour Camps

- A monthly Hygiene and Sanitation Inspection audit will be undertaken by competent individuals, and a Hygiene and Sanitation Inspection Report will be subsequently be produced. This will include reporting on the cleanliness (good/fair/poor) of various aspects of the workers accommodation areas and includes, e.g.:

- Potable Water;
- Kitchen Areas;
- Canteen;
- Toilet Areas; and
- Waste Management.

Rooms and dormitories will be designed with the below specifications:

- Rooms/dormitories will be kept in good condition;
- Rooms/dormitories will be aired and cleaned at regular intervals;
- Rooms/dormitories will be built with easily cleanable flooring material;
- Sanitary facilities will be located within the same buildings and provided separately for men and women;
- Density standards are expressed either in terms of minimal volume per resident or of minimal floor space. Usual standards range from 10 to 12.5 cubic metres (volume) or 4 to 5.5 square metres (surface);
- A minimum ceiling height of 2.10 metres will be provided;
- In collective rooms, which are minimised, in order to provide workers with some privacy, only a reasonable number of workers are allowed to share the same room. Standards will range from 2 to 8 workers;
- All doors and windows wil be lockable, and provided with mosquito screens where conditions warrant;
- There will be mobile partitions or curtains to ensure privacy;
- Every resident will be provided with adequate furniture such as a table, a chair, a mirror and a bedside light; and
- Separate sleeping areas will be provided for men and women, except in family accommodation.

Sleeping arrangements and storage facilities will be as follows:

- Separate bed for each worker will be provided;
- There will be a minimum space between beds of 1 metre;
- Double deck bunks are not advisable for fire safety and hygiene reasons, and their use will be minimised. Where they are used, there must be enough clear space between the lower and upper bunk of the bed. Standards range from to 0.7 to 1.10 metres;
- Triple deck bunks will be prohibited;
- Each worker will be provided with a comfortable mattress, pillow, cover and clean bedding;
- Bed linen will be washed frequently and applied with repellents and disinfectants where conditions warrant;

- Facilities for the storage of personal belongings for workers will be provided. Standards vary from providing an individual cupboard for each worker to providing 475-litre big lockers and 1 metre of shelf unit; and
- Separate storage for work boots and other personal protection equipment, as well as drying/airing areas will need to be provided depending on conditions.

Sanitary and toilet facilities will be as follows:

- Sanitary and toilet facilities will be constructed of materials that are easily cleanable;
- Sanitary and toilet facilities will be cleaned frequently and kept in working condition;
- Sanitary and toilet facilities will be designed to provide workers with adequate privacy, including ceiling to floor partitions and lockable doors;
- Sanitary and toilet facilities will be not shared between men and women, except in family accommodation;
- An adequate number of toilets will be provided to workers. Standards will range from 1 unit to 15 persons to 1 unit per 6 persons. For urinals, usual standards are 1 unit to 15 persons;
- Toilet facilities will be conveniently located and easily accessible. Standards will range from 30 to 60 metres from rooms/dormitories;
- Toilet rooms will be located so as to be accessible without any individual passing through any sleeping room. In addition, all toilet rooms will be well-lit, have good ventilation or external windows, have sufficient hand wash basins and be conveniently located. Toilets and other sanitary facilities will in the same building as rooms and dormitories;
- Shower/bathroom flooring will made of anti-slip hard washable materials;
- An adequate number of handwash facilities will be provided to workers. Standards will range from 1 unit to each 15 persons to 1 unit per 6 workers. Handwash facilities will consist of a tap and a basin, soap and hygienic means of drying hands;
- An adequate number of shower/bathroom facilities will be provided to workers. Standards range from 1 unit to 15 persons to 1 unit per 6 persons;
- Showers/bathrooms will be conveniently located; and
- Shower/bathroom facilities will be provided with an adequate supply of cold and hot running water.
- Canteen, cooking and laundry facilities arrangements will be as follows:
- Canteen, cooking and laundry facilities will be built in adequate and easy to clean materials;
- Canteen, cooking and laundry facilities will be kept in a clean and sanitary condition;
- If workers can cook their own meals, kitchen space will be separated from sleeping areas;
- Adequate facilities for washing and drying clothes will be provided;

- When work clothes are used in contact with dangerous substance (for example, application of pesticide), special laundry facilities (washing machines) will be provided;
- Canteens have a reasonable amount of space per worker. Standards range from 1 square metre to 1.5 square metres;
- Canteens will be adequately furnished. Standards will range from providing tables, benches, individual drinking cups, plates, drinking fountains;
- Places for food preparation will be designed to permit good food hygiene practices, including protection against contamination between and during food preparation;
- Kitchens will be provided with facilities to maintain adequate personal hygiene including a sufficient number of washbasins designated for cleaning hands with clean, running water and materials for hygienic drying;
- Wall surfaces adjacent to cooking areas will be made of fire-resistant materials. Food preparation tables will also be equipped with a smooth durable washable surface. Lastly, in order to enable easy cleaning, it is good practice that stoves are not sealed against a wall, benches and fixtures are not built into the floor, and all cupboards and other fixtures and all walls and ceilings have a smooth durable washable surface;
- All kitchen floors, ceiling and wall surfaces adjacent to or above food preparation and cooking areas will be built using durable, non-absorbent, easily cleanable, non-toxic materials;
- Adequate facilities for cleaning, disinfecting and storage of cooking utensils and equipment will be provided.
- Food waste and other refuse will be to be adequately deposited in sealable containers and removed at least daily from the kitchen in order to avoid accumulation;
- Food provided to workers will contain an appropriate level of nutritional value and will take into account religious/cultural backgrounds;
- Food will prepared by competent cooks. It is also best practice that meals are planned by a trained nutritionist.

Medical Facilities arrangement will be as follows:

- A number of first aid kits adequate to the number of residents will be available;
- First aid kits will be adequately stocked. A 24/7 first aid service/facility will be available;
- An adequate number of staff/workers will be trained to provide first aid; and
- Where possible and depending on the medical infrastructure existing in the nearby community, other medical facilities will be provided such as: nurse rooms, dental care, minor surgery).

Leisure, social and telecommunication facilities arrangement will be as follows:

- Basic collective social/rest spaces will be provided to workers. Standards will range from providing workers multi-purpose halls to providing designated areas for radio, TV, cinema;
- Recreational facilities will be provided. Standards will range from providing exercise equipment to providing a library, swimming pool, tennis courts, table tennis, educational facilities;
- Workers will be provided with dedicated places for religious observance if the context warrants; and
- Workers will have access to public phones at affordable/ public prices (that is, not inflated).

Staff Management

- An appointed person with the adequate background and experience will be in charge of managing the workers' accommodation;
- Depending on the size of the accommodation, there will be a sufficient number of staff in charge of cleaning, cooking and of general maintenance;
- Such staff will be recruited from the local communities where possible;
- Staff will receive basic health and safety training;
- Persons in charge of the kitchen are trained in nutrition and food-handling and adequately supervised;
- Charging fees for accommodation and services arrangement will be as follows:
  - If fees are charged, workers will be provided with clear information and a detailed description of all payments made such as rent, deposit and other fees;
  - When company housing is considered to be part of workers' wages, workers will be provided with an employment contract clearly specifying housing arrangements and regulations, in particular rules concerning payments and fees, facilities and services offered and rules of notice;
  - When fees are charged, the renting arrangements will be fair and do not cost the worker more than a small proportion of income and will never include a speculative profit;
  - Food and other services will be free or are reasonably priced, never above the local market price. and
  - The provision of accommodation or other services by employers as a payment for work will be prohibited.

Security of worker's accommodation will be as follows:

- Security staff will have been checked to ensure that they have not been implicated in any previous crimes or abuses. Where appropriate, security staff from both genders will be recruited;
- Security staff will have a clear mandate and will have received clear instruction about their duties and responsibilities, in particular their duties not to harass, intimidate, discipline or discriminate against workers;
- Security staff will have received adequate training in dealing with domestic violence and the use of force;

- Security staff will have a good understanding about the importance of respecting workers' rights and the rights of the communities;
- Body searches will be only allowed in specific circumstances and are performed by specially trained security staff using the least-intrusive means possible. Pat down searches on female workers can only be performed by female security staff;
- Security staff will adopt an appropriate conduct towards workers and communities;
- Workers and members of the surrounding communities have specific means to raise concerns;
- Accommodation, catering services and utility provisions will meet internationally accepted standards. Workers quarters will be designed with adequate room to avoid overcrowding. This is a vital component of effective management of workers facilities in order to minimise the transmission of diseases, particularly respiratory diseases;
- All tanks used for the storage of drinking water will be constructed and covered as to prevent water stored therein from becoming polluted; the drinking water quality will be regularly monitored against WHO drinking water standards;
- Wastewater, sewage, food and any other waste materials will be segregated and adequately stored. Specific containers for rubbish collection will be provided and emptied on a regular basis. Standards range from providing an adequate number of rubbish containers to providing leak proof, non-absorbent, rust and corrosion-resistant containers protected from insects and rodents;
- Pest extermination, vector control and disinfection will be carried out throughout the living facilities in compliance with local requirements and/or good practice. Where warranted, pest and vector monitoring will be performed on a regular basis;
- All accommodation buildings will be fitted with well-maintained and tested fire detectors, alarm systems and automatic fire fighting equipment;
- Manual fire-fighting equipment will be provided and stored in a readily accessible area; and
- Adequate means of escape in the event of a fire will be provided.

Non-Discrimination and Equal Opportunities

- All decisions undertaken in relation to employees must be in such a way that does not reflect judgment based on a personal characteristic of an individual. Emphasis will be placed on developing employment relationships based on equal and fair opportunity; and
- All aspects of employment, including working conditions, training provision, employment termination, promotion or disciplinary procedures, will be undertaken in a consistent manner, without bias or discrimination.

Management of Staff Withdrawal and Retrenchment

- The construction contractor will develop an effective plan to ensure that withdrawal of staff is undertaken in a phased manner, and which will mitigate any detrimental impacts on workers (and the local community) in the event of imminent redundancies. Adequate notice will be provided where possible, and consultations with workers, organisations and, where appropriate, the Saudi Government, will be undertaken to ensure any job losses are handled in compliance with local law.

Grievance Mechanism

- The construction contractor shall ensure that a Grievance Mechanism for all workers is fully implemented, in order for workplace concerns to be raised, dealt with effectively and within the shortest possible time. Protocol for reporting a grievance must be set out by the construction contractor and communicated to all staff, including sub-contractors staff, during the induction awareness training process. Sufficient resources at a management level will be provided to allow prompt response to any grievances, whilst ensuring that feedback to employees is transparent and does not result in retribution;
- Most routine complaints and grievances will best resolved informally in discussion with the worker's immediate line manager. When a grievance cannot be resolved informally it will be dealt with under the procedure outlined below;
  - Right to accompaniment: Individuals have the right to be accompanied through the grievance proceedings by a fellow employee or worker of their choice. It will not normally be reasonable to be accompanied by anyone:
    - In a position of authority over the employee;
    - Involved in part of the case;
    - Required to give evidence;
    - Who may have a conflict of interest in undertaking such a role; or
    - Whose presence may prejudice the hearing.
  - Standard grievance procedure: If an individual wishes to raise a grievance relating to his employment with the construction contractor or with the sub-contractors firm, then the following procedure will be followed:
    - The employee will put their grievance into writing to the relevant line manager and / or HR Department. If the grievance relates to his manager, then they will forward their grievance in writing to the next appropriate manager;
    - The line manager (or next appropriate manager) or HR manager will reply following receipt of the employee's written grievance, inviting the employee to attend a meeting to discuss the grievance;
    - If appropriate, the employee may bring a colleague to the meeting (as discussed above); and

- Following the meeting, the line manager (or next appropriate manager) or HR manager will respond verbally and in writing, setting out the company's response to the grievance and notify the employee of his right of appeal if the employee is not satisfied with the company's procedure.

– Appeals Procedure: If the employee wishes to appeal against the company's decision, they must appeal to the named individual in the grievance outcome letter within 10 working days of receiving the company's written response. The following procedure will then be followed:

- The employee will be invited to attend an appeal meeting;
- Following the appeal meeting, the employee will be advised of the decision in writing; and
- The decision is final.

Forced or Child Labour

- No persons under the age of 18 will be permitted to undertake dangerous work; and
- No forced labour is permitted on the site. This may involve any work or service which is not voluntarily undertaken and whereby the individual is under threat of force or penalty. This is to include any indentured, bonded or similar labour-contracting arrangements.

17.4.5 Contamination

Hazardous Materials Management

Sourcing of Hazardous Materials

- The procurement manager will look at substitution of any hazardous substances with safer alternatives and limit the quantities of hazardous substances during the construction process to reduce the risk of spillages.

Storage

- The construction contractor and nominated staff members will have responsibility to ensure the correct management of hazardous materials on site. These individuals will be responsible for ensuring the correct placing, construction, maintenance and housekeeping of the hazardous materials storage areas, in addition to provide toolbox talks and training on the control of substances and informing relevant employees of all control measures, health and safety issues and location of spill response equipment on-site;
- The storage area will be designed as to prevent damage to containers by any means, the unauthorized use of material and contain any spillage from hazardous materials (e.g.: by the use of an impermeable surface and walls).
- Types, nature, characteristic of the hazardous materials will be recorded on site, and available to all personnel;

- The unauthorised use of hazardous materials will be prevented by requiring a responsible person to sign materials in and out of a compound;
- Where practicable, substances during the construction process will be retained in a central controlled storage compound in accordance with World Bank guidance and appropriate risk assessment based on the material safety data sheet provided by the supplier;
- Storage areas will be clearly marked and signed with regard to the quantity and hazardous characteristics of the materials stored within;
- The storage areas will be designed in order to prevent damage to containers by any means and the unauthorized use of material.
- Hazardous materials will be stored in a container which is sufficient strength and structural integrity to ensure that it is unlikely to burst or leak in its ordinary use;
- The container will be situated within a secondary containment system;
- Any valve, filter, sight gauge, vent pipe or other equipment ancillary to the container (other than a fill pipe or draw off pipe or, if the oil has a flashpoint of less than 32oC a pump) will be situated within the secondary containment system;
- Where a fill pipe is not within the secondary containment system, a drip tray will be used to catch any spills when the container is being filled;
- Each individual drum, package or container will be clearly labelled. Internationally recognised warning signage shall be used to indicate the hazards of the individual hazard materials;
- Where any drum is used for storage in conjunction with a drip tray as the secondary containment system, the drop tray will have a capacity of not less than 25% of:
  - The drum's storage capacity; or
  - If there is more than one drum used at the same time with the tray, the aggregate storage capacity of the drums;
- Incompatible, hazardous materials will be segregated and stored separately. For example, flammable liquids and other organics must be segregated from acidic and caustic materials;
- Where there is risk of a spill of hazardous materials, responsible parties will prepare a spill control, prevention, and countermeasure plan as a specific component of the Site Emergency Plan;
- Storage areas will be constructed such that any spillage or loss of containment of a particular hazardous material type cannot spread to other material types. This is particularly important where flammable materials are involved;
- The storage area will prevent damage to containers by any means;

- Covered plastics containers will be provided in the first aid area (for syringes, suturing kits and needles) and also clearly identified bagging for infectious or contaminated items;
- Containers will be stored in such a manner that leaks and spillages cannot escape over bunds or the edge of the sealed drainage areas;
- Regular inspection and maintenance of storage areas including drums, vessels, pavements and bunds will be undertaken;
- The stated maximum capacity of storage areas will not be exceeded;
- The use of hazardous substances during the construction process will be reviewed and when feasible decreased in order to reduce the risk of spillages;
- There will be vehicular and pedestrian access at all times to the whole of the storage area such that the transfer of containers is not reliant on the removal of impediments which may be blocking access, other than drums in the same row; and
- Washout from concrete mixing plant or from cleaning ready-mix concrete vehicles is highly alkaline. This will not be allowed to enter the marine environment and will be re-used on site where possible or stored appropriately and removed by a licensed contractor to a PME approved facility.

Handling

- All identified contamination areas will need to be appropriately removed and diverted to a licensed hazardous waste landfill site prior to the development of the area;
- Work methods will be updated if the production or release of potentially contaminative materials occur;
- All vehicle/plant re-fuelling will be closely supervised and appropriate spill trays utilised where appropriate;
- Competent staff member(s) will be assigned to manage hazardous materials on site, in order to ensure that that hazardous materials are handled in the correct manner to reduce potential accidents;
- Prior to commencing work involving handling materials, all personnel will be familiar with the relevant hazardous properties and instructed on what to do in case of an emergency and location of spill response equipment on-site;
- Personnel must wear appropriate PPE according to the type of hazardous materials they are working with;
- Machinery will be situated on sealed surfaces to prevent contamination of soil and groundwater below with oils, chemicals or fuels;
- Use of drip trays will be compulsory to contain spills;
- Vehicle and plant refuelling will be closely supervised and spill trays utilised;
- Refuelling areas and hazardous materials usage areas must be set back at least 50m from any water drainage system;

- All vehicle/plant re-fuelling will be closely supervised;
- The use of potentially hazardous material will be away from high risk areas;
- Enclosing the process or handling system as far as reasonably practicable; and
- Emergency procedures will be put in place in case of spills.

Fixed tanks

- Any fixed tank used for storing oil shall satisfy the following requirements:
- Any sight gauge will be properly supported and fitted with a valve which must be closed automatically when not in use;
- Any fill pipe, draw off pipe or overflow pipe will be positioned, or other steps must be taken, so as to minimise any risk of damage by impact so far as is reasonably practicable;
- Fixed tanks will be adequately protected from physical damage;
- Fixed tanks will have adequate facilities for detecting any leaks;
- If fitted with a leakage detection device which is used continuously to monitor for leaks, the detection device will be maintained in working order and tested at appropriate intervals to ensure that it works properly;
- If not fitted with such a device, Fixed tank must be tested for leaks before it is first used and further tests for leaks must be performed, in the case of pipes which have mechanical joints, at least once in every 5 years and, in other cases, at least once in every 10 years;
- Fixed tanks will be adequately protected against corrosion;
- Fixed tanks will be fitted with an automatic overfill prevention device if the filling operation is controlled from a place where it is not reasonable practicable to observe the tank and any vent pipe;
- Where Hazmat is delivered through a flexible pipe which is permanently attached to the container;
  - The pipe must be fitted with a tap of valve at the delivery end which closes automatically when not in use;
  - The tap or valve must not be capable of being fixed in the open position unless the pipe is fitted with an automatic shut off device;
  - The pipe must be enclosed in a secure cabinet which is locked shut when not in use and is equipped with a drip tray or the pipe must have a lockable valve where it leaves the container which is locked shut when not in use; and
  - Be kept within the secondary containment system when not in use.

Any pump will be:

- Fitted with a non-return valve in its feed line;
- Positioned, or other steps must be taken, so as to minimise any risk of damage by impact so far as is reasonable practicable; and
- Protected from unauthorised use.

Mobile Bowsers

- Any mobile bowser used for storage must satisfy the following requirements:
- Any tap or valve permanently fixed to the unit through which oil can be discharged to the open will be fitted with a lock and locked shut when not in use;
- Where oil is delivered through a flexible pipe which is permanently attached to the unit:
  - The pipe must be fitted with a manually operated pump or with a valve at the delivery end which closes automatically when not in use;
  - The pump or valve will be provided with a lock and locked shut when not in use; and
  - The pipe must be fitted with a lockable valve at the end where it leaves the container and must be locked shut when not in use.

Transportation

- Contractors responsible for transporting hazardous materials to the site will be suitably qualified and possess a license from the PME to perform such work;
- The vehicle will be in a good condition and will be suitable for the material being conveyed. Compartments must also be cleaned prior to being filled;
- A transportation document will be created to establish a chain-of-custody using multiple signed copies in order to demonstrate that hazardous materials have been transported and received by the disposal facility in the correct manner (such as intact, non-leaking labelled containers, licensed transporter, correct handling);
- The volume, nature, integrity and protection of packaging and containers used for transport will be appropriate for the type and quantity of hazardous material and modes of transport involved;
- Employees involved in the transportation of hazardous materials will be trained regarding proper transport procedures and emergency procedures;
- All hazardous materials to be transported will be labelled and external signs on transport vehicles will be appended;
- Competent individual(s) will be available for emergency response on call 24 hours/day;
- The transportation of hazardous materials outside of peak traffic hours will be forbidden; and

- Any spillages during transport will be removed and disposed of in a manner decided by the PME and the Civil Defence.

Emergency Preparedness and Response

- Procedures for the handling of hazardous materials will be established ij order to ensure quick and efficient responses to accidents that may result in injury or environmental damage;
- An detailed Emergency Preparedness and Response Plan supporting will be developed as soon as possible to cover:
  - Informing the public and emergency response agencies;
  - Documenting first aid and emergency medical treatment;
  - Taking emergency response actions;
  - Reviewing and updating the emergency response plan to reflect changes and ensuring that the employees are informed of such changes;
  - Emergency Equipment: The plan should include procedures for using, inspecting, testing, and maintaining emergency response equipment; and
  - Training: Employees should be trained in any relevant procedures.
- Where there is risk of a spill of uncontrolled hazardous materials, the construction contractor will prepare a spill control, prevention, and countermeasure plan as a specific component of their Emergency Preparedness and Response Plan. The plan will be tailored to the hazards associated with the Project, and includes:
  - Training of operators on release prevention, including drills specific to hazardous materials as part of emergency preparedness response training;
  - Implementation of inspection programs to maintain the mechanical integrity and operability of pressure vessels, tanks, piping systems, relief and vent valve systems, containment infrastructure, emergency shutdown systems, controls and pumps, and associated process equipment;
  - Preparation of written Standard Operating Procedures (SOPs) for filling containers or equipment as well as for transfer operations by personnel trained in the safe transfer and filling of the hazardous material, and in spill prevention and response;
  - SOPs for the management of secondary containment structures, specifically the removal of any accumulated fluid, to ensure that the system remains structurally intact;
  - Identification of locations of hazardous materials and associated activities on an emergency plan site map;

- Documentation of availability of specific personal protective equipment (PPE) and training needed to respond to an emergency;
- Documentation of availability of spill response equipment sufficient to handle at least initial stages of a spill and a list of external resources for equipment and personnel, if necessary, to supplement internal resources; and
- Description of response activities in the event of a spill, release, or other chemical emergency including:
- Internal and external notification procedures;
- Specific responsibilities of individuals or groups;
- Decision process for assessing severity of the release, and determining appropriate actions;
- Facility evacuation routes; and
- Post-event activities such as clean-up and disposal, incident investigation, employee re-entry, and restoration of spill response equipment.

Contaminated Soil Handling

- Contaminated soil will be stored separately on hard standing area to prevent soil and groundwater /seawater contamination; and
- Contaminated soil will not be stored along with uncontaminated material and will be bunded and covered to prevent any run off.

Construction Equipment

- Vehicles and equipment will be regularly inspected and maintained to confirm they are not leaking or dripping;
- All stationary diesel and petrol operated construction equipment will have impervious drip trays placed beneath them during operation;
- Operators will also be instructed to notify their supervisors if there are any problems with their vehicles and equipment;
- Refuelling of construction equipment will only be carried out in designated areas not at machinery work locations, in order to avoid potential spills of fuel to the ground;
- Refuelling areas will be sealed to contain any spills or leaks that may occur and will be communicated to all site personnel by signs and notice boards; and
- Washing of vehicles to be undertaken in specific locations and wastewaters to be routed to separate holding tanks.

Fuel and Chemical Handling and Storage

- Fuels and chemicals must be stored on non-permeable surfaces with sufficient bund wall with a 110% capacity of the fuel tank or chemical;
- Diesel dispensing tanker to be used for refuelling construction equipment to the maximum extent possible;
- Fuel tanks and chemical storage area to be provided with covered roof;
- Reduce the quantities of hazardous materials (fuel) stored on site to minimum practical levels. Infrequently used chemicals will be ordered just before they are needed;
- Different types of chemicals will be stored separately according to their Material Safety Data Sheets (MSDS), in order to avoid adverse chemical reactions;
- Hazardous materials will be handled only by operators trained in spill response procedures; and
- All vehicle/plant re-fuelling will be closely supervised.

Piling

- Piling accompanied with hazardous drilling fluids will not be used; and
- Soil contaminated during piling activities to be removed and disposed of as hazardous waste through contractors authorised by the PME.

Sand Blasting

- Sand blasting areas will be concreted or provided with non-permeable membrane.

Painting areas

- Paint drums will be stored on non-permeable membrane / concrete flooring to prevent seepage into soil in case of accidental spillage; and
- Painting area will be concreted to ensure no contamination of soil in the area.

Concrete Batching

- Concrete agitator bowls and chutes must not be washed out to any stormwater system or roadways;
- All process waste water will be drained to a collection pit for recycling or disposed;
- Wastewater stored within the recycling system will be used at the earliest possible opportunity; and
- No discharges of used process water will be allowed to the stormwater drainage system or the marine environment.

General

- Water will not be extracted from any borehole installations for construction purposes;

- Domestic wastewater tanks will be regularly checked for leakages and emptied at periodic intervals;
- Maintenance workshops for construction equipment will to be concreted and placed with spill control systems;
- There will be no discharge or overflow of sanitary waste on site. Modular wastewater storage tanks will be introduced to the site to provide adequate containment facilities for the construction workforce; and
- Work methods will be updated in order to prevent the production or release of potentially contaminative materials.

17.4.6 Terrestrial Ecology Management

Site Ecology

- Unnecessary movement of machinery in undeveloped areas adjacent to the Riyadh PP-13 site will be avoided. Transport access ways will be designated to avoid damage to the existing natural vegetation;
- Construction activities will be limited to the proposed site and measures will be taken to avoid damage to adjacent areas; and
- Wastes from construction will be adequately managed in terms of a waste management regime so that the waste does not end up in the terrestrial environment. An adequately enforced waste management plan will also serve to reduce the attraction of pest species such as rats and flies to the site.

Threatened Species

- If sightings of any protected species are made in the vicinity of the site, the construction contractor will be informed immediately;
- Works will cease in that particular area until the animal has moved away;
- If the animal does not, or cannot move away, the construction contractor will then inform the PME and, where possible, organise relocations of these animals by a trained ecologist;
- Care will be taken not to inadvertently fence in these animals during site preparation periods;
- Ensuring that wastewater dumping does not occur on site will help to facilitate the natural movement of birds and animals away from the site before construction;
- Wastes from construction activities will be adequately managed in terms of a waste management regime so that the waste does not end up in the terrestrial environment. An adequately enforced waste management plan also serves to reduce the attraction of pest species such as rats and flies to the site;
- During construction, unnecessary movement of machinery around the site will be avoided where possible. Dedicated transport access ways will be designated to avoid damage to the existing natural vegetation.

Construction activities will be limited to the proposed site and measures will be taken to avoid damage to adjacent areas; and

- If there is any further significant site levelling and re-grading, the productive top surface layer will be removed separately and either spread back within the site once the re-grading has been completed, or spread on the adjacent environment. This will give seeds that exist in the top surface layer a chance to germinate.

17.4.7 Water Resources and Waste Water

Storm Water Run-Off and Erosion from the Construction Site

To protect the environment from flooding during heavy downpours, a localised run-off management system will be employed by the Contractor. This will include temporary surface water run-off facilities, which in addition to containing contaminants will provide on-site attenuation for surface water flows, thereby reducing the flood risk.

Best practice recommendations for the prevention of impacts associated with storm water runoff during the construction phase include the following controls:

- Areas where erosion may occur will be identified in order to ensure that they are appropriately protected by installing the necessary temporary and/or permanent drainage works as soon as possible;
- Any erosion channels which develop during the construction period will be suitably backfilled, compacted and restored to a proper condition;
- Where excavation takes place, the affected area will be properly stabilised to minimise erosion risk;
- Appropriate storm water management measures will be established in order to ensure that contaminants are not mobilised into the wider environment;
- Stormwater control measures to control sediment will include:
  - Use of silt screens;
  - In the case of high volumes of stormwater flows, retention must be provided;
  - All erosion protection measures have to be maintained on a continual basis.
  - Limit disturbance when excavating;
  - Install sediment fences prior to rain events;
  - Wash equipment in designated area, where wastewater will be diverted to a sump or holding tanks;
  - Place sands and soils stockpile behind a sediment fence;
  - Store all hard waste and litter in designated area(s); and

- Restrict vehicle movement to stabilised road access.

Generation of Sanitary Wastewater from Labour Camps and On-Site Facilities

- There will be no discharge or overflow of sanitary waste on site. Modular wastewater storage tanks will be introduced to the site to provide adequate containment facilities for the construction workforce;
- Sanitary wastes generated during the construction phase will be collected and disposed of by a licensed contractor;
- Wastewater storage tanks will be introduced to the site to provide adequate containment facilities for the construction workforce.
- Functional and well maintained sanitary facilities will be available on site at all times;
- Where there are temporary toilet facilities located on site, these will be placed on concrete bunds;
- Adequate removal of sanitary liquid wastes from temporary toilet facilities, in conjunction with periodic inspections will avoid any overflow and create a zero leakage site; and
- Removal of liquid sanitary waste from the septic system will be undertaken by a licensed waste management sub-contractor.

Potentially Contaminated Wastewater

- Any potentially contaminated water generated by construction activities including concrete washout and plant washdown water will be diverted to a sump or a holding tank;
- Any potentially contaminated wastewater will be removed by an appropriately licensed waste management sub-contractor; and
- A Chain of Consent System will be implemented to ensure that disposal of potentially contaminated liquid waste is correctly undertaken and delivered to the correct, allocated treatment and disposal facilities.

17.4.8 Traffic and Transportation Management

Internal Traffic Network

- Traffic must be kept to designated construction routes;
- Routes will be planned to be as direct as possible; and
- All drivers to the site will be provided with a site map and clear directions which indicates the correct access and exit routes.

External Traffic Network

- Traffic routes will avoid residential areas where possible;
- Where possible, construction traffic will be scheduled in off-peak traffic times and on well-maintained routes;
- Waste collection will be scheduled to minimise journeys at peak times;
- Appropriate traffic safety signage will be provided to warn the public of construction traffic where traffic merges with normal road traffic;
- Where appropriate, locally sourced materials will be utilised within the construction phase to minimise driving distances, and workers will be transported to site by bus to minimise external traffic;
- The loading capacities and clearances of existing connecting roads will require full consideration when undertaking transportation of materials to the site and vice-versa; and
- The access roads frequently used for the Riyadh PP-13 will be designed to incorporate sufficient width and load.

Traffic Safety

- All construction drivers will be trained in road and traffic safety, in order to improve driving standards and appropriate licensing of drivers;
- Trip durations will be capped to prevent excessive driving times and driver exhaustion e.g. construction driver rosters should be formulated;
- Routes and times of day will be avoided in order to reduce the risk of accidents;
- Speed control devices will be fitted to all construction trucks and monitoring of driver actions will be undertaken remotely;
- Communication and training amongst first aid workers to ensure that any traffic related incidents will effectively and efficiently dealt with;
- Appropriate warning signs and flag operators will be used to warn the public of any adverse driving conditions as a result of construction traffic;
- Regular maintenance of all construction vehicles and mobile machinery used on site will be undertaken, e.g. monthly, to ensure safe operation; and
- The transportation of any waste that could represent a hazard to the environment will be undertaken according to an agreed procedure to minimise the risk of accidental spillage or accidents.

17.4.9 Landscape and Visual Management.

Visual Disturbance

- Good site housekeeping will reduce the visual impact of the construction site.

17.4.10 Archaeology Management

Unexpected Archaeological Finds

- Toolbox talks concerning potential archaeological finds during earthworks will be provided to all construction workers;
- An archaeological watching brief should be kept in-case archaeological discoveries are made;
- Any finds or suspected evidence of archaeological and/or cultural materials must be immediately reported by any person/s involved to the construction contractor in the construction phase and all works must be stopped immediately, until further notice;
- The Ministry of Education (Deputy Ministry of Archaeology and Museums), Riyadh will be contacted immediately and a representative be requested to assess any find within 72 hours to determine the next steps. Contact details for Riyadh Museum for History and Archaeology are as follows:
  - King Saud Street, Al-Bathaa, Riyadh, Tel: +966 1 419 1210.
- Work in areas adjacent to the archaeological find area may continue, consistent with the detailed design, unless additional finds are found or suspected.

17.5 Monitoring Programmes

An environmental monitoring programme will be developed and implemented by the construction contractor as part of the Project EHS plan or CEMP.

The monitoring programme will include the ongoing review of emissions which will be reported to PME on an annual basis and more frequently if there are abnormal conditions (e.g. uncontrolled emissions or spillages) or changes which may affect the environmental quality of the emissions.

17.5.1 Waste Management

As part of the Project EHS or CEMP, all paperwork and records of waste management activities on-site will need to be maintained including records of off-site disposal to landfill as follows:

- SEC will maintain the following records and reports:

- Keep one copy of each transport document it has generated pending receipt of the signed copy from the facility designated in the document. It shall also keep the signed copy for at least 5 years as of the date of receipt of the waste by that facility;
- Retain copies of the results of all tests and analysis performed on the hazardous waste as well as copies of all pertinent reports, correspondence and documents for at least five years from the last date of handling of such waste;
- Submit to the PME an annual report on all hazardous waste generated during the year. Copies of such reports shall be retained for at least five years from the date of completion;
- Submit on demand to the PME or the agencies designated by it, all documents, records and reports related to the waste; and

- Hazardous Waste Transporters and Hazardous Waste Management Facilities are required have both a valid identification code and a work permit from the PME. The management at Riyadh PP-13 should maintain an up to date list of local contractors who can satisfy their requirements for the responsible handling and disposal of hazardous waste.

18 Framework Operational Environmental Management Plan

This chapter presents a Framework Operational Environmental Management Plan (OEMP), which aims to manage environmental impacts and, to a lesser degree, the health and safety risks that may arise during the operational phase of the Riyadh PP-13.

It is highly recommended that SEC prepare a full OEMP on the basis of this framework to ensure that all environmental controls, identified within this ESIA, are implemented. In this regard, an overall OEMP aims to bridge the gap between the completion of the ESIA and the full implementation of the operational phase of the project, with a key focus for implementing the mitigation measures as described within the ESIA in order to minimise disturbance to the surrounding environment and sensitive receptors.

The proposed OEMP approach is based on the management philosophy of the ISO 14001 Environmental Management System and OHSAS Occupational Health and Safety Assessment 18001 series; ensuring, therefore, that the environmental and health and safety requirements of the Riyadh PP-13 during its operational phase are not only planned, but that a robust mechanism for implementation is also ensured.

It is intended that this document provides a framework for the development of the full OEMP by SEC, which would be fully established in consultation with all stakeholders, and adequately implemented by the operator.

18.1 Aims and Objectives

An OEMP is a management tool used to ensure that undue or reasonably avoidable adverse risks of the operation of a project are prevented and that any positive effects are enhanced. The primary aim of the OEMP is to provide clear direction on the requirements of the operational management team in the conduct of the activities, where every requirement is measurable and enforceable, whilst any deviation can be identified and addressed swiftly.

The main purpose of the OEMP is:

- To ensure compliance with the General Environmental Regulations and Rules for Implementation in the Kingdom of Saudi Arabia (2006); IFC Performance Standards (2006); and IFC General Environmental, and Health, and Safety Guidelines (2007);
- To ensure that all mitigation measures detailed within the ESIA are adequately implemented;
- To verify environmental performance through information on impacts as they occur;
- To ensure that there is sufficient allocation of resources within the project budget so that the scale of the OEMP related activities are consistent with the significance of project impacts;
- To respond to changes in project implementation not considered in the ESIA; and

- To provide feedback for continual improvement in environmental and social performance.

18.2 Operational Environmental Management System

ISO 14001 provides a logical framework within which to prepare an OEMP, even for organisations not intending to obtain certification. If effectively implemented, the methodology detailed below would lead to:

- Compliance with legislative and other requirements;
- Pollution Prevention; and
- Continual Improvement.

An appropriate environmental management structure should be planned and agreed between all operating parties and the relevant regulatory authorities. The structure should allow for the effective implementation of the Environmental Management System (EMS) and the appropriate interaction with regulatory authorities.

Due regard should be paid to the building of relationships with regulators including the establishment of points of contact for planned monitoring and environmental assessment. These contacts will be useful to assist in developing a trusting and productive partnership that generates tangible benefits for environmental management.

In this regard SEC should seek to involve relevant stakeholders in the development and implementation of an environmental management system. These stakeholders may involve all parties from the client, PME and the local community.

18.3 Operational Environmental Management System Components

18.3.1 Planning Phase

Planning involves identifying and defining the various environmental aspects and associated environmental impacts that can result from the operational phase of the project. In the case of the Riyadh PP-13, the major potential environmental and social impacts are as defined through the ESIA. The planning phase would typically include the following requirements:

Environmental Policy

The development of an Environmental Policy would be aligned with other existing policies so that it can be adopted as part of 'business as usual', provided this policy meets the expectations of all stakeholders, including users and communities affected by the operational phase of the project.

The environmental policy will:

- Include a commitment from top management to continual Environmental, Health and Safety (EHS) improvement;
- Commit to setting objectives and targets for key operational areas;
- Be appropriate to the nature, scale and potential EHS impacts of its activities, products or services;
- Include a commitment to continual improvement of the management system, enhance health and safety controls and the prevention of pollution;
- Include a commitment to comply with relevant EHS legislation and regulations, and with other requirements to which the organisation subscribes;
- Provide the framework for setting and reviewing EHS objectives and targets;
- Be documented, implemented and maintained and communicated to all employees; and
- Be available to the public.

Environmental Aspects

The EMS will set out the detailed process for the identification of significant EHS aspects and assess the level of risk associated with each of those aspects, where a quantitative method would be used to determine the significance of aspects. Those which are significant must be included in the setting of objectives and targets.

All EHS aspects (significant or not) shall be documented in a register along with method statements regarding the assessment of significance; and aspects that are identified should be appropriate to the scale and nature of the activities that are relevant to the project. They will include any impacts that the organisation can be expected to have influence over.

Legal and Other Requirements

A site register will be compiled which details the relevant legislation that applies to EHS issues on site. This register will include an assessment of the key requirements of the legislation and set out the specific actions that must be undertaken to meet these requirements.

Where possible, further information sources should be specified or provided to staff should they need further guidance. Other obligations refer to the formal and informal obligations regarding the local community and society at large, including voluntary agreements.

Objectives, Targets and Programmes

A series of EHS objectives and targets should be developed which draw from the commitments of the EHS policy, the legal requirements placed upon the organisation and the significant aspects identified.

The objectives and targets will however be set in the context of technological scenarios that are available, the financial implications and the requirements of other stakeholders;

The organisation shall establish and maintain a programme for achieving its objectives and targets which shall include:

- Designation of responsibility for achieving objectives and targets at each relevant function and level of the organisation; and
- The means and time frame by which they are to be achieved.

If a project relates to new developments and new or modified activities, products or services, programme(s) shall be amended where relevant to ensure that sound environmental management practices are applied to such projects.

18.3.2 Implementation Phase

Implementation and operation is the heart of the environmental management function, because it is in implementation that the true efficacy of environmental management lies. Even the best planned environmental management approach will fail to achieve its desired outcome if the implementation of that planning is weak. Implementation and operation consists of two key components, namely: Management Structure, Roles and Responsibility; and Operational Control.

18.3.3 Management Structure, Roles and Responsibilities

Roles, responsibilities and authorities shall be defined, documented and communicated in order to facilitate effective environmental management. Management shall provide resources essential to the implementation and control of the EHS management system. Resources include human resources and specialised skills, technology and financial resources.

The organisation's top management shall appoint specific management representative(s) who, irrespective of other responsibilities, shall have defined roles, responsibilities and authority for:

- Ensuring the EHS management system requirements are established, implemented and maintained; and
- Reporting on the performance of the EHS management system to top management, for review and as a basis for improvement of the system.

18.3.4 Competence, Training and Awareness

There must be processes for the assessment of competence within the workforce and a documented system for managing competence and training records. Activities and competencies should be mapped to identify any shortfalls or areas of potential risk. This will comprise details of all training programmes pertinent to the core training processes, and schedules will be central to the success of the programme and should include:

- Document controls for training;

- Induction and toolbox talks;
- Training plans for management and specialist skills;
- Internal communication methods; and
- Management of external communication on environmental issues.

As a minimum, all staff are required to be aware of the Environmental Policy and the responsibilities they have with regards to contributing to this. In addition, staff with more specific roles may require more detailed environmental awareness training as set out in the training programme. Training records must be maintained appropriately including attendances and competency identification assessments.

18.3.5 Communication

The organisation shall establish and maintain procedures for internal communication between the various levels and functions of the organisation; receiving, documenting and responding to relevant communication from interested parties. Internal communication is important to:

- Raise staff awareness of the EHS management system;
- Inform staff of progress towards objectives and targets;
- Promote proactive participation in EHS activities, including feedback and ideas from staff on environmental management; and
- To allow effective action to be taken by qualified personnel if incidents occur.

The organisation shall establish and maintain information, in paper or electronic form, to:

- Describe the core elements of the management system and their interaction; and
- Provide direction to related documentation aspects.

18.3.6 Control of Documents

The operator would set out a detailed procedure in order to:

- Approve documents for adequacy prior to issue;
- Review and update as necessary and re-approve documents;
- Ensure that changes and the current revision status of document are identified;
- Ensure that relevant versions of applicable documents are available at point of use; and
- Ensure that document remain legible and readily identifiable.

18.3.7 Environmental Operational Control Plans

Operational controls are an essential part of the operational environmental management system as it is at the operational level at which many impacts can occur. It is therefore very important that the correct working procedures and protocols are developed and followed.

The operational controls should be documented where they address any significant environmental aspects identified at an earlier stage. This will include the discussion of mitigation procedures that should be addressed within these protocols. Each effect will be considered in terms of relevant legislation and guidance, potential impacts, sensitive receptors, baseline conditions and procedures and, where necessary, recommendations for further monitoring will be provided.

When considering the requirement for procedures to be documented and communicated, the following should be taken into account:

- Extent of environmental risk represented by activity(ies) under consideration;
- Potential for legal non-compliance and/or reputational impact to result;
- The number and turnover of people responsible for implementation of the procedure;
- The importance of ensuring a consistent approach to managing activities;
- The complexity and technical detail to be taken into account when managing an activity; and
- Value of documentation to communicate procedural requirements.

18.3.8 Emergency Preparedness and Response

The nature of the project requires that strong emergency procedures are put in place. The operational EHS will include an emergency management plan which will detail and maintain plans to identify the potential for, and the responses to major site incidents including equipment failures, natural phenomenon and major pollution incidents.

The organisation shall establish and maintain procedures to identify the potential for, and response to, accidents and emergency situations and for preventing and mitigating the environmental impacts that may be associated with them. Evacuation procedures will also be included.

Plans for all foreseeable eventualities that pose significant risks to staff or the local community or environment must be drafted, communicated and made available. The appropriate training for such events should be included within the training programme.

Planned simulated training exercises should be deployed at reasonable intervals to test the plans that have been developed. The results should be recorded and fed into action plans for improvement.

Specific plans must be developed for major hazardous materials stores, fire and electrical safety as a minimum.

The organisation shall review and revise, where necessary, its emergency preparedness and response procedures, in particular, after the occurrence of accidents or emergency situations. The organisation shall also periodically test such procedures where practicable.

18.3.9 Checking Phase

Checking and corrective action forms the fourth component of the environmental management function and is aimed at ensuring that both the necessary environmental management activities are being implemented and that the desired outcomes are being achieved. This component consists of a series of key activities including monitoring selected environmental quality variables and continued inspections of the various operational activities. This would also be supplemented by inspections and audits.

18.3.10 Monitoring and Measurement

The organisation shall establish and maintain documented procedures to monitor and measure, on a regular basis, the key characteristics of its operations and activities that can have a significant impact on the environment or pose risk to health and safety. This shall include the recording of information to track performance, relevant operational controls and conformance with the organisation's environmental objectives and targets.

Monitoring equipment shall be calibrated and maintained and records of this process shall be retained according to the organisation's procedures.

Operational controls will detail the required monitoring for individual aspects and the results should be reported in line with an appropriate programmed schedule. The organisation shall also establish and maintain a documented procedure for periodically evaluating compliance with relevant environmental legislation and regulations.

The operation controls for monitoring should consider the suggested monitoring scope as detailed below and at a minimum to the level as required by pertinent environmental regulations and guidelines.

18.3.11 Evaluation of Compliance

Comprehensive procedures will be deployed for the management of complaints, accidents and pollution incidents. These procedures will include:

- A process for handling the investigation of accidents, incidents, near misses and non-conformances;
- Response activity coordination as a result of any of the above including preventative actions, mitigation and corrective actions; and
- The development and documentation of logging, reporting and progress tracking processes including a change log of core EHS documentation.

18.3.12 Nonconformity, Corrective Action and Preventive Action

Any deviations from the OEMP identified by site personnel or other interested parties through formal site inspection, audit, visual observation (or other means) should be documented, and associated corrective action and preventative action implemented by competent individuals in order to mitigate the environmental impacts and to prevent re-occurrence.

18.3.13 Control of Records

The organisation shall establish and maintain procedures for the identification and maintenance of EHS records. These records shall include training records and the results of audits and reviews.

EHS records shall be legible, identifiable and traceable to the activity, product or service involved. EHS records shall be stored and maintained in such a way that they are readily retrievable and protected against damage, deterioration or loss. Their retention times shall be established and recorded.

18.3.14 Internal Audits

The organisation shall establish and maintain programme(s) and procedures for periodic environmental management system audits to be carried out, in order to:

- Determine whether or not the EHS management system conforms to planned arrangements for EHS management and that is has been properly implemented and maintained; and
- To provide information on the results of audits to management.

The organisation's audit programme, including any schedule, shall be based on the environmental importance of the activity concerned and the results of previous audits. In order to be comprehensive, the audit procedures shall cover the audit scope, frequency, and methodologies, as well as responsibilities and requirements for conducting audits and reporting results.

The audit programme will provide opportunities to ensure that the contents of the Environmental Policy and other commitments are being duly satisfied.

The audit programme should be developed on the basis of the risk posed by various activities i.e. high risk activities will receive more regular checking.

In addition the programme will:

- Check on the performance of the EHS management plan;
- Ensure document compliance;
- Contribute to education and awareness of employees;
- Share best EHS practice; and
- Report findings, non-conformances, corrective actions and preventative measures.

18.3.15 Management Review Phase

The project team's top management shall, at intervals that are predetermined, review the EHS management system to ensure its continuing suitability, adequacy and effectiveness. The management review process shall ensure that the necessary information is collected to allow management to carry out this evaluation. This review shall be fully documented.

The management review shall address the possible need for changes to policy, objectives and other elements of the system in the light of the audit results, changing circumstances, and the commitment to continual improvement.

18.4 Framework Operational Environmental Control Plans

18.4.1 Air Quality

- It is recommended that programme of mitigation is developed to prevent the exposure of operational workers to elevated levels of NOx during operation on back-up fuels. This could include a programme of continuous ambient air quality monitoring.
- All plant on-site will be regularly maintained to ensure optimal efficiency and ensure, as far as practicable, all equipment will be in good working order at all times.
- The proposed facility will incorporate a continuous emission monitoring system (CEMS) for NOx, SOx, O_2 and CO_2 for all main and bypass stacks at the plant. This would accurately determine pollutant concentrations in the emissions and provide an indication of any exceedances in emissions from the plant against the PME and IFC air pollution standards;
- Operating instructions to be provided to ensure that machines do not operate above the allowed limits; and
- Periodic calibration and maintenance programme will be implemented to maintain the monitoring systems in place.

18.4.2 Noise

It is recommended that as part of the Operational Management Plan regular noise monitoring is undertaken at the site boundary to show compliance with PME noise standards. It is further recommended that a full occupational noise survey is undertaken in the interests of the health and safety of the site employees.

Occupational noise standards need to be maintained as part of the Health and Safety of the employees at the facility. It is therefore important that noise levels in working areas are limited to less than 85 dB(A) at 1m from any noise generating equipment.

In addition, to ensure the above noise levels are adhered to, procedures will be implemented to ensure that, where appropriate, staff requiring Personal Safety Equipment to prevent impacts from noise will be provided as part of the Health, Safety and Environment Programme.

18.4.3 Waste Management

It is anticipated that the operational phase will generate waste streams associated with the plant operation, maintenance works and administration functions. Once the plant is in operation it is important that waste management is considered as a priority within the OEMP. Furthermore, waste recording and monitoring requirements are set out in **Section 17.5.1**.

Management of Hazardous Waste

The hazardous waste generated from maintenance works and plant operations are likely to include waste oils, fuels, chemicals, empty containers and filters and replaced parts which may have associated hazardous properties. Sludge from the water evaporation ponds, where toxic or other contaminants are expected to leach out, should be treated before disposal by, for example, a stabilisation process.

Hazardous waste streams will be collected by a locally registered waste contractor and transferred to an appropriately licensed hazardous waste facility for disposal. As part of the OEMP, all paperwork and records of hazardous waste management activities on-site will need to be maintained including records of off-site disposal to landfill.

The GER Appendix 4 (2006) “Hazardous Waste Control Rules and Procedures” details the requirements for managing hazardous waste. A few of the key requirements are included below, which will need to be complied with during the operation of Riyadh PP-13:

- Containerise and pack hazardous waste in a proper and environmentally sound manner placing warning labels on each package in accordance with the specifications and standards applicable in the Kingdom;
- Accurately fill up the product data on the appropriate section of the hazardous waste transportation document in accordance with the instructions provided in the document;
- Confirm with the PME, that the storage, treatment or disposal facility designated in the transportation document is capable of managing the waste that will be sent to it;
- Make the necessary arrangements with both the transporter who will carry the waste and the receiving facility designated in the transportation documents as the destination for the waste (such as providing the facility with full and detailed information on the waste and samples for analysis);
- Provide the transporter with the transportation document and copy of the safety data sheets for each type of hazardous waste being transported; and
- Comply with the hazardous waste transportation instructions provided in the transportation document;

The hazardous waste generator shall comply with the following for keeping of records and reports:

- Keep one copy of each transport document it has generated pending receipt of the signed copy from the facility designated in the document. It shall also keep the signed copy for at least 5 years as of the date of receipt of the waste by that facility;
- Retain copies of the results of all tests and analysis performed on the hazardous waste as well as copies of all pertinent reports, correspondence and documents for at least five years from the last date of handling of such waste;
- Submit to the PME an annual report on all hazardous waste generated during the year. Copies of such reports shall be retained for at least five years from the date of completion;
- Submit on demand to the PME or the agencies designated by it, all documents, records and reports related to the waste; and
- Hazardous Waste Transporters and Hazardous Waste Management Facilities are required have both a valid identification code and a work permit from the PME. The management at Riyadh PP-13 should maintain an up to date list of local contractors who can satisfy their requirements for the responsible handling and disposal of hazardous waste.

In addition, adherence to the guidance set out within the IFC General EHS Guidelines: Community Health and Safety, relating to the on-site and off-site transportation of waste is recommended. These guidelines require that transportation of waste should be undertaken so as to prevent or minimise spills, releases, and exposures to employees and the public. All waste containers designated for off-site shipment should be secured and labelled with the contents and associated hazards, be properly loaded on the transport vehicles prior to leaving the site, and be accompanied by a shipping paper that describes the load and its associated hazards.

Non-Hazardous Solid Waste Management

Solid wastes, including sewage treatment plant sludge, that do not leach toxic substances or other contaminants of concern to the environment, may be disposed by suitably licensed contractors in landfills or other disposal sites provided they do not impact nearby water bodies.

The administration buildings and offices on-site are likely to generate quantities of non-hazardous waste streams including waste paper, cardboard, plastic packaging that have the potential to be segregated for recycling. Therefore suitable waste receptacles will need to be provided at central locations on-site for the segregation of waste streams for recycling and residual general waste. The segregated waste will be transferred to the central storage area on-site for non-hazardous waste which will consist of dedicated containers for recyclable waste and general waste. The storage area for non-hazardous waste will be located on an impermeable hardstanding surface and located under cover.

The waste streams segregated for recycling and the general waste will be collected by a suitably qualified and licensed waste contractor. As part of the OEMP, all paperwork and records of non-hazardous waste management activities on-site and off-site disposal will be maintained for monitoring purposes.

18.4.4 Socio Economic

The operation of the Riyadh PP-13 facility will create economic opportunities for the local area. This is likely to include increased business for services with the additional SEC workers and contractors. There will also be opportunities for various support service providers including guards, cleaners, catering and other site management facilities, which will provide employment and a further source of income.

However, one of the key issues is ensuring that operational staff employed by SEC and contractors, are protected from workplace incidents and illness through appropriate health and safety systems both during normal operation and other tasks such as maintenance and repair. Appropriate safety systems such as fire protection and emergency procedures will also be required.

Operational Worker Welfare

It is recommended that the following measures are adopted during the operational phase of Riyadh PP-13:

- Implementation of Saudi Arabian Labour Law;
- To provide the employees with a safe and risk free environment, it is recommended that a comprehensive EHS plan is developed and implemented. This framework, in line with Performance Standard 2, will address measures for accident prevention, identification, mitigation and management of hazards (including physical, chemical, and radiological hazards), training of workers and reporting of accidents and incidents;
- In accordance with Performance Standard 2 SEC should develop and implement a human resource policy outlining the management approach towards working conditions, entitlement to wages and any benefits and terms of employment. This policy must be disseminated and accessible for all employees, clearly defining the employees' legal rights and the management's statement on child labour, forced labour and on non-discrimination and equal opportunities. This policy will also provide the mechanism through which employees can express and register their concerns and the system through which these grievances will be addressed;
- Expatriate staff must be provided with an induction course (as part of their training), which will highlight social and cultural trends in practice in Saudi Arabia. The objective of this course will be to familiarise the expatriate staff with knowledge of their host country and provide an understanding and respect for other cultures. The aim will be to reduce, prevent and mitigate against social and cultural tensions and potential hostility between workers and the residents of surrounding communities;
- Where feasible, staff will be of local origin where suitably qualified applicants are available. This will ensure a degree of balance between the use of non-Saudi Arabian workers and locally employed personnel during the operational phase, and limit the impact on the local economy;
- In common with Performance Standard 4, all components of and infrastructure associated with the Project will be operated in accordance with industry best practice by qualified staff;

- In line with Performance Standard 1 it is also recommended that a grievance mechanism is established for local residents, giving them a platform to raise any concerns; and
- It is noted that the site is located in a remote area and that a proportion of the staff will be housed on site in a company housing compound. It must be ensured that the compound has adequate facilities (health clinic, recreational facilities, schools etc.) to ensure the welfare of those based there.

Noise Nuisance

It is recommended that as part of the Operational Management Plan regular noise monitoring is undertaken at the site boundary to show compliance with PME noise standards. It is further recommended that a full occupational noise survey is undertaken in the interests of the health and safety of the site employees.

Occupational noise standards need to be maintained as part of the Health and Safety of the employees at the facility. It is therefore important that noise levels in working areas are limited to less than 85 dB(A) at 1m from any noise generating equipment.

Air Quality Impacts on Human Health

- It is recommended that programme of mitigation is developed to prevent the exposure of operational workers to elevated levels of NOx during operation on back-up fuels. This should include a programme of continuous ambient air quality monitoring.
- Ambient air quality monitoring of NOx, SO_2 and PM_{10} should be undertaken using a continuous air quality monitoring station to verify the current baseline and impact of the existing facilities upon the air shed.
- All plant on-site will be regularly maintained to ensure optimal efficiency and ensure, as far as practicable, all equipment will be in good working order at all times.
- The proposed facility will incorporate a Continuous Emissions Monitoring System (CEMS) for NO_x, SO_2 O_2 and CO_2 for all main and bypass stacks proposed as part of the PP-13 extension. This would accurately determine pollutant concentrations in the emissions and provide an indication of any exceedances in emissions from the plant against the PME and IFC air pollution standards.
- Operating instructions to be provided to ensure that machines do not operate above the allowed limits; and
- A periodic calibration and maintenance programme will be implemented to maintain the monitoring systems in place.

Impacts on Local Businesses

As the impacts are considered to be positive there is no need for any mitigation measures to be implemented.

Macro-Economic Impacts

As the impacts are considered to be positive there is no need for any mitigation measures to be implemented

18.4.5 Soils, Geology and Contamination

In order to avoid any contamination during the operational phase of the Riyadh PP-13, the following mitigation measures will be implemented:

- The Material Safety Data Sheets (MSDS) of all chemicals used during operation will be retained on site;
- Procedures will be implemented to ensure the safe storage and disposal of hazardous and waste chemicals;
- Hazardous chemicals and materials will be appropriately stored on-site in a secure, bunded compound and located on an impervious surface. The storage areas will need to be clearly labelled with MSDS maintained as part of the on-site record keeping;
- Details and properties for each material will be clearly noted and will include the nature (poisonous, corrosive, flammable), prohibitions on disposal (dumpster, drain, sewer) and the recommended disposal method (recycle, sewer, storage, landfill). A signed checklist should be developed for users of hazardous materials detailing amount taken, amount used, amount returned and disposal of spent material;
- Good practice measures in terms of health and safety to comply, as a minimum, with KSA law and policy requirements would be proactively promoted;
- Appropriate security measures will be provided in order to ensure that any potential issues that may result in contamination are avoided;
- Appropriate safety zoning to the hazards will be provided in order to ensure that any spillages or incidents are avoided;
- Written standard operating procedures (SOPs) for all processes and appropriate document control will be provided;
- Awareness training will be provided for all employees including management, office staff and technical staff on pollution prevention and control techniques and best practices;
- Daily checklists for plant and office areas will be established in order to confirm cleanliness and adherence to proper storage and security. Specific employees will be assigned specific inspection responsibilities and given the authority to remedy any problems found;
- Emergency response procedures will be provided in order to avoid any potential incidents to ensure that contamination incidents are controlled if they occur;
- Regular reviews of emergency response procedures will be undertaken, including a contingency plan for spills, leaks, weather extremes etc.;
- Continuous monitoring and reporting of the plants' performance should be undertaken in order to establish baseline conditions and whether conditions are improving or deteriorating; and

- To reduce the risk of wind-blown residue contaminating the site or adjacent areas, the evaporation ponds should either have all residue removed on a regular basis or have a continuous supply of water to keep the tanks damp. The residue left in the evaporation ponds will be collected and disposed of as a hazardous waste by a PME licensed hazardous waste contractor.

18.4.6 Terrestrial Ecology

Chapter 11 – Terrestrial Ecology outlines that as there is limited terrestrial ecology in the area the impact of the operation of the project is likely to be of negligible significance, however the following key mitigation measures will be implemented:

- Any additional landscape planting should be proposed and designed to provide some ecological benefit in attracting bird and insect species. Native species should be favoured over exotic species;
- Where practicable, naturally growing vegetation within the site boundary should be protected and/or encouraged, e.g. ensuring that vehicles and members of staff keep to maintained roads and pathways would protect the onsite vegetation from trampling. This will encourage native species which will be free from grazing pressure of livestock animals which would in turn attract fauna species such as birds and insects, increasing the biodiversity of the site;
- The land within the site boundary should be kept clear of any municipal or industrial waste arising from facility processes (other than designated areas where appropriate controls should be applied), staff and staff housing and offsite sources. This would improve the general “environmental quality” and amenity value of the site and reduce potential attraction of pest species such as rats and flies to the site; and
- Vehicles carrying potentially toxic, friable materials should be covered at all times so that these materials are not accidentally deposited into the natural environment, causing harm to flora and fauna.

18.4.7 Wastewater and Water Resources

The Project will not result in any direct discharges to the environment.

Wastewater Process

Industrial wastewater that results from the turbine washing, including wash-water skid drains, detergent tank overflow etc., shall be connected to a separate common underground tank. The wash water will be removed by means of a mobile vacuum truck.

Oily water and waste drainage from the GT building, fuel unloading aprons, fuel unloading pump house, fuel forwarding pump house, gaseous fuel, and any other areas where oils, fuels, and greases may have the potential to be spilled or leaked and will therefore be collected via local collection sumps and then forwarded by gravity or force main via two 100% pumps to the plant’s oil-water separator. The oil-water separator separated oil shall be batch pumped to an independent 1000m^3 storage tank for temporary storage until it is removed from the site.

Wastewater from the waste neutralisation system and chemically contaminated water and clean water from the oil/water separator shall be discharged to an evaporation pond after treatment.

These wastes will need to be collected and disposed of as a hazardous waste by a PME licensed hazardous waste contractor (see **Section 18.4.1** for appropriate controls). Therefore, no further mitigation measures are required.

Sanitary Wastewater Effluent

The generation of treated sewage effluent is considered to be a positive impact as it provides a source of water for raw water demands of the Project. Sanitary sludge generated will be disposed of by tanker by a PME licensed contractor.

If there is sufficient effluent for use within landscaping, prior to re-use for irrigation it will be necessary to implement adequate quality control measures to ensure that no impacts upon the environment or health and safety are realised. The United States Environmental Protection Agency (USEPA) Guidelines for Water Reuse (2004) provide guidance on the safe reuse of wastewater for irrigation. It is recommended that these guidelines, or a suitable recognised alternative, are adhered to when implementing this element of the project.

Local Water Resources

The source of potable water for the site is currently unknown but will be delivered to the Project site by tankers, which indicates that local water resources will be impacted. It is therefore recommended that potable water reduction measures are implemented such as water efficient faucets, urinals, showerheads and toilets.

Storm Water Generation and Management

- Runoff from areas without potential sources of contamination should be minimised by the development of appropriate storm-water and run-off control measures within the design of the Riyadh PP-13 project which could include, for example, reduction in peak discharge rates by using swales and retention ponds;
- Oil water separators and grease traps should be installed and maintained as appropriate at refuelling facilities workshops, parking areas, fuel storage and containment areas; and
- Sludge or other solid wastes arising from storm water catchments or collection and treatment systems may contain elevated levels of pollutants and should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long term sustainability of water and land resources.

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18.4.8 Transport

Whilst a reasonably significant number of vehicle movements may be predicted, particularly heavy goods vehicles, it is considered that the very isolated nature of the site and consequent lack of traffic on Highway 505 ensures that no significant impacts will occur on the local highway network, however the following key preventative measures will be implemented:

- Where possible, construction traffic should be scheduled during off-peak traffic times;
- The loading capacities and clearances of existing bridges and connecting roads will require full consideration when undertaking transportation of materials to the site and vice-versa;
- The access roads frequently used for the Project should be designed to incorporate sufficient width and load. And maintained in an appropriate condition to ensure safe use;
- Materials and/or plant delivered by road should be scheduled in order to avoid peak hours, particularly in the vicinity of Dhurma. Special attention will be made of slow-moving vehicles carrying heavy equipment/loads; which will be transported at times where the traffic on Highway 505 is at its lowest levels;
- In order to minimise congestion at key entrances to the site, the Project proponent should endeavour to ensure (as far as practicable) that separate entrances are nominated for different purposes. Thus an entrance may be designed for the construction workforce; an entrance for site clearance and construction vehicles; and an entrance for waste removal;
- Waste collection will be scheduled to minimise journeys at peak times;
- The transportation of any waste that could represent a hazard to the environment will be undertaken according to an agreed procedure to minimise the risk of accidental spillage or accidents; and
- A designated Traffic Coordinator will be assigned to the project and will be required to prepare and implement a Traffic Plan. The Traffic Plan will be informed by a Traffic Survey which will include physical

examination of the routes, carriers and support activities that could impact the movement of materials and equipment.

18.4.9 Landscape and Visual

Landscaping should be considered where possible within the PP-13 site utilising treated sewage effluent as a source of irrigation.

18.4.10 Culture and Heritage

If buried archaeological remains are discovered or suspected at any time during the construction phase of the proposed project, all works must cease in that area and the SCTA contacted immediately for advice on how to proceed.

18.5 Monitoring Programmes

An environmental monitoring programme will be developed and implemented as part of the OEMP. The monitoring programme will include the ongoing review of emissions which will be reported to the PME on an annual basis and more frequently if there are either abnormal operating conditions, or changes which may affect the environmental quality of the emissions.

18.5.1 Air Quality

It is a requirement of the RFP[61] (as described in Section 3.3.2 of Chapter 3 – Environmental Legislation and Standards) for all stacks of both HRSG and GTs to be fitted to with a continuous emissions monitoring system (CEMS) during the operational phase of the Project.

The following pollutants are required to be monitored, at a minimum:

- NO_x;
- SO_x;
- CO; and
- O_2.

Any exceedance of limit values shall be alarmed.

It is recommended that a programme of mitigation is developed to prevent the exposure of operational workers to elevated levels of NOx during operation on back-up fuels. This could include a programme of continuous ambient air quality monitoring.

[61] *Saudi Electricity Company: PP-13 Riyadh Combined Cycle Power Plant – Schedule B, Attachment III'.*

18.5.2 Noise and Vibration Management

The following aspects relating to noise will be monitored during the operational phase of the Project by the O&M Company:

- Regular noise monitoring at the site boundary to ensure compliance with PME noise standards;
- A full occupational noise survey should be undertaken in the interests of the health and safety of Site employees;
- Periodic monitoring of operational areas where workers are exposed to noise to ensure appropriate working practices and protection for O&M staff and contractors. Noise levels in working areas must be limited to less than 85dB (A) at 1m from any noise generating equipment; and
- Periodic monitoring of existing and proposed O&M operational staff accommodation to ensure compliance with RFP and IFC noise standards within internal spaces.

18.5.3 Waste Management

As part of the OEMP, all paperwork and records of hazardous waste management activities on-site will need to be maintained including records of off-site disposal to landfill as follows:

- SEC will maintain the following records and reports:
  - Keep one copy of each transport document it has generated pending receipt of the signed copy from the facility designated in the document. It shall also keep the signed copy for at least 5 years as of the date of receipt of the waste by that facility;
  - Retain copies of the results of all tests and analysis performed on the hazardous waste as well as copies of all pertinent reports, correspondence and documents for at least five years from the last date of handling of such waste;
  - Submit to the PME an annual report on all hazardous waste generated during the year. Copies of such reports shall be retained for at least five years from the date of completion; and
  - Submit on demand to the PME or the agencies designated by it, all documents, records and reports related to the waste.
- Hazardous Waste Transporters and Hazardous Waste Management Facilities are required have both a valid identification code and a work permit from the PME. The management at PP-13 should maintain an up to date list of local contractors who can satisfy their requirements for the responsible handling and disposal of hazardous waste.

18.6 Decommissioning Plan

A comprehensive plan for decommissioning the facility should be compiled at the end of its 30+ year design life. All decommissioning and restoration activities must adhere to the requirements of appropriate governing authorities and will be in accordance with all applicable local and international regulation and guidance. The decommissioning and restoration process is likely to include:

- The removal of above-ground structures;
- The removal of below-ground structures (turbine foundations);
- The restoration of topsoil; and
- The implementation of a monitoring and remediation period.

Successful decommissioning will only be complete when all buildings, equipment, materials, wastes or any other materials, which could result in environmental pollution, are removed from the site and recycled, recovered or disposed of.

19 Conclusions and Recommendations

The demand for electricity in Saudi Arabia has increased dramatically over the past decade. Power consumption is set to continue to increase with SEC forecasts indicating that power usage will increase to 75,155 MW by 2020. The power industry is a strategic industry in Saudi Arabia and has ensured the continued economic development and industrial diversification in the Kingdom. Therefore the PP-13 facility is a project of national importance in terms of its contribution to the continued economic development of the Kingdom.

SEC intends to develop the PP-13 combined cycle power plant within a greenfield site situated adjacent to the operational Independent Power Plant 11 (IPP-11) and Power Project 12 (PP-12), which is currently under construction, which are both gas fired combined cycle facilities.

The Project site is located in a wide valley known as Al-Batin, approximately 140 kilometres (km) from the capital city of Riyadh, within the Kingdom of Saudi Arabia. The site road is about 31km from the nearest town is Dhurma; with the site itself located about 25km from Route 505. Dhurma has a population of approximately 15,000 residents; whilst the larger town of Muzahmiyya (population 24,000) is approximately 75km away from the site.

The PP-13 facility will need to be designed, constructed and operated in accordance with the environmental and social requirements of the PME. It is expected that private finance will be sought and therefore, the Project will also be required to meet stringent additional requirements including the International Finance Corporation's (IFC) Performance Standards, OECD Common Approaches and Equator Principles and therefore this assessment has been compiled taking into account the following local and international guidelines and standards:

- The General Environmental Regulations (2001) for the Kingdom of Saudi Arabia;
- Environmental Protection Standards (Revised 2012);
- The IFC and World Bank Requirements (including the IFC Performance Standards); and
- International best practice.

This report is primarily concerned with the identification and assessment of the environmental impacts associated with PP-13 facility. However, in addition, it also considers the cumulative impacts associated with existing power facilities associated with the adjacent IPP-11 and PP-12 plants.

During construction and operation, all ambient air quality and noise standards will be achieved. However, there is one exception which relates to the potential exposure of operational workers to elevated levels of NOx during operation under abnormal conditions when utilising back-up fuels. A programme of monitoring and mitigation (if required) should be developed to ensure that during such periods, workers are not exposed to dangerous NOx levels.

Other potentially significant impacts include health and safety impacts upon SEC workers employed within the plant, during both construction and operation. In addition to critical control measures set out for each technical

discipline, specific monitoring requirements are set out, which must be adhered to throughout the construction and operation to ensure that international and national environmental standards and criteria are not exceeded, or that any exceedances that do occur are rectified as soon as possible.

In order to ensure that the Project does not result in exceedances of national or international standards or guidance, the ESIA has developed a comprehensive framework for environmental management and monitoring plans, covering both construction and operation, which includes the following:

- Continuous monitoring of NO_x, SO_2, CO_2, and O_2 shall be undertaken at bypass and main stacks of each gas turbine. Any exceedances of limit values shall be alarmed. This would accurately determine pollutant concentrations in the emissions and provide an indication of any exceedances in emissions from the plant against PME and IFC air pollution standards;
- It is recommended that ambient air quality monitoring is undertaken at the project site, particularly for NOx to ensure that during periods of abnormal (back-up fuel) operation that operational staff are not exposed to unacceptable levels;
- Regular noise monitoring will be undertaken throughout the construction phase within close proximity of noise sensitive locations to assess compliance with relevant noise standards;
- Full occupational noise survey will be undertaken in the interests of health and safety of site employees; and
- Monitoring and audit of solid waste stream production, transport and disposal to ensure compliance with relevant waste regulations.

It is recommended that the EPC contractor develops a Project Environmental Health & Safety Plan or Construction Environmental Management Plan which incorporates all the mitigation measures set out within this ESIA in relation to construction, which are presented in full in **Chapter 17 – Framework Construction Environmental Management Plan**. The measures will need to be adopted by both the EPC contractor and their sub-contractors. This will ensure that the actions identified within the ESIA will be integrated and implemented in full.

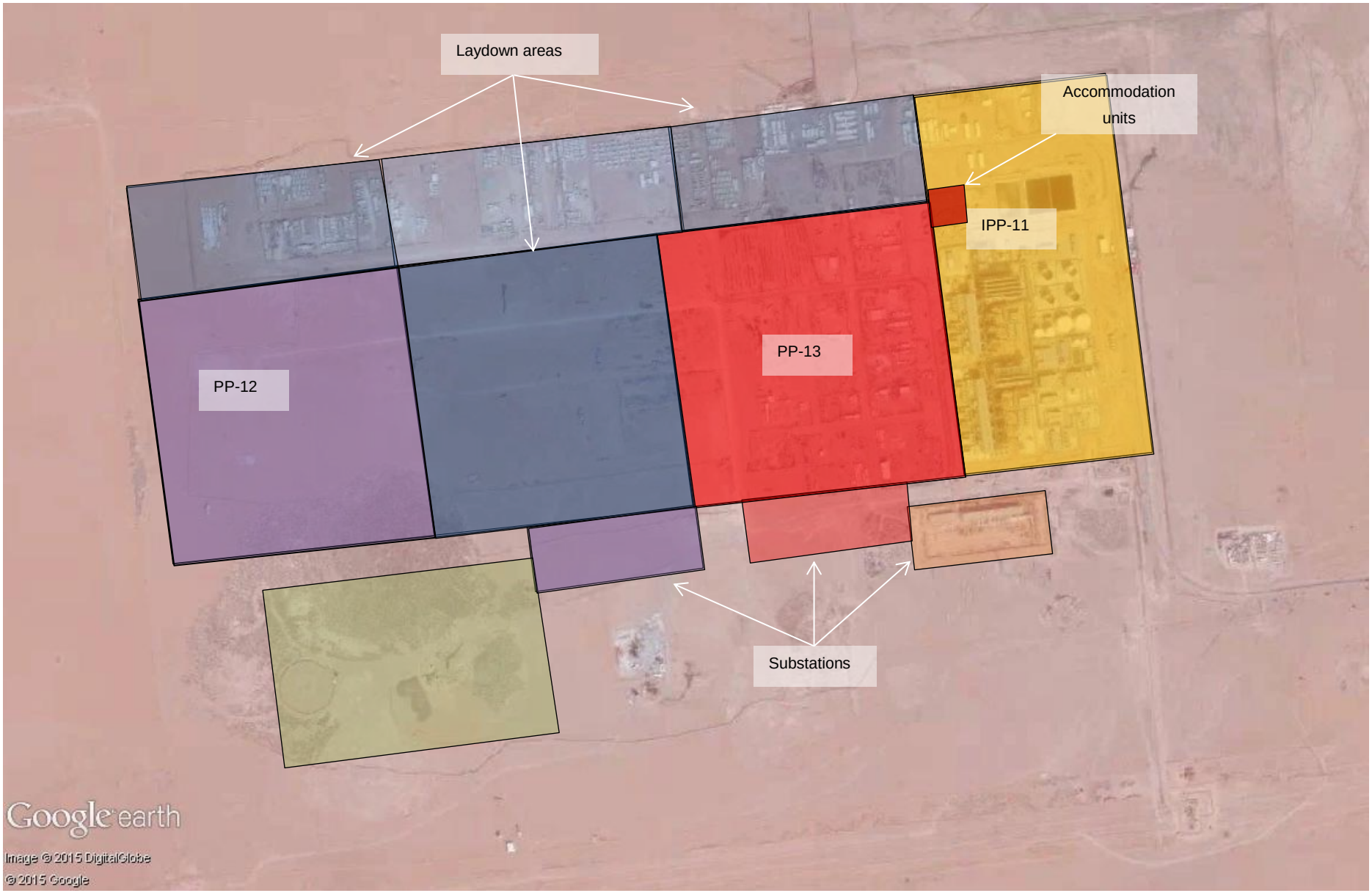
It is also recommended that all mitigation measures set out in full in **Chapter 18 – Framework Operational Environmental Management Plan** are integrated into a full Operational Environmental Management Plan or Environmental Management System by the Operation and Maintenance Company. This will ensure a mechanism for the implementation of all mitigation actions identified within the ESIA to reduce the significance of impacts during the operational phase to acceptable levels. It is also recommended that this includes monitoring measures for air emissions and noise emissions and the generation and management of wastes as a minimum.

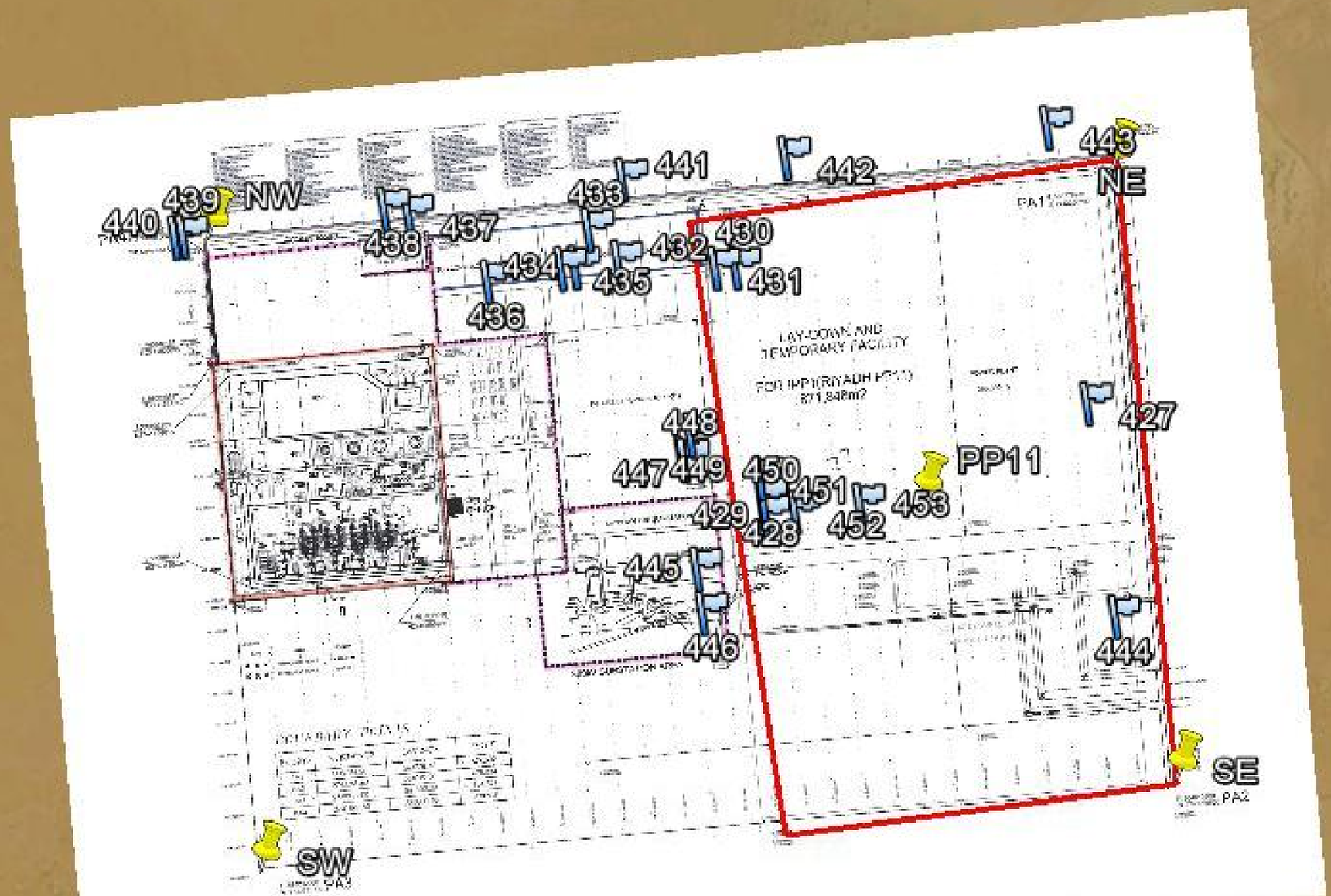
In light of the above, and through the consistent application of the mitigation, monitoring and control measures provided, and in light of the positive impacts which will be afforded to Dhurma and Kingdom of Saudi Arabia

as a whole in terms of power provision, it is considered that the environmental and social impacts can be controlled to within acceptable levels.

Appendices

Appendix 1 – Project Location and Waypoints


Laydown areas
Accommodation units
IPP-11
PP-13
PP-12
Substations
Google earth
Image © 2015 DigitalGlobe
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© 2013 Google
Image © 2013 DigitalGlobe

1311 m

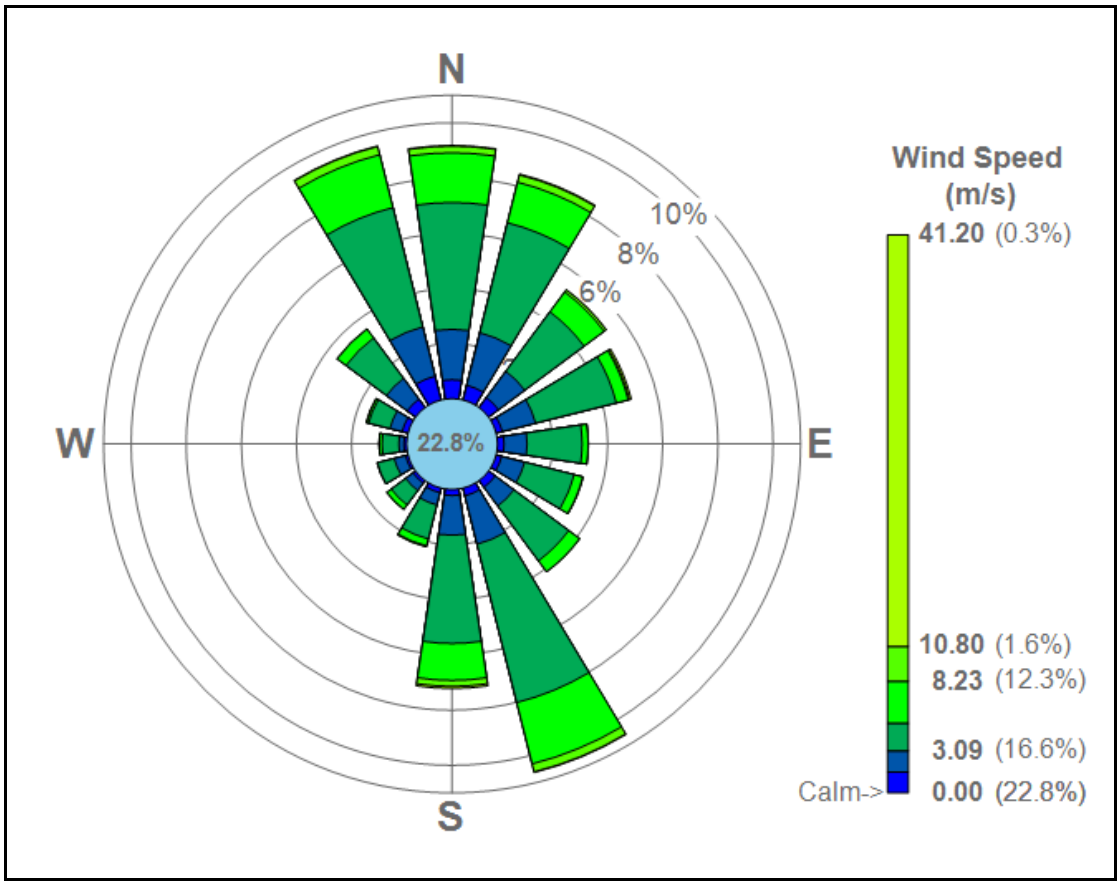
Google earth

Imagery Date: 4/12/2006 2005 24°47'02.70" N 45°37'16.83" E elev 0 m Eye alt 5.67 km

Appendix 2 – Air Quality Data and Results

Appendix 2.1 Wind Rose for Riyadh Airport 2005

WIND ROSE FOR RIYADH INTERNATIONAL AIRPORT (2005)



Appendix 2.2 Operating Conditions and Typical Operating Profile

Dispatch Assumptions for Riyadh PP11 IPP used to develop the Typical Annual Operating Profile for PP11

Parameter	Unit	RSC	Operation points							
			OP1	OP2.1	OP2.2	OP3	OP4.1	OP5	OP6	OP4.2
Ambient air Temp	°C	40	40	35	35	30	20	10	40	20
Relative humidity	%	30	30	30	30	35	35	40	30	35
Season			Summer	Summer	Winter	Winter	Winter	Winter	Summer	Winter
Fuel	-	NG	NG	NG	NG	NG	NG	NG	ASL	ASL
Net power capacity export	%	-	100	80	80	65	50	30	100	50
Annual operation hours	h/year	-	1400	2032	68	2770	1950	300	240	--
Maximum allowable Operation of each GT in relation to max. GT output	%	-	100	95	95	90	90	90	100	40
No. of Turbines Operating (Group 1/Group 2)			4/3	3/3	3/3	3/2	4/0	3/0	4/3	2/2

NOTES:

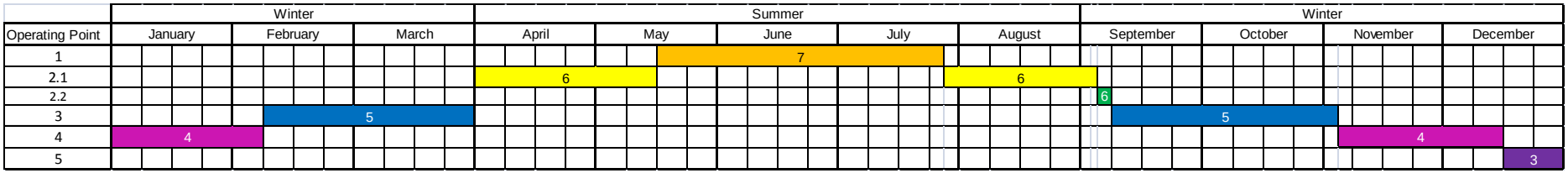
Scenario Point 9 represents abnormal or emergency operating conditions that can occur at anytime. Scenario 3 of the modelling addresses potential impacts during these conditions.

RSC – Reference Site Conditions

NG – Natural Gas

ASL – Arabian Super Light fuel oil

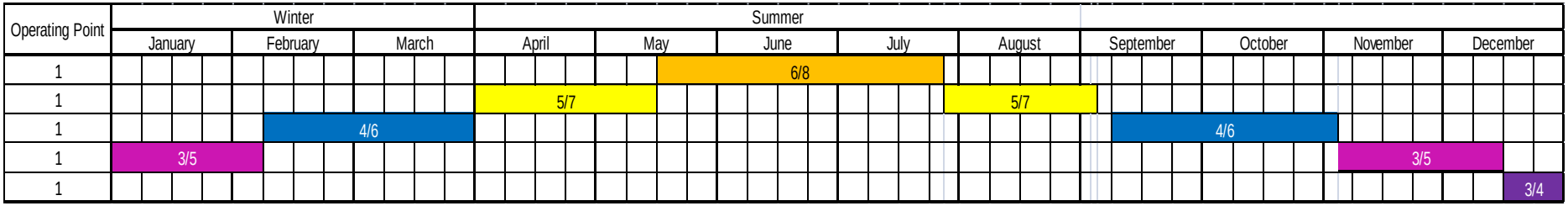
Annual Operating Profile developed from assumed dispatch for Riyadh PP11



NOTE:

The figures on the coloured bars showing operational period refer to the number of turbines operating for each operating point. Operating Point 6 is not included in the operating profile, as these operating conditions represent an abnormal situation that could occur at any time during a year

Annual Operating Profile developed for PP12 and PP13 based on the Profile for Riyadh PP11



NOTE:

The figures on the coloured bars represents the number of GTs assumed to be operating at PP13 and PP12 (PP13/PP12)

When in operation, each turbine is assumed to be operating at 100% output.

Appendix 2.3 Dispersion Model Input Parameters used in the Assessment

MODEL INPUT PARAMETERS

Riyadh PP11:

- The flow and emission data for OPs 1 to 5 were used according to the annual operating profile shown in Appendix 2.

Block 1	**OP1**	**OP2**	**OP3**	**OP4**	**OP5**	**OP6**
No. Operating Units	**4**	**3**	**3**	**4**	**3**	**4**
Emissions (per Stack) [(a)]	NG	NG	NG	NG	NG	ASL
Flue Gas exhaust Temperature (°C)	183	167	165	188	171	201
Flue Gas exhaust flow (Am^3/s)	524.40	488.52	487.29	526.58	433.63	562.37
Normalised Exhaust flow rate (Nm^3/s)[(a)]	402.18	384.90	386.30	361.54	302.54	415.13
Exhaust efflux velocity (m/s);	19.85	18.49	18.44	19.93	16.41	21.29
Internal stack diameter (m)	5.80	5.80	5.80	5.80	5.80	5.80
Stack height (m)	60.00	60.00	60.00	60.00	60.00	60.00
NO_x emissions (g/s)	8.56	8.24	8.26	6.87	5.59	35.81
SO_2 emission (g/s)	0.60	0.57	0.57	0.54	0.45	13.44
PM_{10} emission (g/s)	1.38	1.39	1.38	1.18	1.14	2.22

(a) Reference conditions: 273 K, 1013 mbar, dry gas, 15% oxygen

(b) NG – Natural Gas; ASL – Arabian Super Light crude

Block 2	**OP1**	**OP2**	**OP3**	**OP4**	**OP5**	**OP6**
No. Operating Units	**3**	**3**	**2**	**0**	**0**	**3**
Emissions (per Stack) [(a)]	NG	NG	NG			ASL
Flue Gas exhaust Temperature (°C)	160	161	156			190
Flue Gas exhaust flow (Am^3/s)	501.30	483.05	477.10			549.30
Normalized Exhaust flow rate (Nm^3/s)[(a)]	463.68	410.07	381.87			415.11
Exhaust efflux velocity (m/s)	18.97	18.28	18.06			20.79
Internal stack diameter (m)	5.80	5.80	5.80			5.80
Stack height (m)	60.00	60.00	60.00			60.00
NO_x emissions (g/s)	11.30	9.23	8.11			35.81
SO_2 emission (g/s)	0.69	0.61	0.57			13.44
PM_{10} emission (g/s)	1.74	1.51	1.36			2.22

(a) Reference conditions: 273 K, 1013 mbar, dry gas, 15% oxygen

(b) NG – Natural Gas; ASL – Arabian Super Light crude

Riyadh PP12 and PP13 (Data from Air Dispersion Study for PP12):

Parameter (per GT exhaust)	***Sales Gas***		***ASL***		***Diesel***	
Carbon Dioxide (% at actual stack condition)	3.75		3.75		3.58	
Flue Gas exhaust Temperature (°C) - GT/HRSG	624.9	125	531.5	177.9	531.5	178.1
Flue Gas exhaust flow (kg/hr)	1590600		1562000		1561000	
Flue Gas exhaust flow (Am^3/s)	508.1		558.9		558.5	
Normalised Exhaust flow rate (Nm^3/s)[(a)]	174.38		170.96		162.83	
Exhaust efflux velocity (m/s);	21.4	17.4	23.5	19.1	23.5	19.1
Internal stack diameter (m)	5.5	6.1	5.5	6.1	5.5	6.1
Stack height (m)	40	60	40	60	40	60
Stack Area (m^2)	23.76	29.23	23.76	29.23	23.76	29.23
NO_x emission (kg/hr)	26.1		534.9		537.2	
SO_2 emission (kg/hr)	--		57.7		56.6	
PM_{10} emission (kg/hr)	--		7.7		7.7	
NO_x emission (mg/Nm^3)	41.6		869.1		916.4	
SO_2 emission (mg/Nm^3)	--		93.7		96.6	
PM_{10} emission (mg/Nm^3)	--		12.5		13.1	
NO_x emission (g/s)	7.3		148.9		149.2	
SO_2 emission (g/s)	0.58[(b)]		16.0		15.7	
PM_{10} emission (g/s)	1.34[(b)]		2.14		2.14	

(a) Reference conditions: 273 K, 1013 mbar, dry gas, 15% oxygen

(b) The Air Dispersion Study for PP12 supplied by SEC provided stated there would be no emissions of SO_2 to PM_{10} associated with Sales Gas; however, to ensure a conservative approach, concentration data for these two pollutants from the PP11 data were used to determine an emission rate for PP12 and PP13 taking into account the different flow rates compared to PP11.

Source Locations

The coordinated for each of the sources (stacks) modelled are shown in the table below.

Source	***Coordinates***	
PP11	***Easting***	***Northing***
Block1 Main Stacks		
11MS11	563528.6	2741186.5
11MS12	563524.5	2741220.3
11MS13	563510.5	2741336.6
11MS14	563506.5	2741370.4
Block 2 Main Stacks		
11MS21	563499.6	2741427.9
11MS22	563495.5	2741461.7
11MS23	563491.5	2741495.4
PP12	***Easting***	***Northing***
Block 1 Main Stacks		
12MS11	561144.1	2741011.8
12MS12	561183.9	2741016.9
12MS13	561223.7	2741022.0
12MS14	561263.5	2741027.1
Block 2 Main Stacks		
12MS21	561308.4	2741032.2
12MS22	561348.1	2741037.3
12MS23	561387.9	2741042.4
12MS24	561427.7	2741047.5
PP13	***Easting***	***Northing***
Block 1 Main Stacks		
PP13MS11	562807.4	2741291.1
PP13MS12	562847.2	2741296.2
PP13MS13	562887	2741301.3
Block 1 By-pass Stacks		
PP13BS11	562811.5	2741252.3
PP13BS12	562851.3	2741257.4
PP13BS13	562891.1	2741262.5
Block 2 Main Stacks		
PP13MS21	562971.7	2741311.5
PP13MS22	563011.4	2741316.6
PP13MS23	563051.2	2741321.7
Block 2 By-pass Stacks		
PP13BS21	562976.8	2741272.7
PP13BS22	563016.5	2741277.8
PP13BS23	563056.3	2741282.9

Buildings and structures included in the model

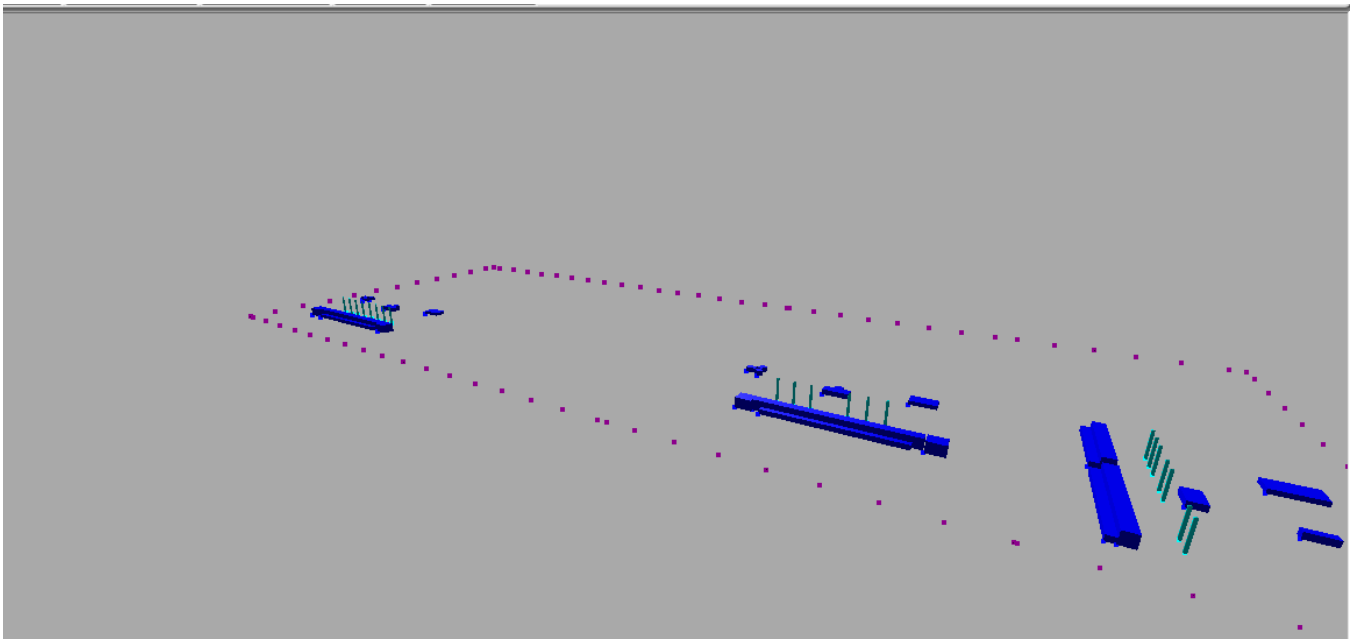
The location and dimensions of the buildings included in the model are given in the table below. The coordinates shown in the table represent the location of the southwest corner of each building.

Building	*Coordinates*		*Height (m)*	*Width(m)*	*Length (m)*	*Angle (deg)*
	Easting	*Northing*				
PP11						
GT & ST Bk 1 Building (low)	563433.5	2741145.5	12	16.4	223	353
GT & ST Bk 1 Building (high)	563449.8	2741147.5	26	24.5	223	353
GT & ST Bk 2 Building (high)	563403.6	2741389.3	12	16.4	169	353
GT & ST Bk 2 Building (low)	563420.0	2741391.3	26	24.5	169	353
Central Control Room	563537.4	2741333.1	15.7	30	50	353
Demin water treatment building	563651.7	2741471.9	10	78	42	353
Administration Building	563670.1	2741335.2	12.8	42	14	353
PP12						
GT & ST Building (high)	561118.6	2740938.3	22	344	26	353
GT & ST Building (low)	561142.1	2740928.1	13	322	12	353
ST Building (west)	561080.9	2740924.0	32.5	40	26	353
ST Building (east)	561484.8	2740975.0	32.5	40	26	353
Central Control Room (Part 1)	561209.4	2741120.9	25	64	8.6	353
Central Control Room (Part 2)	561228.8	2741148.4	15	21	8.6	353
Demin water treatment building	561394.0	2741189.2	34.5	63	10	353
Administration Building (Part 1)	560983.0	2741140.3	16	26.5	12.8	353
Administration Building (Part 2)	561021.7	2741128.0	20	16	12.8	322
Administration Building (Part 3)	561006.4	2741159.7	20	16	12.8	23
PP13						
GT & ST Building (high)	562781.9	2741217.7	22	344	26	353
GT & ST Building (low)	562805.4	2741207.5	13	322	12	353
ST Building (west)	562744.2	2741203.4	32.5	40	26	353
ST Building (east)	563148.1	2741254.4	32.5	40	26	353
Central Control Room (Part 1)	562872.7	2741400.2	25	64	8.6	353
Central Control Room (Part 2)	562892.1	2741427.8	15	21	8.6	353
Demin water treatment building	563057.3	2741468.6	34.5	63	10	353
Administration Building (Part 1)	562646.3	2741419.6	16	26.5	12.8	353
Administration Building (Part 2)	562685.0	2741407.4	20	16	12.8	322
Administration Building (Part 3)	562669.7	2741439.0	20	16	12.8	23

For the purposes of the modelling, the gas and steam turbine buildings were generally divided into two sections lengthways based on the height of the section. This was required to represent the stepped shape of the turbine halls in the model.

A 3-D representation of the existing and proposed combined cycle plants at the complex represented in the dispersion model is shown in the figure below. The view is looking toward the northward, with the purple dots representing regularly spaced boundary receptors.

3-Dimensional View of the Proposed Riyadh Power Plant Complex (towards the northeast)



PP11 is located on the eastern side of the complex (roughly north-south orientation), with PP13 in the centre and PP12 located on the western side of the complex. PP12 and PP13 are roughly east-west in orientation. Note, only the Main Stacks are shown for each power plant.

Appendix 2.4 Modelling Results – Baseline (Scenario 1)

Modelling Results: Baseline (Scenario 1)

Predicted Concentrations – Maximum point of Impact

Table A4-1: NO_2 Concentrations

Stack Height	Air Quality Standard	Concentration (µg/m^3)	Percentage of PME AQS	Date	Time	UTM Grid Ref	
						Easting	Northing
Highest 1-hr Mean	*660*	151.58	23%	20-Jul	17:00	561100	2740850
Annual Mean	*100*	18.65	19%			561100	2740850

NB - 50% oxidation of NO_x to NO_2 assumed for 1-hour mean concentrations; 100% oxidation for annual means

Table A4-2 SO_2 Concentrations

Stack Height	Air Quality Standard	Concentration (µg/m^3)	Percentage of PME AQS	Date	Time	UTM Grid Ref	
						Easting	Northing
10-min mean	*500*	40.82	8%				
Highest 1-hr Mean	*730*	24.09	3%	20-Jul	17:00	561100	274085
99.7th Percentile of 24-hr Means	*365*	9.50	3%	13-Mar		561100	274085
Annual Mean	*80*	1.48	2%			561100	274085

Table A4-3: PM_{10} Concentrations

Stack Height	Air Quality Standard	Concentration (µg/m^3)	Percentage of PME AQS	Date	Time	UTM Grid Ref	
						Easting	Northing
90th Percentile of 24-hr Means	*340*	9.91	3%	05-Apr		561100	2740850
Annual Mean	*80*	3.42	4%			561100	2740850

Predicted Concentrations (Scenario 1) – Maximum at Sensitive Receptors

Table A4-4 NO_2 Concentrations

Receptor		UTM Grid Ref		NO_2 Concentrations (µg/m^3)	
		Easting	Northing	Annual Mean	1-hour Mean
1	PP11 Accommodation Compound (SE)	563768.1	2741155.5	2.05	21.70
2	PP11 Accommodation Compound (SW)	563800.7	2741161.7	1.12	19.83
3	PP11 Accommodation Compound (NW)	563782.4	2741304.5	1.25	21.72
4	PP11 Accommodation Compound (NE)	563747.7	2741298.4	2.14	21.10
5	PP11 Social Building 1	563641.5	2741327.0	0.31	6.98
6	PP11 Social Building 2	563657.9	2741331.1	0.30	6.91
7	PP11 Social Building 3	563655.8	2741351.5	0.29	7.01
8	PP11 Social Building 4	563639.5	2741349.4	0.29	6.96
9	PP11 Administration Building 1	563670.1	2741335.2	0.30	6.95
10	PP11 Administration Building 2	563712.4	2741340.2	0.32	7.58
11	PP11 Administration Building 3	563710.5	2741354.2	0.31	7.52
12	PP11 Administration Building 4	563668.5	2741349.4	0.30	6.84
13	Quarry	579650	2742930	0.05	3.12
14	Goat Farming	583130	2742220	0.04	3.10
15	Grain Silos	576290	2740520	0.06	3.26
16	Aramco Pumping Station	584480	2742840	0.04	2.78
17	Wheat/Fodder Fields	572955	2738800	0.06	4.87
18	PP12 Administration Building	561030.9	2741154.6	2.25	31.62
19	PP12 Musjid	561075.8	2741175.0	2.24	29.11

Table A4-5 SO_2 Concentrations

Receptor		UTM Grid Ref		SO_2 Concentrations (µg/m^3)		
		Easting	Northing	Annual Mean	1-hour Mean	99.7th Percentile of 24-hour Means
1	PP11 Accommodation Compound (SE)	563768.1	2741155.5	0.15	3.00	1.09
2	PP11 Accommodation Compound (SW)	563800.7	2741161.7	0.08	3.15	0.61
3	PP11 Accommodation Compound (NW)	563782.4	2741304.5	0.09	3.08	0.54
4	PP11 Accommodation Compound (NE)	563747.7	2741298.4	0.15	3.07	1.06
5	PP11 Social Building 1	563641.5	2741327.0	0.02	1.08	0.17
6	PP11 Social Building 2	563657.9	2741331.1	0.02	1.08	0.17
7	PP11 Social Building 3	563655.8	2741351.5	0.02	1.06	0.16
8	PP11 Social Building 4	563639.5	2741349.4	0.02	1.09	0.16
9	PP11 Administration Building 1	563670.1	2741335.2	0.02	1.08	0.17
10	PP11 Administration Building 2	563712.4	2741340.2	0.02	1.17	0.20
11	PP11 Administration Building 3	563710.5	2741354.2	0.02	1.17	0.20
12	PP11 Administration Building 4	563668.5	2741349.4	0.02	1.06	0.17
13	Quarry	579650	2742930	0.00	0.45	0.05

Receptor		UTM Grid Ref		SO_2 Concentrations (µg/m^3)		
		Easting	Northing	Annual Mean	1-hour Mean	99.7th Percentile of 24-hour Means
14	Goat Farming	583130	2742220	0.00	0.45	0.04
15	Grain Silos	576290	2740520	0.00	0.47	0.05
16	Aramco Pumping Station	584480	2742840	0.00	0.40	0.04
17	Wheat/Fodder Fields	572955	2738800	0.00	0.70	0.06
18	PP12 Administration Building	561030.9	2741154.6	0.17	5.00	1.40
19	PP12 Musjid	561075.8	2741175.0	0.17	4.67	1.38

Table A4-6 PM_{10} Concentrations

Receptor		UTM Grid Ref		PM_{10} Concentrations (µg/m^3)	
		Easting	Northing	Annual Mean	99.7th Percentile of 24-hour Means
1	PP11 Accommodation Compound (SE)	563768.1	2741155.5	0.09	0.91
2	PP11 Accommodation Compound (SW)	563800.7	2741161.7	0.09	0.49
3	PP11 Accommodation Compound (NW)	563782.4	2741304.5	0.06	0.58
4	PP11 Accommodation Compound (NE)	563747.7	2741298.4	0.06	0.92
5	PP11 Social Building 1	563641.5	2741327.0	0.05	0.14
6	PP11 Social Building 2	563657.9	2741331.1	0.05	0.14
7	PP11 Social Building 3	563655.8	2741351.5	0.05	0.13
8	PP11 Social Building 4	563639.5	2741349.4	0.05	0.13
9	PP11 Administration Building 1	563670.1	2741335.2	0.05	0.14
10	PP11 Administration Building 2	563712.4	2741340.2	0.05	0.14
11	PP11 Administration Building 3	563710.5	2741354.2	0.05	0.15
12	PP11 Administration Building 4	563668.5	2741349.4	0.05	0.13
13	Quarry	579650	2742930	0.01	0.02
14	Goat Farming	583130	2742220	0.01	0.02
15	Grain Silos	576290	2740520	0.01	0.02
16	Aramco Pumping Station	584480	2742840	0.01	0.01
17	Wheat/Fodder Fields	572955	2738800	0.01	0.02
18	PP12 Administration Building	561030.9	2741154.6	0.41	1.10
19	PP12 Musjid	561075.8	2741175.0	0.41	1.19

Appendix 2.5 Modelling Results – Riyadh PP13 (Scenarios 2A, 2B, 2C, 2D & 2E)

Modelling Results: Riyadh PP13 – Scenario 2A

Scenario 2A Operating Conditions:

Load: Maximum Load
Mode: Combined Cycle
Fuel: Sales Gas

Predicted Concentrations – Maximum point of Impact

Table A5-1: NO_2 Concentrations

Averaging Period	Air Quality Standard	Concentration (µg/m^3)	Date	Time	Percentage of PME AQS	Impact Significance	UTM Grid Ref	
							Easting	Northing
Highest 1-hr Mean	*660*	102.90	12-Sep	16:00	16%	MINOR	561950	2740950
Annual Mean	*100*	13.13			18%	MINOR	562800	2741150

NB - 50% oxidation of NO_x to NO_2 assumed for 1-hour mean concentrations; 100% oxidation for annual means

Table A5-2 SO_2 Concentrations

Averaging Period	Air Quality Standard	Concentration (µg/m^3)	Date	Time	Percentage of PME AQS	Impact Significance	UTM Grid Ref	
							Easting	Northing
10-min mean	*500*	30.44	09-May	14:00	6%		563200	2741200
Highest 1-hr Mean	*730*	16.35	12-Sep	16:00	2%	NEGLIGIBLE	561950	2740950
99.7th Percentile of 24-hr Means	*365*	6.75	05-Apr		2%	NEGLIGIBLE	562800	2741100
Annual Mean	*80*	1.04			1%	NEGLIGIBLE	562800	2741150

Table A5-3: PM_{10} Concentrations

Averaging Period	Air Quality Standard	Concentration (µg/m^3)	Date	Time	Percentage of PME AQS	Impact Significance	UTM Grid Ref	
							Easting	Northing
90th Percentile of 24-hr Means	*340*	6.40	05-Apr		2%	MINOR	562800	2741150
Annual Mean	*80*	2.41			3%	NEGLIGIBLE	562800	2741200

Predicted Concentrations (Scenario 2A) – Maximum at Sensitive Receptors

Table A5-4 NO_2 Concentrations

Receptor		UTM Grid Ref		NO_2 Concentrations (µg/m^3)					
		Easting	Northing	Annual Mean	Percentage of PME AQS	Impact Significance	1-hour Mean	Percentage of PME AQS	Impact Significance
1	PP11 Accommodation Compound (SE)	563112.1	2741763.0	0.94	<1%	NEGLIGIBLE	20.56	3%	NEGLIGIBLE
2	PP11 Accommodation Compound (SW)	562822.4	2741730.0	2.82	3%	NEGLIGIBLE	21.22	3%	NEGLIGIBLE
3	PP11 Accommodation Compound (NW)	562809.0	2741831.0	2.92	3%	NEGLIGIBLE	18.61	3%	NEGLIGIBLE
4	PP11 Accommodation Compound (NE)	563099.3	2741864.0	1.10	1%	NEGLIGIBLE	19.79	3%	NEGLIGIBLE
5	PP11 Social Building 1	563641.5	2741327.0	0.29	<1%	NEGLIGIBLE	10.99	2%	NEGLIGIBLE
6	PP11 Social Building 2	563657.9	2741331.1	0.29	<1%	NEGLIGIBLE	10.89	2%	NEGLIGIBLE
7	PP11 Social Building 3	563655.8	2741351.5	0.29	<1%	NEGLIGIBLE	10.18	2%	NEGLIGIBLE
8	PP11 Social Building 4	563639.5	2741349.4	0.29	<1%	NEGLIGIBLE	10.46	2%	NEGLIGIBLE
9	PP11 Administration Building 1	563670.1	2741335.2	0.28	<1%	NEGLIGIBLE	10.73	2%	NEGLIGIBLE
10	PP11 Administration Building 2	563712.4	2741340.2	0.28	<1%	NEGLIGIBLE	10.42	2%	NEGLIGIBLE
11	PP11 Administration Building 3	563710.5	2741354.2	0.28	<1%	NEGLIGIBLE	10.20	2%	NEGLIGIBLE
12	PP11 Administration Building 4	563668.5	2741349.4	0.28	<1%	NEGLIGIBLE	10.24	2%	NEGLIGIBLE
13	Quarry	579650	2742930	0.02	<1%	NEGLIGIBLE	1.46	<1%	NEGLIGIBLE
14	Goat Farming	583130	2742220	0.02	<1%	NEGLIGIBLE	1.40	<1%	NEGLIGIBLE
15	Grain Silos	576290	2740520	0.03	<1%	NEGLIGIBLE	1.69	<1%	NEGLIGIBLE
16	Aramco Pumping Station	584480	2742840	0.02	<1%	NEGLIGIBLE	1.40	<1%	NEGLIGIBLE
17	Wheat/Fodder Fields	572955	2738800	0.03	<1%	NEGLIGIBLE	2.12	<1%	NEGLIGIBLE
18	PP12 Administration Building	561030.9	2741154.6	0.22	<1%	NEGLIGIBLE	5.58	1%	NEGLIGIBLE
19	PP12 Musjid	561075.8	2741175.0	0.23	<1%	NEGLIGIBLE	6.03	1%	NEGLIGIBLE
20	PP13 Administration Building	562694.2	2741434.0	1.75	2%	NEGLIGIBLE	23.60	4%	NEGLIGIBLE
21	PP13 Musjid	562739.1	2741454.0	1.86	2%	NEGLIGIBLE	21.99	3%	NEGLIGIBLE

Table A5-5 SO_2 Concentrations

Receptor		UTM Grid Ref		SO_2 Concentrations (µg/m^3)								
		Easting	Northing	Annual Mean	Percentage of PME AQS	Impact Significance	1-hour Mean	Percentage of PME AQS	Impact Significance	99.7th Percentile of 24-hour Means	Percentage of PME AQS	Impact Significance
1	PP11 Accommodation Compound (SE)	563112.1	2741763.0	0.07	<1%	NEGLIGIBLE	3.27	<1%	NEGLIGIBLE	0.59	<1%	NEGLIGIBLE
2	PP11 Accommodation Compound (SW)	562822.4	2741730.0	0.22	<1%	NEGLIGIBLE	3.37	<1%	NEGLIGIBLE	1.27	<1%	NEGLIGIBLE
3	PP11 Accommodation Compound (NW)	562809.0	2741831.0	0.23	<1%	NEGLIGIBLE	2.96	<1%	NEGLIGIBLE	1.27	<1%	NEGLIGIBLE
4	PP11 Accommodation Compound (NE)	563099.3	2741864.0	0.09	<1%	NEGLIGIBLE	3.14	<1%	NEGLIGIBLE	0.64	<1%	NEGLIGIBLE
5	PP11 Social Building 1	563641.6	2741327.0	0.02	<1%	NEGLIGIBLE	1.75	<1%	NEGLIGIBLE	0.29	<1%	NEGLIGIBLE
6	PP11 Social Building 2	563657.9	2741331.0	0.02	<1%	NEGLIGIBLE	1.73	<1%	NEGLIGIBLE	0.29	<1%	NEGLIGIBLE
7	PP11 Social Building 3	563655.8	2741352.0	0.02	<1%	NEGLIGIBLE	1.62	<1%	NEGLIGIBLE	0.30	<1%	NEGLIGIBLE
8	PP11 Social Building 4	563639.5	2741350.0	0.02	<1%	NEGLIGIBLE	1.66	<1%	NEGLIGIBLE	0.30	<1%	NEGLIGIBLE
9	PP11 Administration Building 1	563670.1	2741335.0	0.02	<1%	NEGLIGIBLE	1.70	<1%	NEGLIGIBLE	0.29	<1%	NEGLIGIBLE
10	PP11 Administration Building 2	563712.4	2741340.0	0.02	<1%	NEGLIGIBLE	1.66	<1%	NEGLIGIBLE	0.29	<1%	NEGLIGIBLE
11	PP11 Administration Building 3	563710.5	2741354.0	0.02	<1%	NEGLIGIBLE	1.62	<1%	NEGLIGIBLE	0.29	<1%	NEGLIGIBLE
12	PP11 Administration Building 4	563668.5	2741350.0	0.02	<1%	NEGLIGIBLE	1.63	<1%	NEGLIGIBLE	0.30	<1%	NEGLIGIBLE
13	Quarry	579650	2742930	<0.01	<1%	NEGLIGIBLE	0.23	<1%	NEGLIGIBLE	0.02	<1%	NEGLIGIBLE
14	Goat Farming	583130	2742220	<0.01	<1%	NEGLIGIBLE	0.22	<1%	NEGLIGIBLE	0.02	<1%	NEGLIGIBLE
15	Grain Silos	576290	2740520	<0.01	<1%	NEGLIGIBLE	0.27	<1%	NEGLIGIBLE	0.02	<1%	NEGLIGIBLE
16	Aramco Pumping Station	584480	2742840	<0.01	<1%	NEGLIGIBLE	0.22	<1%	NEGLIGIBLE	0.02	<1%	NEGLIGIBLE
17	Wheat/Fodder Fields	572955	2738800	<0.01	<1%	NEGLIGIBLE	0.34	<1%	NEGLIGIBLE	0.03	<1%	NEGLIGIBLE
18	PP12 Administration Building	561030.9	2741155.0	0.02	<1%	NEGLIGIBLE	0.89	<1%	NEGLIGIBLE	0.15	<1%	NEGLIGIBLE
19	PP12 Musjid	561075.8	2741175.0	0.02	<1%	NEGLIGIBLE	0.96	<1%	NEGLIGIBLE	0.15	<1%	NEGLIGIBLE
20	PP13 Administration Building	562694.2	2741434.0	0.14	<1%	NEGLIGIBLE	3.75	<1%	NEGLIGIBLE	1.17	<1%	NEGLIGIBLE
21	PP13 Musjid	562739.1	2741454.0	0.15	<1%	NEGLIGIBLE	3.50	<1%	NEGLIGIBLE	1.17	<1%	NEGLIGIBLE

Table A5-6 PM_{10} Concentrations

Receptor		UTM Grid Ref		PM_{10} Concentrations (µg/m^3)					
		Easting	Northing	Annual Mean	Percentage of PME AQS	Impact Significance	99.7th Percentile of 24-hour Means	Percentage of PME AQS	Impact Significance
1	PP11 Accommodation Compound (SE)	563112.1	2741763.0	0.17	<1%	NEGLIGIBLE	0.45	<1%	NEGLIGIBLE
2	PP11 Accommodation Compound (SW)	562822.4	2741730.0	0.52	<1%	NEGLIGIBLE	1.43	<1%	NEGLIGIBLE
3	PP11 Accommodation Compound (NW)	562809.0	2741831.0	0.54	<1%	NEGLIGIBLE	1.52	<1%	NEGLIGIBLE
4	PP11 Accommodation Compound (NE)	563099.3	2741864.0	0.20	<1%	NEGLIGIBLE	0.57	<1%	NEGLIGIBLE
5	PP11 Social Building 1	563641.6	2741327.0	0.05	<1%	NEGLIGIBLE	0.11	<1%	NEGLIGIBLE
6	PP11 Social Building 2	563657.9	2741331.0	0.05	<1%	NEGLIGIBLE	0.11	<1%	NEGLIGIBLE
7	PP11 Social Building 3	563655.8	2741352.0	0.05	<1%	NEGLIGIBLE	0.10	<1%	NEGLIGIBLE
8	PP11 Social Building 4	563639.5	2741350.0	0.05	<1%	NEGLIGIBLE	0.10	<1%	NEGLIGIBLE
9	PP11 Administration Building 1	563670.1	2741335.0	0.05	<1%	NEGLIGIBLE	0.11	<1%	NEGLIGIBLE
10	PP11 Administration Building 2	563712.4	2741340.0	0.05	<1%	NEGLIGIBLE	0.09	<1%	NEGLIGIBLE
11	PP11 Administration Building 3	563710.5	2741354.0	0.05	<1%	NEGLIGIBLE	0.09	<1%	NEGLIGIBLE
12	PP11 Administration Building 4	563668.5	2741350.0	0.05	<1%	NEGLIGIBLE	0.10	<1%	NEGLIGIBLE
13	Quarry	579650	2742930	0.00	<1%	NEGLIGIBLE	0.01	<1%	NEGLIGIBLE
14	Goat Farming	583130	2742220	0.00	<1%	NEGLIGIBLE	0.01	<1%	NEGLIGIBLE
15	Grain Silos	576290	2740520	0.00	<1%	NEGLIGIBLE	0.01	<1%	NEGLIGIBLE
16	Aramco Pumping Station	584480	2742840	0.00	<1%	NEGLIGIBLE	0.01	<1%	NEGLIGIBLE
17	Wheat/Fodder Fields	572955	2738800	0.01	<1%	NEGLIGIBLE	0.01	<1%	NEGLIGIBLE
18	PP12 Administration Building	561030.9	2741155.0	0.04	<1%	NEGLIGIBLE	0.11	<1%	NEGLIGIBLE
19	PP12 Musjid	561075.8	2741175.0	0.04	<1%	NEGLIGIBLE	0.11	<1%	NEGLIGIBLE
20	PP13 Administration Building	562694.2	2741434.0	0.32	<1%	NEGLIGIBLE	1.00	<1%	NEGLIGIBLE
21	PP13 Musjid	562739.1	2741454.0	0.34	<1%	NEGLIGIBLE	1.09	<1%	NEGLIGIBLE

Modelling Results: Riyadh PP13 – Scenario 2B

Scenario 2B Operating Conditions:

Load: Annual Operating Profile
Mode: Combined Cycle
Fuel: Sales Gas

Predicted Concentrations – Maximum point of Impact

Table A5-7: NO_2 Concentrations

Averaging Period	Air Quality Standard	Concentration (µg/m^3)	Date	Time	Percentage of PME AQS	Impact Significance	UTM Grid Ref	
							Easting	Northing
Highest 1-hr Mean	*660*	100.11	16-Jun	18:00	15%	MINOR	562750	2741150
Annual Mean	*100*	10.82			11%	MINOR	562800	2741150

NB - 50% oxidation of NO_x to NO_2 assumed for 1-hour mean concentrations; 100% oxidation for annual means

Table A5-8 SO_2 Concentrations

Averaging Period	Air Quality Standard	Concentration (µg/m^3)	Date	Time	Percentage of PME AQS	Impact Significance	UTM Grid Ref	
							Easting	Northing
10-min mean	*500*	29.10	18-Jul	21:00	6%		562750	2741150
Highest 1-hr Mean	*730*	15.91	16-Jun	18:00	2%	NEGLIGIBLE	562750	2741150
99.7th Percentile of 24-hr Means	*365*	5.29	20-Jul		1%	NEGLIGIBLE	562750	2741150
Annual Mean	*80*	0.86			1%	NEGLIGIBLE	562800	2741150

Table A5-9: PM_{10} Concentrations

Averaging Period	Air Quality Standard	Concentration (µg/m^3)	Date	Percentage of PME AQS	Impact Significance	UTM Grid Ref	
						Easting	Northing
90th Percentile of 24-hr Means	*340*	5.70		2%	NEGLIGIBLE	562800	2741150
Annual Mean	*80*	1.99		2%	NEGLIGIBLE	562800	2741150

Predicted Concentrations (Scenario 2B) – Maximum at Sensitive Receptors

Table A5-10 NO_2 Concentrations

Receptor		UTM Grid Ref		NO_2 Concentrations (µg/m^3)					
		Easting	Northing	Annual Mean	Percentage of PME AQS	Impact Significance	1-hour Mean	Percentage of PME AQS	Impact Significance
1	PP11 Accommodation Block 1	563112.1	2741763.0	0.70	1%	NEGLIGIBLE	18.59	3%	NEGLIGIBLE
2	PP11 Accommodation Block 2	562822.4	2741730.0	1.41	1%	NEGLIGIBLE	16.00	2%	NEGLIGIBLE
3	PP11 Accommodation Block 3	562809.0	2741831.0	1.55	2%	NEGLIGIBLE	14.60	2%	NEGLIGIBLE
4	PP11 Accommodation Block 4	563099.3	2741864.0	0.78	1%	NEGLIGIBLE	18.90	3%	NEGLIGIBLE
5	PP11 Social Building 1	563641.6	2741327.0	0.23	<1%	NEGLIGIBLE	9.51	1%	NEGLIGIBLE
6	PP11 Social Building 2	563657.9	2741331.0	0.23	<1%	NEGLIGIBLE	9.44	1%	NEGLIGIBLE
7	PP11 Social Building 3	563655.8	2741352.0	0.23	<1%	NEGLIGIBLE	8.97	1%	NEGLIGIBLE
8	PP11 Social Building 4	563639.5	2741350.0	0.23	<1%	NEGLIGIBLE	9.00	1%	NEGLIGIBLE
9	PP11 Administration Building 1	563670.1	2741335.0	0.23	<1%	NEGLIGIBLE	9.16	1%	NEGLIGIBLE
10	PP11 Administration Building 2	563712.4	2741340.0	0.22	<1%	NEGLIGIBLE	8.85	1%	NEGLIGIBLE
11	PP11 Administration Building 3	563710.5	2741354.0	0.22	<1%	NEGLIGIBLE	8.85	1%	NEGLIGIBLE
12	PP11 Administration Building 4	563668.5	2741350.0	0.23	<1%	NEGLIGIBLE	8.95	1%	NEGLIGIBLE
13	Quarry	579650	2742930	0.02	<1%	NEGLIGIBLE	1.22	<1%	NEGLIGIBLE
14	Goat Farming	583130	2742220	0.02	<1%	NEGLIGIBLE	1.17	<1%	NEGLIGIBLE
15	Grain Silos	576290	2740520	0.02	<1%	NEGLIGIBLE	1.27	<1%	NEGLIGIBLE
16	Aramco Pumping Station	584480	2742840	0.02	<1%	NEGLIGIBLE	1.08	<1%	NEGLIGIBLE
17	Wheat/Fodder Fields	572955	2738800	0.02	<1%	NEGLIGIBLE	1.83	<1%	NEGLIGIBLE
18	PP12 Administration Building	561030.9	2741155.0	0.18	<1%	NEGLIGIBLE	4.91	1%	NEGLIGIBLE
19	PP12 Musjid	561075.8	2741175.0	0.18	<1%	NEGLIGIBLE	5.09	1%	NEGLIGIBLE
20	PP13 Administration Building	562694.2	2741434.0	1.00	1%	NEGLIGIBLE	23.36	4%	NEGLIGIBLE
21	PP13 Musjid	562739.1	2741454.0	0.98	1%	NEGLIGIBLE	21.87	3%	NEGLIGIBLE

Table A5-11 SO_2 Concentrations

Receptor		UTM Grid Ref		SO_2 Concentrations (µg/m^3)								
		Easting	Northing	Annual Mean	Percentage of PME AQS	Impact Significance	1-hour Mean	Percentage of PME AQS	Impact Significance	99.7th Percentile of 24-hour Means	Percentage of PME AQS	Impact Significance
1	PP11 Accommodation Block 1	563112.1	2741763.0	0.06	<1%	NEGLIGIBLE	2.95	<1%	NEGLIGIBLE	0.53	<1%	NEGLIGIBLE
2	PP11 Accommodation Block 2	562822.4	2741730.0	0.11	<1%	NEGLIGIBLE	2.54	<1%	NEGLIGIBLE	0.92	<1%	NEGLIGIBLE
3	PP11 Accommodation Block 3	562809.0	2741831.0	0.12	<1%	NEGLIGIBLE	2.32	<1%	NEGLIGIBLE	1.06	<1%	NEGLIGIBLE
4	PP11 Accommodation Block 4	563099.3	2741864.0	0.06	<1%	NEGLIGIBLE	3.00	<1%	NEGLIGIBLE	0.58	<1%	NEGLIGIBLE
5	PP11 Social Building 1	563641.6	2741327.0	0.02	<1%	NEGLIGIBLE	1.51	<1%	NEGLIGIBLE	0.24	<1%	NEGLIGIBLE
6	PP11 Social Building 2	563657.9	2741331.0	0.02	<1%	NEGLIGIBLE	1.50	<1%	NEGLIGIBLE	0.24	<1%	NEGLIGIBLE
7	PP11 Social Building 3	563655.8	2741352.0	0.02	<1%	NEGLIGIBLE	1.43	<1%	NEGLIGIBLE	0.25	<1%	NEGLIGIBLE
8	PP11 Social Building 4	563639.5	2741350.0	0.02	<1%	NEGLIGIBLE	1.43	<1%	NEGLIGIBLE	0.25	<1%	NEGLIGIBLE
9	PP11 Administration Building 1	563670.1	2741335.0	0.02	<1%	NEGLIGIBLE	1.46	<1%	NEGLIGIBLE	0.24	<1%	NEGLIGIBLE
10	PP11 Administration Building 2	563712.4	2741340.0	0.02	<1%	NEGLIGIBLE	1.41	<1%	NEGLIGIBLE	0.24	<1%	NEGLIGIBLE
11	PP11 Administration Building 3	563710.5	2741354.0	0.02	<1%	NEGLIGIBLE	1.41	<1%	NEGLIGIBLE	0.24	<1%	NEGLIGIBLE
12	PP11 Administration Building 4	563668.5	2741350.0	0.02	<1%	NEGLIGIBLE	1.42	<1%	NEGLIGIBLE	0.25	<1%	NEGLIGIBLE
13	Quarry	579650	2742930	<0.01	<1%	NEGLIGIBLE	0.19	<1%	NEGLIGIBLE	0.02	<1%	NEGLIGIBLE
14	Goat Farming	583130	2742220	<0.01	<1%	NEGLIGIBLE	0.19	<1%	NEGLIGIBLE	0.02	<1%	NEGLIGIBLE
15	Grain Silos	576290	2740520	<0.01	<1%	NEGLIGIBLE	0.20	<1%	NEGLIGIBLE	0.02	<1%	NEGLIGIBLE
16	Aramco Pumping Station	584480	2742840	<0.01	<1%	NEGLIGIBLE	0.17	<1%	NEGLIGIBLE	0.02	<1%	NEGLIGIBLE
17	Wheat/Fodder Fields	572955	2738800	<0.01	<1%	NEGLIGIBLE	0.29	<1%	NEGLIGIBLE	0.03	<1%	NEGLIGIBLE
18	PP12 Administration Building	561030.9	2741155.0	0.01	<1%	NEGLIGIBLE	0.78	<1%	NEGLIGIBLE	0.10	<1%	NEGLIGIBLE
19	PP12 Musjid	561075.8	2741175.0	0.01	<1%	NEGLIGIBLE	0.81	<1%	NEGLIGIBLE	0.11	<1%	NEGLIGIBLE
20	PP13 Administration Building	562694.2	2741434.0	0.08	<1%	NEGLIGIBLE	3.71	<1%	NEGLIGIBLE	0.93	<1%	NEGLIGIBLE
21	PP13 Musjid	562739.1	2741454.0	0.08	<1%	NEGLIGIBLE	3.47	<1%	NEGLIGIBLE	0.83	<1%	NEGLIGIBLE

Table A5-12 PM_{10} Concentrations

Receptor		UTM Grid Ref		PM_{10} Concentrations (µg/m^3)					
		Easting	Northing	Annual Mean	Percentage of PME AQS	Impact Significance	99.7th Percentile of 24-hour Means	Percentage of PME AQS	Impact Significance
1	PP11 Accommodation Block 1	563112.1	2741763.0	0.13	<1%	NEGLIGIBLE	0.37	<1%	NEGLIGIBLE
2	PP11 Accommodation Block 2	562822.4	2741730.0	0.26	<1%	NEGLIGIBLE	0.70	<1%	NEGLIGIBLE
3	PP11 Accommodation Block 3	562809.0	2741831.0	0.28	<1%	NEGLIGIBLE	0.80	<1%	NEGLIGIBLE
4	PP11 Accommodation Block 4	563099.3	2741864.0	0.14	<1%	NEGLIGIBLE	0.43	<1%	NEGLIGIBLE
5	PP11 Social Building 1	563641.6	2741327.0	0.04	<1%	NEGLIGIBLE	0.09	<1%	NEGLIGIBLE
6	PP11 Social Building 2	563657.9	2741331.0	0.04	<1%	NEGLIGIBLE	0.09	<1%	NEGLIGIBLE
7	PP11 Social Building 3	563655.8	2741352.0	0.04	<1%	NEGLIGIBLE	0.09	<1%	NEGLIGIBLE
8	PP11 Social Building 4	563639.5	2741350.0	0.04	<1%	NEGLIGIBLE	0.09	<1%	NEGLIGIBLE
9	PP11 Administration Building 1	563670.1	2741335.0	0.04	<1%	NEGLIGIBLE	0.09	<1%	NEGLIGIBLE
10	PP11 Administration Building 2	563712.4	2741340.0	0.04	<1%	NEGLIGIBLE	0.08	<1%	NEGLIGIBLE
11	PP11 Administration Building 3	563710.5	2741354.0	0.04	<1%	NEGLIGIBLE	0.09	<1%	NEGLIGIBLE
12	PP11 Administration Building 4	563668.5	2741350.0	0.04	<1%	NEGLIGIBLE	0.09	<1%	NEGLIGIBLE
13	Quarry	579650	2742930	0.00	<1%	NEGLIGIBLE	0.01	<1%	NEGLIGIBLE
14	Goat Farming	583130	2742220	0.00	<1%	NEGLIGIBLE	0.01	<1%	NEGLIGIBLE
15	Grain Silos	576290	2740520	0.00	<1%	NEGLIGIBLE	0.01	<1%	NEGLIGIBLE
16	Aramco Pumping Station	584480	2742840	0.00	<1%	NEGLIGIBLE	0.01	<1%	NEGLIGIBLE
17	Wheat/Fodder Fields	572955	2738800	0.00	<1%	NEGLIGIBLE	0.01	<1%	NEGLIGIBLE
18	PP12 Administration Building	561030.9	2741155.0	0.03	<1%	NEGLIGIBLE	0.08	<1%	NEGLIGIBLE
19	PP12 Musjid	561075.8	2741175.0	0.03	<1%	NEGLIGIBLE	0.09	<1%	NEGLIGIBLE
20	PP13 Administration Building	562694.2	2741434.0	0.18	<1%	NEGLIGIBLE	0.54	<1%	NEGLIGIBLE
21	PP13 Musjid	562739.1	2741454.0	0.18	<1%	NEGLIGIBLE	0.53	<1%	NEGLIGIBLE

Modelling Results: Riyadh PP13 – Scenario 2C

Scenario 2C Operating Conditions:

Load: Maximum Load
Mode: Combined Cycle
Fuel: Diesel (NO_2) and ASL (SO_2 and PM_{10})

Predicted Concentrations – Maximum point of Impact

Table A5-13: NO_2 Concentrations

Averaging Period	Air Quality Standard	Concentration (µg/m^3)	Date	Time	Percentage of PME AQS	Impact Significance	UTM Grid Ref	
							Easting	Northing
Highest 1-hr Mean	*660*	1,804.05	04-May	21:00	273%	CRITICAL	563200	2741200

NB - 50% oxidation of NO_x to NO_2 assumed for 1-hour mean concentrations; 100% oxidation for annual means

Table A5-14 SO_2 Concentrations

Averaging Period	Air Quality Standard	Concentration (µg/m^3)	Date	Time	Percentage of PME AQS	Impact Significance	UTM Grid Ref	
							Easting	Northing
10-min mean	*500*	767.84	09-May	14:00	154%	NA	563200	2741200
Highest 1-hr Mean	*730*	388.49	05-May	21:00	53%	MODERATE	563200	2741200
99.7th Percentile of 24-hr Means	*365*	132.78	05-Apr		36%	MODERATE	562800	2741150

Table A5-15: PM_{10} Concentrations

Averaging Period	Air Quality Standard	Concentration (µg/m^3)	Date	Time	Percentage of PME AQS	Impact Significance	UTM Grid Ref	
							Easting	Northing
90th Percentile of 24-hr Means	*340*	7.21	18-Aug		2%	MINOR	562800	2741150

Predicted Concentrations (Scenario 2C) – Maximum at Sensitive Receptors

Table A5-16 NO_2 Concentrations

Receptor		UTM Grid Ref		NO_2 Concentrations (µg/m^3)		
		Easting	Northing	1-hour Mean	Percentage of PME AQS	Impact Significance
1	PP11 Accommodation Compound (SE)	563112.1	2741763.0	341.79	52%	MODERATE
2	PP11 Accommodation Compound (SW)	562822.4	2741730.0	338.43	51%	MODERATE
3	PP11 Accommodation Compound (NW)	562809.0	2741831.0	289.39	44%	MODERATE
4	PP11 Accommodation Compound (NE)	563099.3	2741864.0	327.02	50%	MODERATE
5	PP11 Social Building 1	563641.6	2741327.0	166.96	25%	MODERATE
6	PP11 Social Building 2	563657.9	2741331.0	167.31	25%	MODERATE
7	PP11 Social Building 3	563655.8	2741352.0	160.25	24%	MINOR
8	PP11 Social Building 4	563639.5	2741350.0	160.05	24%	MINOR
9	PP11 Administration Building 1	563670.1	2741335.0	167.31	25%	MODERATE
10	PP11 Administration Building 2	563712.4	2741340.0	164.13	25%	MINOR
11	PP11 Administration Building 3	563710.5	2741354.0	156.94	24%	MINOR
12	PP11 Administration Building 4	563668.5	2741350.0	160.10	24%	MINOR
13	Quarry	579650	2742930	23.50	4%	NEGLIGIBLE
14	Goat Farming	583130	2742220	23.33	4%	NEGLIGIBLE
15	Grain Silos	576290	2740520	27.54	4%	NEGLIGIBLE
16	Aramco Pumping Station	584480	2742840	21.50	3%	NEGLIGIBLE
17	Wheat/Fodder Fields	572955	2738800	38.43	6%	MINOR
18	PP12 Administration Building	561030.9	2741155.0	89.82	14%	MINOR
19	PP12 Musjid	561075.8	2741175.0	93.00	14%	MINOR
20	PP13 Administration Building	562694.2	2741434.0	395.09	60%	MODERATE
21	PP13 Musjid	562739.1	2741454.0	373.92	57%	MODERATE

Table A5-17 SO_2 Concentrations

Receptor		UTM Grid Ref		SO_2 Concentrations (µg/m^3)					
		Easting	Northing	1-hour Mean	Percentage of PME AQS	Impact Significance	99.7th Percentile of 24-hour Means	Percentage of PME AQS	Impact Significance
1	PP11 Accommodation Compound (SE)	563112.1	2741763.0	80.93	11%	MINOR	12.19	3%	NEGLIGIBLE
2	PP11 Accommodation Compound (SW)	562822.4	2741730.0	77.74	11%	MINOR	28.64	8%	MINOR
3	PP11 Accommodation Compound (NW)	562809.0	2741831.0	68.44	9%	MINOR	26.74	7%	MINOR
4	PP11 Accommodation Compound (NE)	563099.3	2741864.0	70.49	10%	MINOR	11.05	3%	NEGLIGIBLE
5	PP11 Social Building 1	563641.6	2741327.0	82.90	11%	MINOR	9.14	3%	NEGLIGIBLE
6	PP11 Social Building 2	563657.9	2741331.0	80.11	11%	MINOR	8.79	2%	NEGLIGIBLE
7	PP11 Social Building 3	563655.8	2741352.0	75.70	10%	MINOR	7.35	2%	NEGLIGIBLE
8	PP11 Social Building 4	563639.5	2741350.0	78.20	11%	MINOR	7.75	2%	NEGLIGIBLE
9	PP11 Administration Building 1	563670.1	2741335.0	77.85	11%	MINOR	8.33	2%	NEGLIGIBLE
10	PP11 Administration Building 2	563712.4	2741340.0	71.57	10%	MINOR	7.26	2%	NEGLIGIBLE
11	PP11 Administration Building 3	563710.5	2741354.0	68.88	9%	MINOR	6.30	2%	NEGLIGIBLE
12	PP11 Administration Building 4	563668.5	2741350.0	74.90	10%	MINOR	7.22	2%	NEGLIGIBLE
13	Quarry	579650	2742930	4.23	<1%	NEGLIGIBLE	0.40	<1%	NEGLIGIBLE
14	Goat Farming	583130	2742220	4.30	<1%	NEGLIGIBLE	0.44	<1%	NEGLIGIBLE
15	Grain Silos	576290	2740520	5.23	<1%	NEGLIGIBLE	0.44	<1%	NEGLIGIBLE
16	Aramco Pumping Station	584480	2742840	3.97	<1%	NEGLIGIBLE	0.39	<1%	NEGLIGIBLE
17	Wheat/Fodder Fields	572955	2738800	7.24	1%	NEGLIGIBLE	0.59	<1%	NEGLIGIBLE
18	PP12 Administration Building	561030.9	2741155.0	13.78	2%	NEGLIGIBLE	1.79	<1%	NEGLIGIBLE
19	PP12 Musjid	561075.8	2741175.0	13.82	2%	NEGLIGIBLE	1.81	<1%	NEGLIGIBLE
20	PP13 Administration Building	562694.2	2741434.0	130.42	18%	MINOR	38.16	10%	MINOR
21	PP13 Musjid	562739.1	2741454.0	129.43	18%	MINOR	38.43	11%	MINOR

Table A5-18 PM_{10} Concentrations

Receptor		UTM Grid Ref		PM_{10} Concentrations (µg/m^3)		
		Easting	Northing	90th Percentile of 24-hour Means	Percentage of PME AQS	Impact Significance
1	PP11 Accommodation Compound (SE)	563112.1	2741763.0	0.48	<1%	NEGLIGIBLE
2	PP11 Accommodation Compound (SW)	562822.4	2741730.0	1.45	<1%	NEGLIGIBLE
3	PP11 Accommodation Compound (NW)	562809.0	2741831.0	1.49	<1%	NEGLIGIBLE
4	PP11 Accommodation Compound (NE)	563099.3	2741864.0	0.61	<1%	NEGLIGIBLE
5	PP11 Social Building 1	563641.6	2741327.0	0.12	<1%	NEGLIGIBLE
6	PP11 Social Building 2	563657.9	2741331.0	0.12	<1%	NEGLIGIBLE
7	PP11 Social Building 3	563655.8	2741352.0	0.11	<1%	NEGLIGIBLE
8	PP11 Social Building 4	563639.5	2741350.0	0.12	<1%	NEGLIGIBLE
9	PP11 Administration Building 1	563670.1	2741335.0	0.12	<1%	NEGLIGIBLE
10	PP11 Administration Building 2	563712.4	2741340.0	0.12	<1%	NEGLIGIBLE
11	PP11 Administration Building 3	563710.5	2741354.0	0.11	<1%	NEGLIGIBLE
12	PP11 Administration Building 4	563668.5	2741350.0	0.11	<1%	NEGLIGIBLE
13	Quarry	579650	2742930	0.01	<1%	NEGLIGIBLE
14	Goat Farming	583130	2742220	0.01	<1%	NEGLIGIBLE
15	Grain Silos	576290	2740520	0.01	<1%	NEGLIGIBLE
16	Aramco Pumping Station	584480	2742840	0.01	<1%	NEGLIGIBLE
17	Wheat/Fodder Fields	572955	2738800	0.02	<1%	NEGLIGIBLE
18	PP12 Administration Building	561030.9	2741155.0	0.14	<1%	NEGLIGIBLE
19	PP12 Musjid	561075.8	2741175.0	0.15	<1%	NEGLIGIBLE
20	PP13 Administration Building	562694.2	2741434.0	1.05	<1%	NEGLIGIBLE
21	PP13 Musjid	562739.1	2741454.0	1.23	<1%	NEGLIGIBLE

Modelling Results: Riyadh PP13 – Scenario 2D

Scenario 2D Operating Conditions:

Load: Maximum Load
Mode: Simple Cycle
Fuel: Sales Gas

Predicted Concentrations – Maximum point of Impact

Table A5-19: NO_2 Concentrations

Averaging Period	Air Quality Standard	Concentration (µg/m^3)	Date	Time	Percentage of PME AQS	Impact Significance	UTM Grid Ref	
							Easting	Northing
Highest 1-hr Mean	*660*	101.60	23-Mar	21:00	15%	MINOR	562950	2741050

NB - 50% oxidation of NO_x to NO_2 assumed for 1-hour mean concentrations; 100% oxidation for annual means

Table A5-20 SO_2 Concentrations

Averaging Period	Air Quality Standard	Concentration (µg/m^3)	Date	Time	Percentage of PME AQS	Impact Significance	UTM Grid Ref	
							Easting	Northing
10-min mean	*500*	27.26	08-Aug	12:00	5%		562950	2741050
Highest 1-hr Mean	*730*	16.14	23-Mar	21:00	2%	NEGLIGIBLE	562950	2741050
99.7th Percentile of 24-hr Means	*365*	6.04	13-Mar		2%	NEGLIGIBLE	562900	2741100

Table A5-21: PM_{10} Concentrations

Averaging Period	Air Quality Standard	Concentration (µg/m^3)	Date	Percentage of PME AQS	Impact Significance	UTM Grid Ref	
						Easting	Northing
90th Percentile of 24-hr Means	*340*	6.12	13-Mar	2%	NEGLIGIBLE	562950	2741150

Predicted Concentrations (Scenario 2D) – Maximum at Sensitive Receptors

Table A5-22 NO_2 Concentrations

Receptor		UTM Grid Ref		NO_2 Concentrations (µg/m^3)		
		Easting	Northing	1-hour Mean	Percentage of PME AQS	Impact Significance
1	PP11 Accommodation Compound (SE)	563112.1	2741763.0	18.62	3%	NEGLIGIBLE
2	PP11 Accommodation Compound (SW)	562822.4	2741730.0	18.01	3%	NEGLIGIBLE
3	PP11 Accommodation Compound (NW)	562809.0	2741831.0	16.09	2%	NEGLIGIBLE
4	PP11 Accommodation Compound (NE)	563099.3	2741864.0	16.24	2%	NEGLIGIBLE
5	PP11 Social Building 1	563641.6	2741327.0	18.52	3%	NEGLIGIBLE
6	PP11 Social Building 2	563657.9	2741331.0	17.87	3%	NEGLIGIBLE
7	PP11 Social Building 3	563655.8	2741352.0	16.88	3%	NEGLIGIBLE
8	PP11 Social Building 4	563639.5	2741350.0	17.47	3%	NEGLIGIBLE
9	PP11 Administration Building 1	563670.1	2741335.0	17.35	3%	NEGLIGIBLE
10	PP11 Administration Building 2	563712.4	2741340.0	15.89	2%	NEGLIGIBLE
11	PP11 Administration Building 3	563710.5	2741354.0	15.29	2%	NEGLIGIBLE
12	PP11 Administration Building 4	563668.5	2741350.0	16.69	3%	NEGLIGIBLE
13	Quarry	579650	2742930	0.98	<1%	NEGLIGIBLE
14	Goat Farming	583130	2742220	1.00	<1%	NEGLIGIBLE
15	Grain Silos	576290	2740520	1.21	<1%	NEGLIGIBLE
16	Aramco Pumping Station	584480	2742840	0.93	<1%	NEGLIGIBLE
17	Wheat/Fodder Fields	572955	2738800	1.66	<1%	NEGLIGIBLE
18	PP12 Administration Building	561030.9	2741155.0	3.21	<1%	NEGLIGIBLE
19	PP12 Musjid	561075.8	2741175.0	3.23	<1%	NEGLIGIBLE
20	PP13 Administration Building	562694.2	2741434.0	30.54	5%	MINOR
21	PP13 Musjid	562739.1	2741454.0	30.31	5%	MINOR

Table A5-23 SO_2 Concentrations

Receptor		UTM Grid Ref		SO_2 Concentrations (µg/m^3)					
		Easting	Northing	1-hour Mean	Percentage of PME AQS	Impact Significance	99.7th Percentile of 24-hour Means	Percentage of PME AQS	Impact Significance
1	PP11 Accommodation Compound (SE)	563112.1	2741763.0	2.96	<1%	NEGLIGIBLE	0.46	<1%	NEGLIGIBLE
2	PP11 Accommodation Compound (SW)	562822.4	2741730.0	2.86	<1%	NEGLIGIBLE	1.06	<1%	NEGLIGIBLE
3	PP11 Accommodation Compound (NW)	562809.0	2741831.0	2.56	<1%	NEGLIGIBLE	0.99	<1%	NEGLIGIBLE
4	PP11 Accommodation Compound (NE)	563099.3	2741864.0	2.58	<1%	NEGLIGIBLE	0.41	<1%	NEGLIGIBLE
5	PP11 Social Building 1	563641.6	2741327.0	2.94	<1%	NEGLIGIBLE	0.32	<1%	NEGLIGIBLE
6	PP11 Social Building 2	563657.9	2741331.0	2.84	<1%	NEGLIGIBLE	0.31	<1%	NEGLIGIBLE
7	PP11 Social Building 3	563655.8	2741352.0	2.68	<1%	NEGLIGIBLE	0.27	<1%	NEGLIGIBLE
8	PP11 Social Building 4	563639.5	2741350.0	2.78	<1%	NEGLIGIBLE	0.28	<1%	NEGLIGIBLE
9	PP11 Administration Building 1	563670.1	2741335.0	2.76	<1%	NEGLIGIBLE	0.30	<1%	NEGLIGIBLE
10	PP11 Administration Building 2	563712.4	2741340.0	2.52	<1%	NEGLIGIBLE	0.26	<1%	NEGLIGIBLE
11	PP11 Administration Building 3	563710.5	2741354.0	2.43	<1%	NEGLIGIBLE	0.23	<1%	NEGLIGIBLE
12	PP11 Administration Building 4	563668.5	2741350.0	2.65	<1%	NEGLIGIBLE	0.26	<1%	NEGLIGIBLE
13	Quarry	579650	2742930	0.16	<1%	NEGLIGIBLE	0.02	<1%	NEGLIGIBLE
14	Goat Farming	583130	2742220	0.16	<1%	NEGLIGIBLE	0.02	<1%	NEGLIGIBLE
15	Grain Silos	576290	2740520	0.19	<1%	NEGLIGIBLE	0.02	<1%	NEGLIGIBLE
16	Aramco Pumping Station	584480	2742840	0.15	<1%	NEGLIGIBLE	0.01	<1%	NEGLIGIBLE
17	Wheat/Fodder Fields	572955	2738800	0.26	<1%	NEGLIGIBLE	0.02	<1%	NEGLIGIBLE
18	PP12 Administration Building	561030.9	2741155.0	0.51	<1%	NEGLIGIBLE	0.07	<1%	NEGLIGIBLE
19	PP12 Musjid	561075.8	2741175.0	0.51	<1%	NEGLIGIBLE	0.07	<1%	NEGLIGIBLE
20	PP13 Administration Building	562694.2	2741434.0	4.85	<1%	NEGLIGIBLE	1.41	<1%	NEGLIGIBLE
21	PP13 Musjid	562739.1	2741454.0	4.82	<1%	NEGLIGIBLE	1.42	<1%	NEGLIGIBLE

Table A5-24 PM_{10} Concentrations

Receptor		UTM Grid Ref		PM_{10} Concentrations (µg/m^3)		
		Easting	Northing	90th Percentile of 24-hour Means	Percentage of PME AQS	Impact Significance
1	PP11 Accommodation Compound (SE)	563112.1	2741763.0	0.38	<1%	NEGLIGIBLE
2	PP11 Accommodation Compound (SW)	562822.4	2741730.0	0.94	<1%	NEGLIGIBLE
3	PP11 Accommodation Compound (NW)	562809.0	2741831.0	0.91	<1%	NEGLIGIBLE
4	PP11 Accommodation Compound (NE)	563099.3	2741864.0	0.39	<1%	NEGLIGIBLE
5	PP11 Social Building 1	563641.6	2741327.0	0.07	<1%	NEGLIGIBLE
6	PP11 Social Building 2	563657.9	2741331.0	0.06	<1%	NEGLIGIBLE
7	PP11 Social Building 3	563655.8	2741352.0	0.06	<1%	NEGLIGIBLE
8	PP11 Social Building 4	563639.5	2741350.0	0.06	<1%	NEGLIGIBLE
9	PP11 Administration Building 1	563670.1	2741335.0	0.06	<1%	NEGLIGIBLE
10	PP11 Administration Building 2	563712.4	2741340.0	0.06	<1%	NEGLIGIBLE
11	PP11 Administration Building 3	563710.5	2741354.0	0.06	<1%	NEGLIGIBLE
12	PP11 Administration Building 4	563668.5	2741350.0	0.06	<1%	NEGLIGIBLE
13	Quarry	579650	2742930	0.01	<1%	NEGLIGIBLE
14	Goat Farming	583130	2742220	0.01	<1%	NEGLIGIBLE
15	Grain Silos	576290	2740520	0.01	<1%	NEGLIGIBLE
16	Aramco Pumping Station	584480	2742840	0.01	<1%	NEGLIGIBLE
17	Wheat/Fodder Fields	572955	2738800	0.01	<1%	NEGLIGIBLE
18	PP12 Administration Building	561030.9	2741155.0	0.06	<1%	NEGLIGIBLE
19	PP12 Musjid	561075.8	2741175.0	0.06	<1%	NEGLIGIBLE
20	PP13 Administration Building	562694.2	2741434.0	1.06	<1%	NEGLIGIBLE
21	PP13 Musjid	562739.1	2741454.0	1.23	<1%	NEGLIGIBLE

Modelling Results: Riyadh PP13 – Scenario 2E

Scenario 2E Operating Conditions:

Load: Maximum Load
Mode: Simple Cycle
Fuel: Diesel (NO_2) and ASL (SO_2 and PM_{10})

Predicted Concentrations – Maximum point of Impact

Table A5-25: NO_2 Concentrations

Averaging Period	Air Quality Standard	Concentration (µg/m^3)	Date	Time	Percentage of PME AQS	Impact Significance	UTM Grid Ref	
							Easting	Northing
Highest 1-hr Mean	*660*	2,022.07	05-May	17:00	306%	CRITICAL	562950	2741050

NB - 50% oxidation of NO_x to NO_2 assumed for 1-hour mean concentrations; 100% oxidation for annual means

Table A5-26 SO_2 Concentrations

Averaging Period	Air Quality Standard	Concentration (µg/m^3)	Date	Time	Percentage of PME AQS	Impact Significance	UTM Grid Ref	
							Easting	Northing
10-min mean	*500*	767.84	09-May	14:00	154%	NA	563200	2741200
Highest 1-hr Mean	*730*	388.49	05-May	21:00	53%	MODERATE	563200	2741200
99.7th Percentile of 24-hr Means	*365*	132.78	05-Apr		36%	MODERATE	562800	2741150

Table A5-27: PM_{10} Concentrations

Averaging Period	Air Quality Standard	Concentration (µg/m^3)	Date	Percentage of PME AQS	Impact Significance	UTM Grid Ref	
						Easting	Northing
90th Percentile of 24-hr Means	*340*	7.21	18-Aug	2%	MINOR	562800	2741150

Predicted Concentrations (Scenario 2E) – Maximum at Sensitive Receptors

Table A5-28 NO_2 Concentrations

Receptor		UTM Grid Ref		NO_2 Concentrations (µg/m^3)		
		Easting	Northing	1-hour Mean	Percentage of PME AQS	Impact Significance
1	PP11 Accommodation Compound (SE)	563112.1	2741763.0	375.83	56.9%	MODERATE
2	PP11 Accommodation Compound (SW)	562822.4	2741730.0	361.02	54.7%	MODERATE
3	PP11 Accommodation Compound (NW)	562809.0	2741831.0	317.83	48.2%	MODERATE
4	PP11 Accommodation Compound (NE)	563099.3	2741864.0	327.31	49.6%	MODERATE
5	PP11 Social Building 1	563641.6	2741327.0	384.99	58.3%	MODERATE
6	PP11 Social Building 2	563657.9	2741331.0	372.01	56.4%	MODERATE
7	PP11 Social Building 3	563655.8	2741352.0	351.51	53.3%	MODERATE
8	PP11 Social Building 4	563639.5	2741350.0	363.16	55.0%	MODERATE
9	PP11 Administration Building 1	563670.1	2741335.0	361.54	54.8%	MODERATE
10	PP11 Administration Building 2	563712.4	2741340.0	332.35	50.4%	MODERATE
11	PP11 Administration Building 3	563710.5	2741354.0	319.85	48.5%	MODERATE
12	PP11 Administration Building 4	563668.5	2741350.0	347.82	52.7%	MODERATE
13	Quarry	579650	2742930	19.63	3.0%	NEGLIGIBLE
14	Goat Farming	583130	2742220	19.98	3.0%	NEGLIGIBLE
15	Grain Silos	576290	2740520	24.30	3.7%	NEGLIGIBLE
16	Aramco Pumping Station	584480	2742840	18.42	2.8%	NEGLIGIBLE
17	Wheat/Fodder Fields	572955	2738800	33.63	5.1%	MINOR
18	PP12 Administration Building	561030.9	2741155.0	64.00	9.7%	MINOR
19	PP12 Musjid	561075.8	2741175.0	64.20	9.7%	MINOR
20	PP13 Administration Building	562694.2	2741434.0	605.63	91.8%	MAJOR
21	PP13 Musjid	562739.1	2741454.0	601.03	91.1%	MAJOR

Table A5-29 SO_2 Concentrations

Receptor		UTM Grid Ref		SO_2 Concentrations (µg/m^3)					
		Easting	Northing	1-hour Mean	Percentage of PME AQS	Impact Significance	99.7th Percentile of 24-hour Means	Percentage of PME AQS	Impact Significance
1	PP11 Accommodation Compound (SE)	563112.1	2741763.0	80.93	11%	MINOR	12.19	3%	NEGLIGIBLE
2	PP11 Accommodation Compound (SW)	562822.4	2741730.0	77.74	11%	MINOR	28.64	8%	MINOR
3	PP11 Accommodation Compound (NW)	562809.0	2741831.0	68.44	9%	MINOR	26.74	7%	MINOR
4	PP11 Accommodation Compound (NE)	563099.3	2741864.0	70.49	10%	MINOR	11.05	3%	NEGLIGIBLE
5	PP11 Social Building 1	563641.6	2741327.0	82.90	11%	MINOR	9.14	3%	NEGLIGIBLE
6	PP11 Social Building 2	563657.9	2741331.0	80.11	11%	MINOR	8.79	2%	NEGLIGIBLE
7	PP11 Social Building 3	563655.8	2741352.0	75.70	10%	MINOR	7.35	2%	NEGLIGIBLE
8	PP11 Social Building 4	563639.5	2741350.0	78.20	11%	MINOR	7.75	2%	NEGLIGIBLE
9	PP11 Administration Building 1	563670.1	2741335.0	77.85	11%	MINOR	8.33	2%	NEGLIGIBLE
10	PP11 Administration Building 2	563712.4	2741340.0	71.57	10%	MINOR	7.26	2%	NEGLIGIBLE
11	PP11 Administration Building 3	563710.5	2741354.0	68.88	9%	MINOR	6.30	2%	NEGLIGIBLE
12	PP11 Administration Building 4	563668.5	2741350.0	74.90	10%	MINOR	7.22	2%	NEGLIGIBLE
13	Quarry	579650	2742930	4.23	<1%	NEGLIGIBLE	0.40	<1%	NEGLIGIBLE
14	Goat Farming	583130	2742220	4.30	<1%	NEGLIGIBLE	0.44	<1%	NEGLIGIBLE
15	Grain Silos	576290	2740520	5.23	<1%	NEGLIGIBLE	0.44	<1%	NEGLIGIBLE
16	Aramco Pumping Station	584480	2742840	3.97	<1%	NEGLIGIBLE	0.39	<1%	NEGLIGIBLE
17	Wheat/Fodder Fields	572955	2738800	7.24	1%	NEGLIGIBLE	0.59	<1%	NEGLIGIBLE
18	PP12 Administration Building	561030.9	2741155.0	13.78	2%	NEGLIGIBLE	1.79	<1%	NEGLIGIBLE
19	PP12 Musjid	561075.8	2741175.0	13.82	2%	NEGLIGIBLE	1.81	<1%	NEGLIGIBLE
20	PP13 Administration Building	562694.2	2741434.0	130.42	18%	MINOR	38.16	10%	MINOR
21	PP13 Musjid	562739.1	2741454.0	129.43	18%	MINOR	38.43	11%	MINOR

Table A5-30 PM_{10} Concentrations

Receptor		UTM Grid Ref		PM_{10} Concentrations (µg/m^3)		
		Easting	Northing	90th Percentile of 24-hour Means	Percentage of PME AQS	Impact Significance
1	PP11 Accommodation Compound (SE)	563768.1	2741155.5	0.57	<1%	NEGLIGIBLE
2	PP11 Accommodation Compound (SW)	563800.7	2741161.7	1.43	<1%	NEGLIGIBLE
3	PP11 Accommodation Compound (NW)	563782.4	2741304.5	1.36	<1%	NEGLIGIBLE
4	PP11 Accommodation Compound (NE)	563747.7	2741298.4	0.58	<1%	NEGLIGIBLE
5	PP11 Social Building 1	563641.5	2741327.0	0.10	<1%	NEGLIGIBLE
6	PP11 Social Building 2	563657.9	2741331.1	0.10	<1%	NEGLIGIBLE
7	PP11 Social Building 3	563655.8	2741351.5	0.10	<1%	NEGLIGIBLE
8	PP11 Social Building 4	563639.5	2741349.4	0.10	<1%	NEGLIGIBLE
9	PP11 Administration Building 1	563670.1	2741335.2	0.10	<1%	NEGLIGIBLE
10	PP11 Administration Building 2	563712.4	2741340.2	0.09	<1%	NEGLIGIBLE
11	PP11 Administration Building 3	563710.5	2741354.2	0.09	<1%	NEGLIGIBLE
12	PP11 Administration Building 4	563668.5	2741349.4	0.10	<1%	NEGLIGIBLE
13	Quarry	579650	2742930	0.01	<1%	NEGLIGIBLE
14	Goat Farming	583130	2742220	0.01	<1%	NEGLIGIBLE
15	Grain Silos	576290	2740520	0.01	<1%	NEGLIGIBLE
16	Aramco Pumping Station	584480	2742840	0.01	<1%	NEGLIGIBLE
17	Wheat/Fodder Fields	572955	2738800	0.01	<1%	NEGLIGIBLE
18	PP12 Administration Building	561030.9	2741154.6	0.09	<1%	NEGLIGIBLE
19	PP12 Musjid	561075.8	2741175.0	0.09	<1%	NEGLIGIBLE
20	PP13 Administration Building	561894.1	2741259.1	1.67	<1%	NEGLIGIBLE
21	PP13 Musjid	561938.9	2741279.5	1.87	<1%	NEGLIGIBLE

Appendix 2.6 Modelling Results – Cumulative Impacts (Scenarios 3A, 3B & 3C)

Modelling Results: Riyadh PP13 – Scenario 3A

Scenario 3A Operating Conditions (PP13):

Load: Annual Operating Profile
Mode: Combined Cycle
Fuel: Sales Gas

Predicted Concentrations – Maximum point of Impact

Table A6-1: NO_2 Concentrations

Stack Height	Air Quality Standard	Concentration (µg/m^3)	Percentage of PME AQS	Date	Time	UTM Grid Ref	
						Easting	Northing
Highest 1-hr Mean	*660*	151.60	23%	20-Jul	18:00	561100	2740850
Annual Mean	*100*	18.88	19%			561100	2740850

NB - 50% oxidation of NO_x to NO_2 assumed for 1-hour mean concentrations; 100% oxidation for annual means

Table A6-2 SO_2 Concentrations

Stack Height	Air Quality Standard	Concentration (µg/m^3)	Percentage of PME AQS	Date	Time	UTM Grid Ref	
						Easting	Northing
10-min mean	*500*	40.82	8%	16-Jun	18:00	561100	274085
Highest 1-hr Mean	*730*	24.09	3%	20-Jul	17:00	561100	2740850
99.7th Percentile of 24-hr Means	*365*	9.52	3%	13-Mar		561100	2740850
Annual Mean	*80*	1.50	2%			561100	2740850

Table A6-3: PM_{10} Concentrations

Stack Height	Air Quality Standard	Concentration (µg/m^3)	Percentage of PME AQS	Date	UTM Grid Ref	
					Easting	Northing
90th Percentile of 24-hr Means	*340*	10.01	3%	13-Mar	561100	2740850
Annual Mean	*80*	3.46	4%		561100	2740850

Predicted Concentrations (Scenario 3A) – Maximum at Sensitive Receptors

Table A6-4 NO_2 Concentrations

Receptor		UTM Grid Ref		NO_2 Concentrations (µg/m^3)	
		Easting	Northing	Annual Mean	1-hour Mean
1	PP11 Accommodation Compound (SE)	563112.1	2741763.0	2.75	21.70
2	PP11 Accommodation Compound (SW)	562822.4	2741730.0	2.53	19.83
3	PP11 Accommodation Compound (NW)	562809.0	2741831.0	2.80	21.72
4	PP11 Accommodation Compound (NE)	563099.3	2741864.0	2.92	21.14
5	PP11 Social Building 1	563641.5	2741327.0	0.54	13.10
6	PP11 Social Building 2	563657.9	2741331.0	0.53	13.09
7	PP11 Social Building 3	563655.8	2741352.0	0.52	13.08
8	PP11 Social Building 4	563639.5	2741350.0	0.52	13.09
9	PP11 Administration Building 1	563670.1	2741335.0	0.53	13.10
10	PP11 Administration Building 2	563712.4	2741340.0	0.54	13.28
11	PP11 Administration Building 3	563710.5	2741354.0	0.54	13.31
12	PP11 Administration Building 4	563668.5	2741350.0	0.53	13.10
13	Quarry	579650	2742930	0.06	4.28
14	Goat Farming	583130	2742220	0.06	4.27
15	Grain Silos	576290	2740520	0.08	4.53
16	Aramco Pumping Station	584480	2742840	0.06	3.83
17	Wheat/Fodder Fields	572955	2738800	0.09	6.84
18	PP12 Administration Building	561030.9	2741155.0	2.43	31.62
19	PP12 Musjid	561075.8	2741175.0	2.42	29.11
20	PP13 Administration Building	562694.2	2741434.0	1.65	24.72
21	PP13 Musjid	562739.1	2741454.0	1.63	23.10

Table A6-5 SO_2 Concentrations

Receptor		UTM Grid Ref		SO_2 Concentrations (µg/m^3)		
		Easting	Northing	Annual Mean	1-hour Mean	99.7th Percentile of 24-hour Means
1	PP11 Accommodation Compound (SE)	563112.1	2741763.0	0.20	3.06	1.12
2	PP11 Accommodation Compound (SW)	562822.4	2741730.0	0.19	3.15	0.98
3	PP11 Accommodation Compound (NW)	562809.0	2741831.0	0.21	3.08	1.13
4	PP11 Accommodation Compound (NE)	563099.3	2741864.0	0.22	3.09	1.08
5	PP11 Social Building 1	563641.5	2741327.0	0.04	2.08	0.40
6	PP11 Social Building 2	563657.9	2741331.0	0.04	2.08	0.40
7	PP11 Social Building 3	563655.8	2741352.0	0.04	2.08	0.41
8	PP11 Social Building 4	563639.5	2741350.0	0.04	2.08	0.40
9	PP11 Administration Building 1	563670.1	2741335.0	0.04	2.08	0.41
10	PP11 Administration Building 2	563712.4	2741340.0	0.04	2.03	0.44
11	PP11 Administration Building 3	563710.5	2741354.0	0.04	2.07	0.44
12	PP11 Administration Building 4	563668.5	2741350.0	0.04	2.08	0.42
13	Quarry	579650	2742930	0.00	0.64	0.07
14	Goat Farming	583130	2742220	0.00	0.64	0.06
15	Grain Silos	576290	2740520	0.01	0.68	0.07
16	Aramco Pumping Station	584480	2742840	0.00	0.57	0.05
17	Wheat/Fodder Fields	572955	2738800	0.01	1.00	0.09
18	PP12 Administration Building	561030.9	2741155.0	0.19	5.02	1.46
19	PP12 Musjid	561075.8	2741175.0	0.19	4.63	1.40
20	PP13 Administration Building	562694.2	2741434.0	0.13	3.88	1.06
21	PP13 Musjid	562739.1	2741454.0	0.12	3.63	0.96

Table A6-6 PM_{10} Concentrations

Receptor		UTM Grid Ref		PM_{10} Concentrations (µg/m^3)	
		Easting	Northing	Annual Mean	90th Percentile of 24-hour Means
1	PP11 Accommodation Compound (SE)	563112.1	2741763.0	0.47	1.11
2	PP11 Accommodation Compound (SW)	562822.4	2741730.0	0.45	1.09
3	PP11 Accommodation Compound (NW)	562809.0	2741831.0	0.50	1.22
4	PP11 Accommodation Compound (NE)	563099.3	2741864.0	0.51	1.25
5	PP11 Social Building 1	563641.5	2741327.0	0.10	0.22
6	PP11 Social Building 2	563657.9	2741331.0	0.09	0.22
7	PP11 Social Building 3	563655.8	2741352.0	0.09	0.23
8	PP11 Social Building 4	563639.5	2741350.0	0.09	0.23
9	PP11 Administration Building 1	563670.1	2741335.0	0.09	0.22
10	PP11 Administration Building 2	563712.4	2741340.0	0.09	0.23
11	PP11 Administration Building 3	563710.5	2741354.0	0.09	0.23
12	PP11 Administration Building 4	563668.5	2741350.0	0.09	0.23
13	Quarry	579650	2742930	0.01	0.02
14	Goat Farming	583130	2742220	0.01	0.02
15	Grain Silos	576290	2740520	0.01	0.03
16	Aramco Pumping Station	584480	2742840	0.01	0.02
17	Wheat/Fodder Fields	572955	2738800	0.02	0.03
18	PP12 Administration Building	561030.9	2741155.0	0.44	1.17
19	PP12 Musjid	561075.8	2741175.0	0.44	1.32
20	PP13 Administration Building	562694.2	2741434.0	0.29	0.81
21	PP13 Musjid	562739.1	2741454.0	0.29	0.73

Modelling Results: Riyadh PP13 – Scenario 3B

Scenario 3B Operating Conditions (PP13):

Load: Annual Operating Profile (PP11 & PP12); PP13 Maximum Load
Mode: Combined Cycle
Fuel: Diesel (NO_2) and ASL (SO_2 and PM_{10})

Predicted Concentrations – Maximum point of Impact

Table A6-7: NO_2 Concentrations

Stack Height	Air Quality Standard	Concentration (µg/m^3)	Percentage of PME AQS	Date	Time	UTM Grid Ref	
						Easting	Northing
Highest 1-hr Mean	*660*	1809.35	274%	04-May	21:00	563200	2741200

NB - 50% oxidation of NO_x to NO_2 assumed for 1-hour mean concentrations; 100% oxidation for annual means

Table A6-8 SO_2 Concentrations

Stack Height	Air Quality Standard	Concentration (µg/m^3)	Percentage of PME AQS	Date	Time	UTM Grid Ref	
						Easting	Northing
10-min mean	*500*	767.85	154%	05-May	14:00	563200	2741200
Highest 1-hr Mean	*730*	388.49	53%	04-May	21:00	563200	2741200
99.7th Percentile of 24-hr Means	*365*	132.83	36%	18-Aug		562800	2741150

Table A6-9: PM_{10} Concentrations

Stack Height	Air Quality Standard	Concentration (µg/m^3)	Percentage of PME AQS	Date	UTM Grid Ref	
					Easting	Northing
90th Percentile of 24-hr Means	*340*	10.07	3%	18-Aug	561100	2740850

Predicted Concentrations (Scenario 3B) – Maximum at Sensitive Receptors

Table A6-10 NO_2 Concentrations

Receptor		UTM Grid Ref		NO_2 Concentrations (µg/m^3)
		Easting	Northing	1-hour Mean
1	PP11 Accommodation Compound (SE)	563112.1	2741763.0	341.80
2	PP11 Accommodation Compound (SW)	562822.4	2741730.0	338.43
3	PP11 Accommodation Compound (NW)	562809.0	2741831.0	289.39
4	PP11 Accommodation Compound (NE)	563099.3	2741864.0	327.02
5	PP11 Social Building 1	563641.5	2741327.0	170.61
6	PP11 Social Building 2	563657.9	2741331.0	170.92
7	PP11 Social Building 3	563655.8	2741352.0	163.96
8	PP11 Social Building 4	563639.5	2741350.0	163.76
9	PP11 Administration Building 1	563670.1	2741335.0	170.13
10	PP11 Administration Building 2	563712.4	2741340.0	166.84
11	PP11 Administration Building 3	563710.5	2741354.0	159.59
12	PP11 Administration Building 4	563668.5	2741350.0	162.43
13	Quarry	579650	2742930	26.55
14	Goat Farming	583130	2742220	26.68
15	Grain Silos	576290	2740520	31.58
16	Aramco Pumping Station	584480	2742840	24.26
17	Wheat/Fodder Fields	572955	2738800	42.57
18	PP12 Administration Building	561030.9	2741155.0	95.34
19	PP12 Musjid	561075.8	2741175.0	98.50
20	PP13 Administration Building	562694.2	2741434.0	396.32
21	PP13 Musjid	562739.1	2741454.0	374.92

Table A6-11 SO_2 Concentrations

Receptor		UTM Grid Ref		SO_2 Concentrations (µg/m^3)	
		Easting	Northing	1-hour Mean	99.7th Percentile of 24-hour Means
1	PP11 Accommodation Compound (SE)	563112.1	2741763.0	73.60	11.68
2	PP11 Accommodation Compound (SW)	562822.4	2741730.0	72.88	22.67
3	PP11 Accommodation Compound (NW)	562809.0	2741831.0	62.32	22.59
4	PP11 Accommodation Compound (NE)	563099.3	2741864.0	70.42	12.62
5	PP11 Social Building 1	563641.5	2741327.0	36.53	5.69
6	PP11 Social Building 2	563657.9	2741331.0	36.60	5.71
7	PP11 Social Building 3	563655.8	2741352.0	35.10	5.86
8	PP11 Social Building 4	563639.5	2741350.0	35.05	5.86
9	PP11 Administration Building 1	563670.1	2741335.0	36.50	5.73
10	PP11 Administration Building 2	563712.4	2741340.0	35.76	5.70
11	PP11 Administration Building 3	563710.5	2741354.0	34.20	5.80
12	PP11 Administration Building 4	563668.5	2741350.0	34.84	5.83
13	Quarry	579650	2742930	5.51	0.57
14	Goat Farming	583130	2742220	5.50	0.55
15	Grain Silos	576290	2740520	6.51	0.56
16	Aramco Pumping Station	584480	2742840	5.03	0.49
17	Wheat/Fodder Fields	572955	2738800	8.79	0.82
18	PP12 Administration Building	561030.9	2741155.0	20.09	3.33
19	PP12 Musjid	561075.8	2741175.0	20.74	3.31
20	PP13 Administration Building	562694.2	2741434.0	85.25	24.81
21	PP13 Musjid	562739.1	2741454.0	80.66	26.52

Table A6-12 PM_{10} Concentrations

Receptor		UTM Grid Ref		NO_2 Concentrations (µg/m^3)
		Easting	Northing	1-hour Mean
1	PP11 Accommodation Compound (SE)	563112.1	2741763.0	341.80
2	PP11 Accommodation Compound (SW)	562822.4	2741730.0	338.43
3	PP11 Accommodation Compound (NW)	562809.0	2741831.0	289.39
4	PP11 Accommodation Compound (NE)	563099.3	2741864.0	327.02
5	PP11 Social Building 1	563641.5	2741327.0	170.61
6	PP11 Social Building 2	563657.9	2741331.0	170.92
7	PP11 Social Building 3	563655.8	2741352.0	163.96
8	PP11 Social Building 4	563639.5	2741350.0	163.76
9	PP11 Administration Building 1	563670.1	2741335.0	170.13
10	PP11 Administration Building 2	563712.4	2741340.0	166.84
11	PP11 Administration Building 3	563710.5	2741354.0	159.59
12	PP11 Administration Building 4	563668.5	2741350.0	162.43
13	Quarry	579650	2742930	26.55
14	Goat Farming	583130	2742220	26.68
15	Grain Silos	576290	2740520	31.58
16	Aramco Pumping Station	584480	2742840	24.26
17	Wheat/Fodder Fields	572955	2738800	42.57
18	PP12 Administration Building	561030.9	2741155.0	95.34
19	PP12 Musjid	561075.8	2741175.0	98.50
20	PP13 Administration Building	562694.2	2741434.0	396.32
21	PP13 Musjid	562739.1	2741454.0	374.92

Modelling Results: Riyadh PP13 – Scenario 3C

Scenario 3C Operating Conditions for all sources:

Load: Maximum Load (All Plants)
Mode: Combined Cycle
Fuel: ASL (NO_2, SO_2 and PM_{10})

Predicted Concentrations – Maximum point of Impact

Table A6-13: NO_2 Concentrations

Stack Height	Air Quality Standard	Concentration (µg/m^3)	Percentage of PME AQS	Date	Time	UTM Grid Ref	
						Easting	Northing
Highest 1-hr Mean	*660*	2687.62	407%	20-Jul	17:00	561100	2740850

NB - 50% oxidation of NO_x to NO_2 assumed for 1-hour mean concentrations; 100% oxidation for annual means

Table A6-14 SO_2 Concentrations

Stack Height	Air Quality Standard	Concentration (µg/m^3)	Percentage of PME AQS	Date	Time	UTM Grid Ref	
						Easting	Northing
10-min mean	*500*	977.33	195%	30-Aug	17:00	561100	2740850
Highest 1-hr Mean	*730*	576.60	79%	20-Jul	17:00	561100	2740850
99.7th Percentile of 24-hr Means	*365*	208.25	57%	18-Aug		561100	2740850

Table A6-15: PM_{10} Concentrations

Stack Height	Air Quality Standard	Concentration (µg/m^3)	Percentage of PME AQS	Date	UTM Grid Ref	
					Easting	Northing
90th Percentile of 24-hr Means	*340*	11.82	3%	18-Aug	561100	2740850

Predicted Concentrations (Scenario 3C) – Maximum at Sensitive Receptors

Table A6-16 NO_2 Concentrations

Receptor		UTM Grid Ref		NO_2 Concentrations (µg/m^3)
		Easting	Northing	1-hour Mean
1	PP11 Accommodation Compound (SE)	563768.1	2741155.5	341.88
2	PP11 Accommodation Compound (SW)	563800.7	2741161.7	340.24
3	PP11 Accommodation Compound (NW)	563782.4	2741304.5	289.39
4	PP11 Accommodation Compound (NE)	563747.7	2741298.4	328.57
5	PP11 Social Building 1	563641.5	2741327.0	225.81
6	PP11 Social Building 2	563657.9	2741331.1	226.76
7	PP11 Social Building 3	563655.8	2741351.5	224.53
8	PP11 Social Building 4	563639.5	2741349.4	225.19
9	PP11 Administration Building 1	563670.1	2741335.2	223.97
10	PP11 Administration Building 2	563712.4	2741340.2	226.78
11	PP11 Administration Building 3	563710.5	2741354.2	222.88
12	PP11 Administration Building 4	563668.5	2741349.4	222.45
13	Quarry	579650	2742930	58.80
14	Goat Farming	583130	2742220	60.63
15	Grain Silos	576290	2740520	68.36
16	Aramco Pumping Station	584480	2742840	53.89
17	Wheat/Fodder Fields	572955	2738800	93.58
18	PP12 Administration Building	561030.9	2741154.6	533.88
19	PP12 Musjid	561075.8	2741175.0	482.97
20	PP13 Administration Building	561894.1	2741259.1	397.92
21	PP13 Musjid	561938.9	2741279.5	382.27

Table A6-17 SO_2 Concentrations

Receptor		UTM Grid Ref		SO_2 Concentrations (µg/m^3)	
		Easting	Northing	1-hour Mean	99.7th Percentile of 24-hour Means
1	PP11 Accommodation Compound (SE)	563768.1	2741155.5	73.62	22.92
2	PP11 Accommodation Compound (SW)	563800.7	2741161.7	73.27	25.32
3	PP11 Accommodation Compound (NW)	563782.4	2741304.5	62.32	26.08
4	PP11 Accommodation Compound (NE)	563747.7	2741298.4	70.76	22.76
5	PP11 Social Building 1	563641.5	2741327.0	48.66	9.38
6	PP11 Social Building 2	563657.9	2741331.1	48.90	9.53
7	PP11 Social Building 3	563655.8	2741351.5	48.61	9.71
8	PP11 Social Building 4	563639.5	2741349.4	48.61	9.58
9	PP11 Administration Building 1	563670.1	2741335.2	48.23	9.67
10	PP11 Administration Building 2	563712.4	2741340.2	48.89	10.15
11	PP11 Administration Building 3	563710.5	2741354.2	49.06	10.31
12	PP11 Administration Building 4	563668.5	2741349.4	48.33	9.80
13	Quarry	579650	2742930	16.08	1.64
14	Goat Farming	583130	2742220	16.42	1.63
15	Grain Silos	576290	2740520	18.94	1.63
16	Aramco Pumping Station	584480	2742840	14.77	1.45
17	Wheat/Fodder Fields	572955	2738800	25.50	2.26
18	PP12 Administration Building	561030.9	2741154.6	114.97	34.77
19	PP12 Musjid	561075.8	2741175.0	104.01	35.04
20	PP13 Administration Building	561894.1	2741259.1	88.10	26.00
21	PP13 Musjid	561938.9	2741279.5	84.56	27.70

Table A6-18 PM_{10} Concentrations

Receptor		UTM Grid Ref		PM_{10} Concentrations ($\mu g/m^3$)
		Easting	Northing	90th Percentile of 24-hour Means
1	PP11 Accommodation Compound (SE)	563768.1	2741155.5	1.51
2	PP11 Accommodation Compound (SW)	563800.7	2741161.7	1.85
3	PP11 Accommodation Compound (NW)	563782.4	2741304.5	2.03
4	PP11 Accommodation Compound (NE)	563747.7	2741298.4	1.70
5	PP11 Social Building 1	563641.5	2741327.0	0.31
6	PP11 Social Building 2	563657.9	2741331.1	0.31
7	PP11 Social Building 3	563655.8	2741351.5	0.30
8	PP11 Social Building 4	563639.5	2741349.4	0.29
9	PP11 Administration Building 1	563670.1	2741335.2	0.31
10	PP11 Administration Building 2	563712.4	2741340.2	0.31
11	PP11 Administration Building 3	563710.5	2741354.2	0.31
12	PP11 Administration Building 4	563668.5	2741349.4	0.31
13	Quarry	579650	2742930	0.04
14	Goat Farming	583130	2742220	0.04
15	Grain Silos	576290	2740520	0.05
16	Aramco Pumping Station	584480	2742840	0.04
17	Wheat/Fodder Fields	572955	2738800	0.05
18	PP12 Administration Building	561030.9	2741154.6	1.54
19	PP12 Musjid	561075.8	2741175.0	1.65
20	PP13 Administration Building	561894.1	2741259.1	1.32
21	PP13 Musjid	561938.9	2741279.5	1.43

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