JUBAIL EXPORT REFINERY PROJECT

Environmental and Social Impact Assessment for the Jubail Export Refinery

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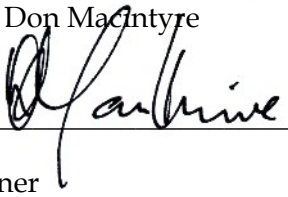
Environmental and Social Impact Assessment for the Jubail Export Refinery

For and on behalf of
Environmental Resources Management

Approved by: Don MacIntyre

Signed: 

Position: Partner

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LIST OF ACRONYMS & GLOSSARY

agl	Above ground level
Ambient noise	Ambient noise is the "totally encompassing sound in a given situation in a given time. Usually composed of sound from many sources near and far" (ISO 1996-1)
API	American Petroleum Institute
ARU	Amine Recovery / Treatment Unit
A-weighting	This is a frequency weighting devised to attempt to take into account the fact that human response to sound is not equally sensitive to all frequencies. A-weighting most closely matches the sensitivity of the human ear to sound
Baseline	Existing conditions. See also "Baseline studies"
Baseline studies	Studies conducted to establish the actual conditions at a specific period in time, to enable predictive and comparative studies to be conducted in the future in order to determine whether there is a predicted impact.
BAT	Best Available Techniques, as defined by RCER2004 is "*…the application at facilities of the most effective and advanced production processes, methods/ technologies or operational practices to prevent and, where that is not practicable, to reduce emissions or discharges and other impacts to the environment as a whole. BAT must as a minimum achieve emission or discharge standards in these Regulations taking into account energy, environmental and economic impacts and other costs to the facility*".
BGP	BERRI Gas Plant
bbl	Barrel
bgl	Below ground level
Biological diversity (biodiversity)	Variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part (Convention on Biological Diversity 1992)
BFW	Boiler Feed Water
BOD	Biochemical Oxygen Demand - Measure of how much of the oxygen is used up by organisms in the water. BOD is the most important general indicator of pollution for most streams
BOD_5	BOD_5 is a most commonly used test where BOD is determined by measuring the dissolved oxygen (DO) level of a water sample after 5 days and comparing it to the original DO level. The test is generally used to identify the level of pollution in waters
BPSD	Barrels Per Stream Day
BS	British Standard
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CEMP	Construction Environmental Management Plan
CEMS	Continuous Emissions Monitoring System
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand is a test for assessing the quality of effluents and wastewaters prior to discharge. The COD test predicts the oxygen requirement of the effluent and is used for the monitoring and control of discharges, and for assessing treatment plant performance
Cumulative Impacts	Impacts that result from incremental changes caused by other past, present or reasonably foreseeable actions together with the project
dB(A)	A measurement on the decibel scale with A-weighting (see "Decibel")
dB	Decibel - Sound can be defined as any pressure variation that the human ear can detect, such that the decibel is the unit of measurement of that pressure variation
DCU	Delayed Coker Unit
DO	Dissolved Oxygen – represented either as a % or as mg/l
EC	Electrical Conductivity
ECA	Export Credit Agency
ECC	Environmental Consent to Construct
EPC	Engineering, Procurement and Construction

EPO	Environmental Permit to Operate
ESIA	Environmental and Social Impact Assessment - the process of collecting data, consulting with interested parties, assessing significant environmental impacts (positive and negative) and defining mitigation measures
EMS	Environmental Management System
EP	Equator Principle
EPFI	Equator Principle Financial Institute
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
ESP	Electrostatic Precipitator
ESS	Environmental Scoping Study
FCC	Fluidised Catalytic Cracking
FEED	Front End Engineering and Design
FGR	Flue Gas Recirculation
Flare	A process system for burning gas, either waste gas or vented for emergency relief
Fugitives (emissions)	Discontinuous, diffuse, usually accidental, emissions to atmosphere
GEP	Good Engineering Practice
GER	General Environmental Regulations (advocated by the PME)
GHG	Greenhouse Gases
GIIP	Good International Industrial Practice
GIS	Geographical Information System - a digital process of mapping data in layers related to a geo-referenced base
GPS	Global Positioning System
HAP	Hazardous Air Pollutant
HCGO	Heavy Coke Gas Oil
HP	High Pressure
H_2S	Hydrogen Sulphide
HSE	Health, Safety and Environment
Hz	Hertz
KHz	Kilohertz
ICAPS	Integrated Commissioning and Progress System
IEC	International Electrotechnical Commission
IFC	International Finance Corporation
IFI	International Finance Institution
IMO	International Maritime Organization
Impact (environmental)	"Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's activities, products or services" (ISO 14001). Not always quantifiable (e.g. nuisance).
Impact (social)	"The consequences to human populations of any public or private actions that alter the ways in which people live, work, play, relate to one another, organize to meet their needs and generally cope as members or society. The term also includes cultural impacts involving changes to the norms, values, and beliefs that guide and rationalize their cognition of themselves and their society" (US Department of Commerce, May 1994)
ISO	International Standards Organization
ISO 14000	The International Standardization Organization's Set of Standards on Environmental Management
ISO 14001	ISO's Environmental Management System: Specification with Guidance for Use
IWPP	Independent Water and Power Project
LCGO	Light Coker Gas Oil
LoU	Letter of Understanding between SATORP and Saudi Aramco for the use of land proposed for the TCF area. The LoU was signed by SATORP on the 18th February 2009.
JBIC	Japan Bank for International Cooperation
JIC	Jubail Industrial City
JIC 1	The first establish industrial city in the Jubail area of Saudi Arabia, initiated in the 1970's
JIC 2	The second phase of the Jubail industrial city
Kg/m^3	Kilo-grams per cubic metre
kJ	Kilo-joule

kPa	Kilo-Pascals
KSA	Kingdom of Saudi Arabia
kW	Kilowatt
kW/m²	Kilowatts per metre square
L_{10}	Noise level exceeded for 10% of measurement period
L_{90}	Noise level exceeded for 90% of measurement period
LAeq	The equivalent continuous noise level over a measurement period
LDAR	Leak Detection and Repair
LNB	Low NO_x Burner
LP	Low Pressure
LPG	Liquefied Petroleum Gas
MARPOL	Marine Pollution Convention, for the Prevention of Pollution from Ships
m/s	Metre/s
MSDS	Material Safety Data Sheet
meq/100g	Milliequivalents of negative charge per 100 grams
mg/dscf	Milligram per dry standard cubic foot
mg/l	Milligram per litre
MinPet	The Kingdom of Saudi Arabian Ministry of Petroleum
mm	Millimetre
Mitigation	Measures that may reduce potentially significant adverse environmental impacts to acceptable levels
MJ/SCM	Mega-joules per standard cubic metre
MMSCFD	Million Standard Cubic Feet per Day
MPN	Most Probable Number
MW	Megawatt
µg/m³	Microgram per cubic metre ($10^{-6}g/m^3$)
µS/cm	Micro-Siemens/cm
N_2O	Nitrous oxide
NCWCD	National Commission for Wildlife Conservation and Development, a Saudi agency responsible for wildlife protection
NEXI	Nippon Export and Investment Insurance
NFPA	National Fire Protection Agency
Nm³ or Normal cubib meter	Normalised volume of a cubic meter of exhaust gas - i.e. zero degrees C, one atmosphere pressure, dry and 3% excess oxygen for steam boilers and fired heaters.
NIOSH	National Institute of Occupational Safety and Health
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
NRTI	Net Rated Thermal Input
O_2	Oxygen
O_3	Ozone
OFA	Over Fire Air
OSHA	Occupation Safety and Health and Administrative
PAP	Permit Application Package, the report / information submitted to the RC as part of their permitting protocol
PCB	Polychlorinated Biphenyl
pH	Measure of acidity/alkalinity
PHC	Primary Health Care
PID	Photo-ionisation Detector
PLOT9	The specific plot within which the refinery will be located. This plot is within the Jubail 2 Industrial City
PM	Particulate Matter
PM_{10}	Particulate Matter of less than 10µm aerodynamic diameter
PME	The Kingdom of Saudi Arabian Presidency of Meteorology and Environment
ppb	Parts per billion
PPE	Personal Protective Equipment
ppm	Parts per million
ppmv	Parts per million v
PS (IFC)	Performance Standard
psi	Pounds per square inch
psia	Pounds per square inch atmospheric

OECD	Established in 1961 to replace the Organisation for European Economic Co-operation (OEEC), the Organization for Economic Cooperation and Development (OECD) is an international organization composed of the industrialized market economy countries, as well as some developing countries, by providing a forum in which to establish and coordinate policies.
OSCP	Oil Spill Contingency Plan
RBOB	Reformulated gasoline blendstock for oxygen blending
RATA	Relative Accuracy Test Audit, normally applied annual to CEMS systems
RECSO	Regional Clean Sea Organisation
RC	The Royal Commission of Jubail and Yanbu
RCER2004	The Royal Commission of Jubail and Yanbu Environmental Regulations 2004
Residual impact	Residual impacts are impacts that cannot be mitigated
Residual noise	"The ambient noise remaining at a given position in a given situation when one or more specified noises are suppressed" (ISO 1996-1). See also "ambient noise"
RH	Relative Humidity
RPE	Respiratory Protective Equipment
ROPME	Regional Organisation for the Protection of the Marine Environment
SATORP	Saudi Aramco TOTAL Refining and Petrochemical Company
Scoping	The process of identifying the key environmental and social issues in the development of a project and seeking agreement with interested parties in how these are to be addressed in the EIA process
SEC	Saudi Electricity Company
SCR	Selective Catalytic Reduction
SHC	Secondary Health Care
SLM	Sound Level Meter
SNCR	Selective Non-Catalytic Reduction
Sm^3	Standard cubic metre
SO_2	Sulphur dioxide
Source	The point or place from which something originates
Spoil	Any type of material removed during excavation that is typically stored temporarily before replacement or disposal
SRU	Sulphur Recovery Unit
SWCC	Seawater Conversion Company
SWS	Sour Water Stripper
SWTP	Sanitary Waste Water Treatment Plant
t/hr	Tonnes per hour
TCF	Temporary Construction Facilities – to be established to support the JER construction programme. The TCF will include worker accommodation, light fabrication areas, warehousing and laydown, and utilities (e.g. power production, a WWTP etc).
TDS	Total Dissolved Solids. Measured in mg/l
Temperature	The level of heat energy of the atmosphere as measured by a thermometer and expressed on a given temperature scale, usually Celsius or Fahrenheit
TGT	Tail Gas Treatment
TPIT	Technip Italy
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TPSD	Tonnes Per Stream Day
TSS	Total Suspended Solids. Measured in mg/l
TVP	True Vapour Pressure
ULNB	Ultra Low NOx Burner
UNCLOS	United Nations Convention on the Laws of the Sea
UNFCCC	United Nations Framework Convention on Climate Change
US EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds
VRU	Vapour Recovery Unit
WHO	World Health Organization
WMP	Waste Management Plan
WWTP	Wastewater Treatment Plant

1 INTRODUCTION

1.1 BACKGROUND TO THE PROJECT

The Jubail Export Refinery (JER) Project represents the design, construction, commissioning and operations of a grass roots refinery capable of processing 400,000 Barrels per Stream Day (BPSD) of Arabian heavy crude oil to produce gasoline, diesel, jet fuel, p-xylene, petroleum coke and fuel oil for export and fuel oil, liquid sulphur, propylene and benzene for domestic consumption or further processing.

The JER will be located in Saudi Arabia on the west coast of the Arabian Gulf, within PLOT 9 of Jubail Industrial City 2 (JIC 2), about 3 km west of the long established Jubail Industrial City 1 (JIC 1) (*Figure 1-1*). The project is being implemented by the Saudi Aramco TOTAL Refining and Petrochemical Company (SATORP), a joint venture between Saudi Aramco and TOTAL.

Figure 1-1 Project Location

Loading facilities and storage for export products will be located within the long established King Fahd Industrial Port (KFIP) situated on the Arabian Gulf coast to the east of the proposed refinery.

1.2 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) PROCESS

The ESIA process has considered the various elements of the proposed development and their effects on the environment and society. This process has incorporated significant interaction between the ESIA and project design functions, thereby enabling a high level of mitigation to be incorporated into the fundamental design and implementation of the project. The major outputs

of the ESIA process are the identification and assessment of environmental and social effects of the proposed project activities and the development of commitments by SATORP to prevent or minimise such effects.

In summary, the ESIA process has comprised the following steps:

- Definition of the proposed development across the various project phases and identification of the infrastructure, processes and activities that will be involved;
- Description of the existing geographical, environmental, social and policy contexts of the project sites and their surrounds;
- Identification and assessment of environmental and social impacts that may arise from the project activities and processes;
- Development of a framework environmental and social management plan (ESMP) which identifies actions that implement SATORP's commitments aimed at mitigating adverse environmental and social impacts. The framework ESMP includes a programme for monitoring to ensure the effectiveness of the commitments and mitigation measures proposed.

This Final ESIA Report (June 2009) incorporates comments received following a detailed review of the earlier (July 2008) version by the Project financing parties and their nominated due diligence consultant AEA Technology PLC.

1.3 OBJECTIVES OF THE ESIA

The main goal of this ESIA is to provide SATORP with the basis for ensuring that the JER project will be designed and operated in accordance with the company's environmental and social objectives. It further serves to provide prospective Lenders contributing project financing with essential environmental and social due diligence information, specifically an ESIA that meets the essential requirements of the Equator Principles, the OECD Common Approaches protocols, and financing party guidelines (including guidelines provided by the Nippon Export and Investment Insurance (NEXI) and Japan Bank for International Cooperation (JBIC). The ESIA may also support permitting with the relevant competent authority, the Royal Commission for Jubail and Yanbu (the RC), although the permitting process within the JIC does not normally require the development of an ESIA Report.

Specifically, the aims of the ESIA are to:

- Collect and review available environmental and demographic / socio-economic data to determine the existing baselines and their sensitivities;
- Use internationally recognised models and undertake quantitative studies where relevant to identify the environmental and social impacts of activities that are planned to take place throughout the project life cycle;

- Establish and evaluate the potential impacts of the project on the environment and principally the residents of the Jubail area;
- Propose mitigation measures to reduce or prevent the environmental and social impacts and where possible propose measures to enhance the baseline environment;
- Establish a monitoring programme to ensure that the mitigation measures are implemented effectively and efficiently; and
- Ensure that the project is compliant with the relevant environmental and social standards of the Kingdom of Saudi Arabia (KSA), the Equator Principles (EPs), relevant guidance provided by the International Finance Corporation (IFC), the OECD Common Approaches protocols and financing party guidelines (including guidance from NEXI and JBIC).

1.4 PROJECT PROPONENT AND ESIA CONSULTANT

This ESIA has been prepared for SATORP, through their Front End Engineering and Design (FEED) contractor Technip Italy (TPIT), by Environmental Resources Management (ERM).

1.5 DATA SOURCES

Details of the proposed project have been provided by TPIT. Primary data has been gathered by specialist teams from ERM through field surveys, sampling and measurements. Additional environmental and social data has been reviewed and collated from existing literature, including data provided by the RC.

1.6 STRUCTURE OF THE ESIA REPORT

The purpose of the ESIA Report is to present and communicate to SATORP, the financing parties, the RC and other stakeholders the outcome of the impact assessment process. The ESIA Report is comprised of the following chapters:

Non-Technical Summary (NTS)

The Executive Summary presents in simple (non-technical) terms the key findings of the ESIA process and the recommended actions for the project.

Chapter 1 – Introduction

This chapter sets the context of the JER project and the associated ESIA.

Chapter 2 – ESIA Methodology

This chapter describes the systematic approach that has been undertaken for this ESIA process.

Chapter 3 – Environmental and Social Policy and Regulatory Review

This chapter identifies the enabling policy and regulatory framework related to the JER project, the ESIA and the management of environmental and social impacts associated with the project. It also outlines the standards that have to be complied with by the project.

Chapter 4 - Project Description

This chapter provides a description of the project in its geographic, environmental and temporal context, and identifies those activities throughout the various stages in the project life cycle that may have the potential to cause detrimental environmental or social effects. The chapter also summarises waste, emissions and discharge inventories for the refinery construction programme and for normal operations.

Chapter 5 – Project Alternatives

This chapter provides an assessment of the key strategic and technological alternatives that have been considered for the project, and discusses the integration of best available technology (BAT) principles within the facility design.

Chapter 6 – Environment and Social Baseline

This chapter provides information on the existing environmental and socio-economic conditions within the proposed JER project sites and within the project's wider zone of influence.

Chapter 7 – Environmental and Social Aspects

This chapter identifies those elements of the project that have the potential to interact with the environment or society (an essential step towards determining the impacts of the project).

Chapter 8 – Assessment of Impacts

This chapter describes potential environmental and social impacts, along with their significance. The proposed measures (which are additional to those inherent in the project design) for the control and mitigation of identified impacts are also outlined in this chapter.

Chapter 9 – Framework Environmental and Social Management Plan

This chapter presents the framework for a project environmental and social management plan that can be used to control and mitigate adverse impacts arising from the project. Commitments made by SATORP are summarised in this chapter.

Chapter 10 – References

This chapter lists the primary references and data sources that were consulted and used in the course of the ESIA.

Appendices

Supporting information and studies generated during the ESIA Process are provided as follows.

- ***Appendix A*** – **Scoping Report and Policies**
  - ***Annex I*** - JER Scoping Report
  - ***Annex II*** - RC Response Letter on Public Consultation
  - ***Annex III-V*** - COMPANY HSE Policies
  - ***Annex VI*** - Letter of Understanding (LoU) from Saudi Aramco for the use of land by SATORP for Temporary Construction Facilities (TCF)
- ***Appendix B*** – **Baseline Survey Reports**
  - ***Annex I*** - Baseline Noise Monitoring Report
  - ***Annex II*** - Ecology Baseline Survey Report
- ***Appendix C*** – **Best Available Techniques Report**
- ***Appendix D*** – **Impact Assessment Reports**
  - ***Annex I*** - Construction Phase Air Dispersion Modelling Report
  - ***Annex II*** - Construction Phase Noise Assessment
  - ***Annex III*** - Operational Phase Air Dispersion Modelling Report
  - ***Annex IV*** - GHG Assessment
  - ***Annex V*** - Operational Phase Noise Modelling Report
  - ***Annex VI*** - ToC for the Construction Safety Manual

- *Appendix E* – **Management Systems**

  Annex I - Framework Construction Environmental Management Plan

  Annex II - Framework Operational Waste Management Plan

- *Appendix F* – **Oil Spill Sensitivity Analysis**

2 METHODOLOGY

2.1 INTRODUCTION

ESIA is the systematic process of identifying and assessing the potential effects on the biophysical and socioeconomic environment as a consequence of a project or development. As a planning tool, the ESIA aims to ensure that environmental and social issues throughout the entire project lifecycle are anticipated and considered by the project proponent, in this case SATORP. It also serves as a framework for establishing project controls to reduce or prevent adverse environmental or social impacts. This ESIA Report will also support the application for financing from international banks and export credit agencies (1) (ECAs).

This chapter of the ESIA Report summarises the key stages of the ESIA process undertaken for the proposed JER Project. As such, it presents the approach that has been adopted for the execution of this ESIA and defines the methodology that has been used for the collection of baseline data and the assessment of impacts.

2.2 SUMMARY OF ESIA PROCESS

The key steps in an ESIA process can be considered in terms of phases as described below.

Pre-study activities such as screening, preliminary assessment and scoping. This phase establishes the environmental and social considerations in advance of detailed studies.

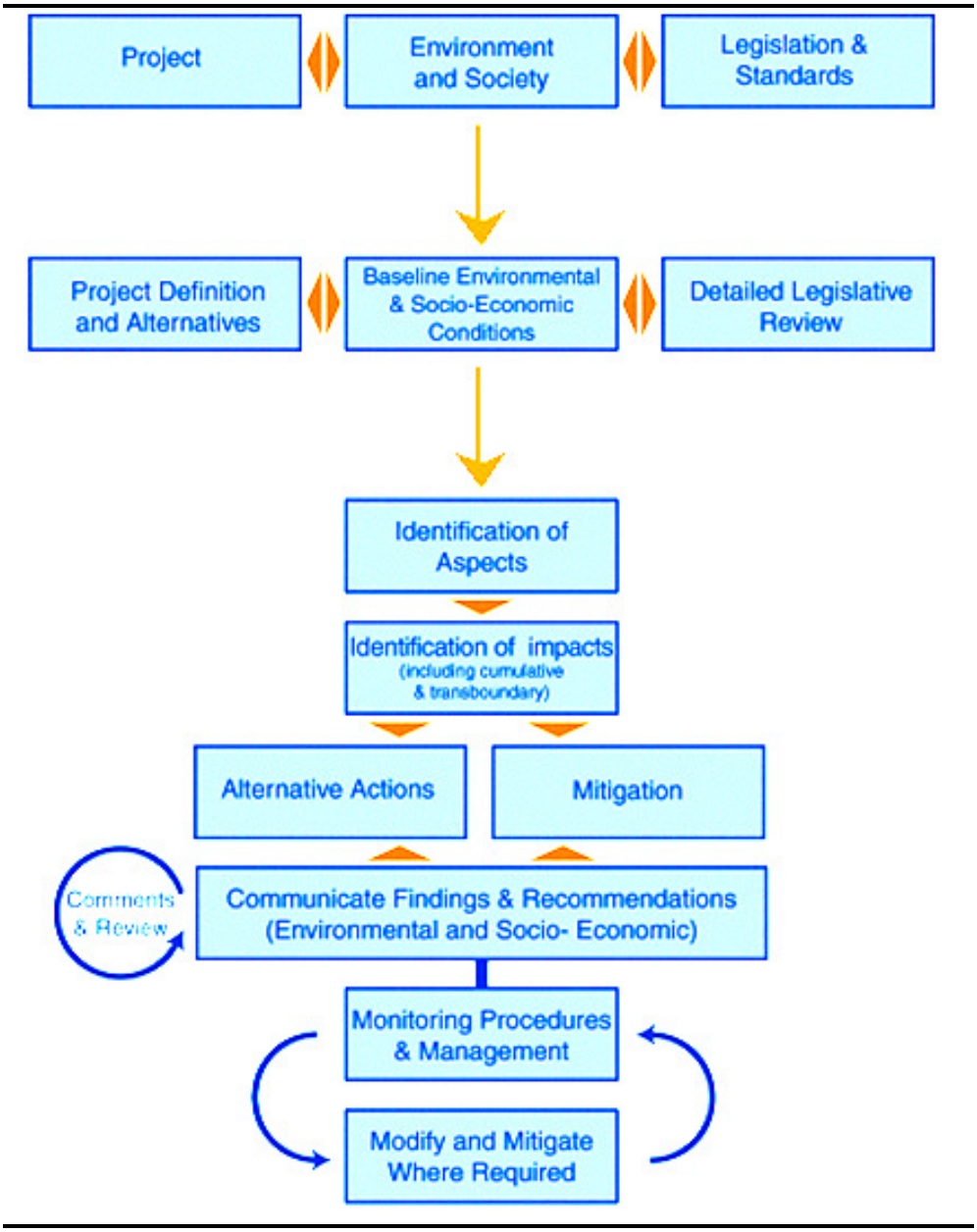
The ESIA study, which results in the identification and assessment of impacts. Integral to this study is the development of measures to mitigate and reduce or remove adverse impacts.

The post-study stage, which includes steps undertaken for review and monitoring to ensure that mitigation measures are implemented, and that they are effective during construction and operations.

In summary, the ESIA follows a systematic and iterative process of examining the environmental, socio-economic and regulatory context within which the project is situated. The key stages that have been followed for the ESIA of the JER project are presented in *Figure 2-1* below.

(1) The role of this ESIA as a decision making tool and as a basis for approval by the *Royal Commission of Jubail and Yanbu* is discussed in *Chapter 3 Environmental & Social Policy and Regulatory Review* of this ESIA Report..

Figure 2-1 ESIA Process Adopted for the JER Project



2.3 SUMMARY OF THE KEY STAGES OF THE ESIA

Table 2-1 below presents the key stages that have been implemented for the JER ESIA process.

Table 2-1 Key Stages of the JER ESIA Process

Key stages of ESIA undertaken	Description
Scoping of the project	Identification of socio-economic considerations/ analysis of the feasibility of the project /establishment of the scope of the ESIA
Project description and alternatives	Comprehensive and accurate description of those aspects of the project pertinent to the assessment of potential impacts, including project footprint, schedule, construction, commissioning and operational programmes. This section also provides detailed emissions and waste inventories for construction and commissioning. This process has included a rigorous assessment of project alternatives within the context of a BAT assessment.
Legal and policy review	Overview of key legislative requirements (national and international) and other standards of performance that the JER project has elected to adopt.
Baseline assessments	Assessments undertaken to gain a quantitative understanding of the existing environment. Both primary and secondary data have been collected for this project. Land use and demographic data have also been collected to support assessment of potential social impacts.
Identification of impacts	Identification of potential impacts associated with the development. Significant environmental impacts are considered further. Those activities that have the potential to cause social impact (either positive or negative) have also been considered.
Assessment of impacts	Comprehensive description and analyses, by project phase, of the environmental and social impacts of the development.
Framework environmental and social management plan	The proposed mitigation measures to be applied to minimise / remove environmental or social impacts during construction and operations.

2.4 SCOPING

As an initial step of the ESIA process, ERM has undertaken project scoping to establish key issues for the project and to define the full scope of the ESIA. The Environmental Scoping Study (ESS) Report provided the following information:

- Scope and content of the ESIA to be undertaken;
- Introduction of the legal framework and policy environment to be considered in the ESIA process;
- Description of the project and 'key issues' that needed further assessment during in the ESIA;
- Proposed methodologies for baseline studies; and
- Proposed methodology for the impact assessment.

During the scoping phase, a meeting with the RC was held at their offices in Jubail. A key outcome of the meeting was their position regarding consultation with potentially Interested and Affected Parties (I&APs) both within and outside of the JIC. Both the Scoping Report and communication from the RC on their position regarding consultation are provided in *Appendix A*.

It should be recognised that the Scoping Report presents an overview of the JER design basis which was current at the time of submission. This has been superseded with the design basis presented in *Chapter 4,*, which is considered up to date at the time of issue of this ESIA Report.

2.5 PROJECT DESCRIPTION

The project description is presented in *Chapter 4* of this Report. The description of the proposed JER is based on the information provided by TPIT, the FEED contractor for the JER project.

2.6 PROJECT ALTERNATIVES

Key technical and strategic alternatives have been assessed during the ESIA programme.

Where applicable, key technical alternatives have been considered following the principles of 'Best Available Techniques', or 'BAT'.

BAT is defined by the Royal Commission Environmental Regulations (RCER) 2004 as *"…the application at facilities of the most effective and advanced production processes, methods / technologies or operational practices to prevent and, where that is not practicable, to reduce emissions or discharges and other impacts to the environment as a whole. BAT must as a minimum achieve emission or discharge standards in these Regulations taking into account energy, environmental and economic impacts and other costs to the facility".*

Following the requirements of RCER in terms of which emission or discharge stream requires BAT assessment, the ESIA programme has considered BAT in the context of the following:

- Minimisation of releases of nitrogen oxides (NOx) to the atmosphere from process heaters and steam boilers;
- Control of Volatile Organic Compounds (VOCs) from certain storage tanks; and
- Treatment of waste water.

Each feasible control option (where alternatives exist) has been considered in the context of the following criteria:

- Performance;

- Energy use and need for raw materials;
- Impact on performance / availability of the system subject to control; and
- Cost.

Although focus has been provided to those three areas noted above, the assessment has also considered other elements of the project design basis and summarises the general application of BAT in the project design basis.

2.7 ENVIRONMENTAL AND SOCIAL POLICY AND REGULATORY REVIEW

A review of environmental and social policy, regulatory requirements, standards and guidelines relevant to this project is presented in *Chapter 3* of this report. International, national and local policies, particularly on environmental and societal protection (including international conventions to which the Kingdom of Saudi Arabia is party) have been considered in the context of the JER project.

2.8 BASELINE ASSESSMENT

Baseline information is the reference against which potential impacts of the proposed project may be identified and subsequent future changes detected through monitoring. For the proposed JER project, baseline conditions have been considered in terms of the natural biophysical environment (such as air, noise, ground water, soil, wildlife, and vegetation) and the socio-economic environment (such as demography, archaeology, economics and public sector services). The baseline study for this ESIA has included primary surveys for the following:

- Demographics and land use;
- Noise;
- Soil and groundwater quality (yet to be undertaken); and
- Ecology.

To supplement the primary data, secondary data were gathered, reviewed and collated such as those belonging to previous commissioned studies and relevant literature. Details of the approach to each survey are provided below and in detail within *Chapter 6*.

2.8.1 Demographics

Land-use and population within and adjacent to project areas has been established both through a review of satellite imagery and through a walk / drive over of all project areas. Details of this are provided in *Chapter 6 Environmental and Social Baseline*.

2.8.2 Baseline Noise Survey

A background noise survey has been undertaken by an ERM noise competency-certified specialist. Noise monitoring has been conducted using a sound level meter which complies with the requirements of the International Electrotechnical Commission (IEC) for Type 1 Precision sound level measurement instrumentation. The sound level meter was calibrated prior to use with a portable certified acoustical calibrator. The sound level meter has recorded noise levels in terms of the equivalent (Leq), minimum (Lmin), maximum (Lmax), and statistical levels (e.g. L_{10}, L_{90}, etc.) at representative hourly intervals during the day and evening periods.

2.8.3 Soil and Groundwater Quality Assessment

A soil and groundwater survey is planned for Q3 2009. The programme will include both soil and groundwater testing at the proposed JER facility, the Temporary Construction Facilities (TCF) and port areas.

2.8.4 Ecology Baseline Assessment

A field survey has been conducted, covering a sufficient area to evaluate the impact of the project footprint and associated facilities (e.g. interconnecting pipelines, access roads, TCF areas etc) on the fauna and flora, as compared to relatively undisturbed habitat adjacent to the project site. This data has been used to assess future environmental impacts as well as providing a baseline for monitoring change in the future. An experienced ERM local biologist and wildlife expert has conducted the survey.

Survey methods applied are described below.

Fauna survey

- Direct observations made along transects and in time constrained searches of birds, reptiles and mammals; and
- Searching for and quantifying animal tracks and traces such as droppings, burrows and carcases.

Flora survey

- Recording of dominant and co-dominant plant species, species associations and total plant species lists in a systematic sampling programme to cover areas directly affected by the facilities;
- Habitat classification; and
- Setting up of photographic records to determine floral changes after the facility installation.

Surveys were conducted during March 2008 and March 2009.

2.8.5 *Ambient Air Quality*

Ambient air quality data have been collected for a number of years by the RC. The RC employs continuous (hourly) measurement sites for most criteria pollutants. Techniques applied for the collection of monitoring data is as follows (personal communication with the RC, 2008):

Parameter	Method
Sulphur Dioxide (SO_2)	UV-Fluorescence
Nitrogen oxides (NO_2)	Chemiluminescence
Photochemical oxidants as O_3	Chemiluminescence
Particulate (PM_{10})	Beta Gauge with selective inlet
Carbon Monoxide (CO)	Nondispersive IR technique

Data was provided and reviewed by the RC for two consecutive years (2006 and 2007) for Station 6, located approximately 4.5km south west of the JER site.

2.9 *IDENTIFICATION OF IMPACTS*

2.9.1 *Methodology*

Using the information collected in the baseline study, project design data provided by TPIT, and legislative requirements, 'environmental and social aspects' of the project have been identified. 'Environmental and social aspects' serve as a link between baseline studies / project data, and the identification and prediction of impacts.

The analysis and identification of impacts for this ESIA has been guided by the considerations outlined in IFC Performance Standard PS1 on Social and Environmental Assessment and Management Systems. This standard requires the Proponent to conduct a process of Social and Environmental Assessment which considers relevant social and environmental risks and impacts of the project, and which includes consideration of the following issues (to the extent that they are relevant to the project):

- Labour and working conditions;
- Pollution prevention and abatement;
- Community health, safety and security;
- Land acquisition and involuntary resettlement;
- Biodiversity conservation and sustainable natural resource management;
- Indigenous peoples; and
- Cultural heritage.

Of the above issues, the last four points are of limited or no relevance to the context in which the JER project will be implemented on previously made ground at its designated site (PLOT 9) within the long established JIC industrial conurbation, and are only discussed further in this assessment

where they have some relevance. The focus of this ESIA Report is therefore on the first three points listed above.

2.9.2 Assessment of Impacts

The identified impacts have been analysed according to set criteria. As a predictive function of the ESIA, this stage forecasts the nature, timing, severity, and likelihood of occurrence of the identified environmental impacts.

Nature of Impact
This describes the type of impact arising from the project such as whether it is direct, indirect, or cumulative.

Timing
Impacts can occur at different times during the project life cycle, either immediately or some time in the future. The duration of an impact also has an impact on its significance.

Severity
The severity of the impact has been derived as a function of factors such as the magnitude of an impact, its spatial extent, duration and reversibility. Values have been assigned for each severity index as described below:

Table 2-2 Severity Index and Values

Consequence Index	Value	Description
Catastrophic	5	Massive effect – Persistent severe environmental damage or severe nuisance extending over a large area. In terms of commercial or recreational use or nature conservation, a major economic loss for the host country. Constant, high exceedance of statutory or prescribed limits.
Severe	4	Major effect – Severe environmental damage. Extended breaches of statutory or prescribed limits.
Critical	3	Localised effect – Limited discharges of known toxicity. Repeated breaches of statuary or prescribed limit. Affecting neighbourhood. Spontaneous recovery of limited damage within one year.
Marginal	2	Minor effect – Damage sufficiently large to impact the environment. Single exceedance of statutory or prescribed criterion. Single complaint. No permanent effect on the environment.
Negligible	1	Slight effect – Local environmental damage. Within the fence and within systems. Negligible financial severity.
None	0	Negligible impact.
Positive	+	Beneficial impact – enhances the environment.

Likelihood of Occurrence
Likelihood of occurrence is the estimate of probability that an identified impact will occur in a period of time. For this ESIA, the likelihood of occurrence has been estimated based the index and values set out in *Table 2-3*.

Table 2-3 Probability Index and Values

Category Index	Value	Definition
Certain	5	The impact will occur under normal operating conditions.
Very Likely	4	The impact is very likely to occur under normal operational conditions.
Likely	3	The impact is likely to occur at some time under normal operating conditions.
Unlikely	2	The impact is unlikely to but may occur at some time under normal operating conditions.
Very Unlikely	1	The impact is very unlikely to occur under normal operating conditions but may occur in exceptional circumstances.

Significance

The significance of impacts used for this ESIA is a correlation between the severity and the likelihood of occurrence.

Each impact is analysed to determine the need for additional mitigation. Residual impacts are identified and predicted after the mitigation measures have been taken into account.

Table 2-4 Significance Matrix

		Probability				
Severity		**Very Unlikely**	**Unlikely**	**Likely**	**Very Likely**	**Certain**
		1	2	3	4	5
Catastrophic	5	M	H	H	H	H
Severe	4	L	M	H	H	H
Critical	3	L	M	M	M	H
Marginal	2	L	L	M	M	M
Negligible	1	L	L	L	L	L

The significance is determined using the following definitions:

H - High (or Major) impact. No alternative is feasible and no further mitigation is possible. Compensation or offset measures must be provided.

M - Moderate impact. The residual impact has been subjected to all feasible cost effective mitigation and hence is reduced to a level that is as low as is reasonably practicable. This will receive ongoing attention during detailed design and will be monitored during project implementation.

L - Low (or Minor) impact. This impact will be controlled via good practice management measures.

2.10 QUANTITATIVE MODELLING STUDIES

The assessment of impacts has been supported by studies and modelling conducted for this ESIA on key identified environmental aspects such as releases to air and noise.
Studies conducted include:

Air Dispersion Modelling: AERMOD dispersion model has been utilised to demonstrate that predicted ground-level concentrations of criteria pollutants comply with RC air quality standards. Parameters have been modelled in terms of oxides of nitrogen (as NO_x), carbon monoxide (CO), sulphur dioxide (SO_2), fine particulate matter (PM_{10}) and Volatile Organic Compounds (VOCs). The assessment has (separately) considered both construction and operational phase activities.

In accordance with the requirements of the RC, one year of meteorological data from Jubail meteorological station has been used for modelling. In addition, four years of meteorological data from Dammam International Airport has been applied. The modelled data has been analysed in conjunction with baseline data (from RC Station 6), and compared with RC ambient air quality standards.

Generally, the approach to air dispersion modelling has involved comparing maximum modelling data against RC ambient air quality standards. In addition to this, modelled concentrations of criteria pollutants have been considered at sensitive receptors near to the refinery. These receptors are discussed (and mapped) in *Chapter 6 Environmental and Social Baseline*.

Noise Modelling: The objective of the modelling has been to apply noise prediction techniques to calculate expected noise levels at the boundary of the project site and at nearby sensitive receptors. Modelled data has then been assessed to establish if the design basis meets boundary noise limits set by the RC. Any design elements that require additional noise control measures to meet boundary limits or minimise impact have subsequently been identified.

Noise modelling of major equipment has been undertaken using the acoustic model SoundPLAN. SoundPLAN is a recognised noise prediction and presentation tool used extensively worldwide.

The impact of operational noise to sensitive receptors near to the refinery has also been considered by estimating the propagation of modelled boundary noise levels using inverse square law principles. These receptors are discussed (and mapped) in *Chapter 6 Environmental and Social Baseline*.

Construction noise has also been assessed, mainly using methods described in British Standard (BS) 5228.

2.11 FRAMEWORK ESMP

The framework environmental and social management plan (ESMP) provides a basis for implementing mitigation and management measures for the construction and operational phases of the Project. It serves as a project control tool to ensure that the mitigation measures are carried out in the most effective and efficient manner possible, and that they are shown to be effective.

It is anticipated that during detailed engineering the framework ESMP will provide the basis for developing a comprehensive environmental and social management system for both construction and operational phases of the Project.

3 ENVIRONMENTAL AND SOCIAL POLICY AND REGULATORY REVIEW

3.1 INTRODUCTION

This chapter of the ESIA Report describes the environmental and social policy and legal framework that applies to the proposed JER project and summarises the environmental and social standards and guidelines with which the project is required to comply.

The operating refinery is legally required to comply with the environmental regulations issued by the Royal Commission of Jubail and Yanbu (RC) (1), whose jurisdiction for regulating environmental matters includes JIC 1 and 2, and the KFIP. The Project has elected to also adopt international standards for environmental and social management; in this regard it will aspire to meet the environmental and social guidelines mandated under the EPs(2) and the IFC (3) Performance Standards on Social and Environmental Sustainability.

In the event of any ambiguity or conflict between national standards and international standards, the most stringent specific requirement will apply unless otherwise stated in this Environmental and Social Impact Assessment Report, demonstrating that the most stringent standard is inappropriate or unattainable or that the implementation of such requirement would breach the laws of the Kingdom of Saudi Arabia.

The JER project's environmental and social policy is currently based upon the TOTAL and Saudi Aramco HSE policies (*Appendix A, Annexes II, III and IV*).

3.2 THE REGULATORY FRAMEWORK

3.2.1 *Applicable Regulatory Framework*

Within KSA there are two authorities with the mandate to regulate environmental matters: the Presidency of Meteorology and the Environment (PME) and the Royal Commission (RC).

- Although the PME has overall authority in Saudi Arabia for environmental matters, within the designated areas of the Royal Commission for Jubail and Yanbu it is the RC that has been designated responsibility for regulating environmental matters. The RC has published

(1) Royal Commission for Jubail and Yanbu, Royal Commission Environmental Regulations 2004 (RCER 2004), Volumes 1 and 2.

(2) The Equator Principles (EPs) are a set of voluntary environmental and social guidelines that have been adopted by a significant number of financial institutions influential in the project finance market).

(3) The International Finance Corporation (IFC) is the private sector funding vehicle of the World Bank Group. The IFC Performance Standards on Social and Environmental Sustainability were published in 2006.

the RCER 2004 regulations as a basis for environmental regulation (see *Section 3.1.2*).

- Outside the designated RC boundaries (i.e. throughout the rest of the Kingdom) the primary regulating body is the PME. Although the PME has the overall authority in KSA, the PME does not actively participate in areas that fall under the jurisdiction of RC. The PME has published the General Environmental Regulations (GERs) and Rules for Implementation (2001) as a basis for environmental regulation.

Besides these two authorities, under the GERs, the Ministry of Petroleum (MinPet) is a designated Competent Authority for oil and gas projects.

With regard to the JER project, the only component which is not located within the designated boundaries of the RC is the Temporary Construction Facility (TCF) which is to be located on Saudi Aramco owned land and is located immediately outside of the RC boundary.

The GERs call for an Environmental Impact Assessment (EIA) to be submitted to the Competent Authority, and in accordance with this requirement, SATORP will submit the ESIA Report to MinPet for approval.

3.2.2 Jurisdictional Boundaries for the JER Project

As described in detail in *Chapter 4*, the JER project comprises four primary components:

- The refinery, to be located at PLOT 9 within JIC 2;
- The export facilities and tankage, to be located within KFIP;
- The interconnecting pipelines and coke conveyor to transport material between the refinery and KFIP port, in addition to interconnecting pipelines between the JER and the Berri Gas Plant; and
- The TCF which will be located to the south east of the refinery outside of the RC designated area.

The jurisdictional boundaries of these project components are summarised below. Reference can be made to the land-use map presented in *Chapter 6 Environmental and Social Baseline*, which delineates the JIC jurisdictional boundaries and land owned and controlled by Saudi Aramco.

Box 3-1 Jurisdictional Boundaries of the JER Project

Project Element	Jurisdiction
Refinery	Located in Plot 9 of JIC 2. The plot is under the control of the RC. Environmental regulations applicable to the operation of the refinery are the RCER2004.
Port Facilities	Located in the existing KFIP, which is under the jurisdiction of the RC. The RCER 2004 regulations apply to all activity undertaken within the port.
Interconnecting pipelines and petroleum coke conveyor	Interconnecting pipelines will be established within the Jubail Pipeline Corridor which is owned by Saudi Aramco and which falls under the jurisdiction of the RC. Again, national environmental regulations (where applicable) for the operation of the pipelines are the RCER 2004.
Temporary Construction Facilities (TCF)	The TCF will be established outside the designated RC boundaries, on land owned and controlled by Saudi Aramco. Saudi Aramco, under the terms of a Letter of Understanding (LoU), has temporarily provided the necessary land for the TCF. Saudi Aramco has dispensation from the MinPet for the use of the land for the development of the TCF. Since it will be located outside of the RC designated area, the TCF will fall under the jurisdiction of the PME. However, SATORP has elected to apply, where applicable, RCER 2004 standards to the operation of the TCF as these are generally more stringent than those enforced by the PME. SATORP will (if necessary) clear (i.e. restore) and return the TCF plot to Saudi Aramco following the completion of the JER Project construction. Note: The LoU is provided in *Appendix A, Annex VI* to this ESIA.

Those components of the project that fall under the RC's jurisdiction will be permitted via the application for and obtaining of an *Environmental Consent to Construct (ECC)* and an *Environment Permit to Operate (EPO)* from the RC in accordance with RCER 2004 (see *Section 3.2.3* below). Although the PME has the overall authority in the Kingdom of Saudi Arabia, the PME does not actively participate in areas that fall under the jurisdiction of RC.

It is only the TCF which will not strictly fall under the direct jurisdiction of the RC. Outside of the RC boundaries, under the GERs, the MinPet is also designated the Competent Authority. The GERs call for an Environmental Impact Assessment (EIA) to be submitted to the Competent Authority, and in accordance with this requirement, SATORP will submit the ESIA Report to MinPet for approval.

As stated above, SATORP has elected to apply, where applicable, RCER 2004 air quality standards to the operation of the TCF as these are equivalent to or more stringent than PME air quality standards.

3.2.3 Royal Commission of Jubail and Yanbu

The competent authority and regulatory body for environmental management and protection within JIC is the RC. The RC's mandate includes the remit to develop and implement regulations to control substances emitted, discharged,

or deposited, and noise generated within the industrial cities of Jubail and Yanbu. These regulations are updated periodically to reflect the environmental needs of the two RC designated industrial areas and the standards of performance that can be achieved via the application of the latest pollution control technologies.

3.2.4 Royal Commission Environmental Regulations 2004

The current RC regulations are the *Royal Commission Environmental Regulations (RCER) 2004*. These regulations superseded the Royal Commission Environmental Regulations (September 1999) in JIC and the Environmental Protection Manual (January 1991) in Yanbu Industrial City with effective date of 1st September 2005. Any facility (such as the proposed JER) operating or planning to operate within Jubail (or Yanbu) is required to comply with RCER 2004.

RCER 2004 comprises two volumes as follows.

- *Volume I* of RCER 2004 includes all regulations, standards and guidelines required to protect the environment of the two industrial cities from adverse impacts. It is divided into eight sections:
    - *Section 1 – Environmental Regulatory System;*
    - *Section 2 – Air Environment;*
    - *Section 3 – Water Environment;*
    - *Section 4 – Hazardous Materials Management;*
    - *Section 5 – Waste Management;*
    - *Section 6 – Dredging;*
    - *Section 7 – Noise; and*
    - *Section 8 – Reporting and Record Keeping.*
- *Volume II* of the RCER regulations presents the *Consolidated Permit Programme* which covers procedures and forms for applying for an *Environmental Consent to Construct (ECC)* and *Environmental Permit to Operate* (*EPO*). Following receipt of an application on behalf of the project owner(s), the RC may issue an ECC (or EPO as applicable) for an individual facility, or group of inter-related facilities which produce or manufacture a common product and provided they are owned and operated by the same owner(s).

A Permit Application Package (PAP) was submitted to the RC on the 24th November 2008. The ECC for the JER Project was provided by the RC on the 28th February 2009.

3.2.5 The KSA Labour Law

The regulation of employment, labour relations, worker contracts and work place conditions is defined in the *Labour Law* promulgated by *Royal Decree No*

M/51 of 27 September 2005 (23 Sha'ban 1426). It supersedes the *Labour and Workers Law* promulgated by *Royal Decree No M/21* (6 Ramadan 1389H). The contents of the Law are presented in *Box 3-2*.

This Law contains provisions intended to protect the interests of both employers and workers with the aim of establishing a stable, equitable and sustainable work environment. As such, it establishes the legal (and hence minimum) requirements that will apply to engagement of the JER Project work force. It will govern how JER and its contractors employ and house their construction workforce and it will establish the minimum conditions and facilities that they will need to apply, both in the work place and in the worker accommodation.

Box 3-2 ***Contents of Saudi Labour Law 2005***

CONTENTS

3.2.6 *International Treaties and Conventions*

The Kingdom of Saudi Arabia is party to almost 60 international environmental conventions or agreements. Those with requirements applicable to the JER and which are therefore considered in this ESIA are stated below and have either been considered in the design / operation of the refinery or in the assessment of impacts:

- Convention on the Maritime Organization (IMO);
- The United Nations Convention on the Law of the Sea, and 1982 Amendments;
- The 1985 Vienna Convention for the Protection of the Ozone Layer;
- The Montreal Protocol;
- The Kuwait Regional Convention for Cooperation on the Protection of the Marine Environment from Pollution, 1978;
- MARPOL;
- Protocol Concerning Regional Co-operation in Combating Pollution and other Harmful Substances in Cases of Emergency, Jedda, 1982;
- Regional Organization for the Preservation of the Marine Environment, 1982 (ROPME) and associated protocols;
- The 1989 Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and Their Disposal;
- United Nations Framework Convention on Climate Change, 1992 (UNFCCC); and
- The Kyoto Protocol, which was ratified as a non-Annex I state in December 2004.

3.3 *FRAMEWORK FOR THE ADOPTION OF INTERNATIONAL ENVIRONMENTAL AND SOCIAL STANDARDS*

As established in *Section 3.1*, in addition to its commitment to absolute compliance with RCER 2004, the Labour Law and any other applicable Kingdom of Saudi Arabia regulatory provisions, SATORP is committed (subject to certain specific identified constraints beyond the control of the Project) to the adoption of international standards of environmental and social performance, specifically those of the EPs, the IFC Performance Standards (and relevant IFC guidelines) and the OECD Common Approaches (1).

Guidelines associated with certain financing parties (JBIC and NEXI) are also considered to have been addressed through meeting the requirements of the IFC guidance (again subject to certain specific identified constraints beyond the control of the Project).

(1) OECD Revised Council Recommendations on Common Approaches on Environment and Officially Supported Export Credits (2007).

3.3.1 The Equator Principles 2006

Equator Principles Overview

The EPs are a set of voluntary environmental and social guidelines that have been adopted by a significant number of financial institutions influential in the project finance market (collectively the *Equator Principles Financial Institutions, EPFIs*). The objective of the EPs is to provide the EPFIs with a mechanism to incorporate into their financing decisions a structured and rigorous consideration of environmental and social impacts associated with a particular investment initiative.

The EPs comprise a set of ten broad principles that are underpinned by the environmental and social policies, standards and guidelines of the IFC. Under the EPs, the EPFIs undertake publicly to only contribute financing to projects where the project sponsors are able to demonstrate to the EPFIs' satisfaction that they are both able and committed to comply with the provisions of the EPs.

The ten EPs may be summarised as follows:

- *EP 1* requires all projects considered for financing to be categorised according to the degree of environmental and/or social risk they present. Projects with minimal environmental or social impacts require no further analysis under the EPs; those with attributable impacts are potentially subject to meeting the requirements of the remaining Principles.

- *EP 2* mandates a project specific environmental and social impact assessment (ESIA) and provides an illustrative list of potential environmental and social issues to be addressed in the assessment.

- *EP 3* concerns the environmental and social standards that the project must adhere to during its construction, operation and decommissioning.

- *EP 4* addresses requirements for a comprehensive ESMP which needs to be implemented within a structured management system to ensure that the provisions of the remaining EPs are effectively implemented.

- *EP 5* covers the requirements for consultation as well as the public disclosure of key project documentation and information.

- *EP 6* concerns requirements for a structured grievance mechanism to be put in place to enable project-affected communities (including workers engaged on the project and workers at neighbouring sites) to express any concerns or grievances they may have concerning the development.

- *EP 7* provides for the possible requirement for an independent review of EP compliance in order to assist the EPFI's due diligence.

- *EP 8* provides for the incorporation of covenants linked to EP compliance to be included in the project financing agreements.

- *EP 9* deals with the possible requirement for independent verification of monitoring carried out by the project sponsors.

- *EP 10* commits each EPFI to report publicly at least annually about its EP implementation processes (and hence is the only one of the ten Principles not to address specific project financing applications).

EPs 1 to 6 focus on obligations of the project proponent (in this case the JER Project) and hence are considered wherever applicable in this ESIA, while EPs 7 to 10 place obligations on the EPFIs and hence are not considered further in this assessment.

Project Categorisation and its Implications for the ESIA and for the Standards Adopted by the JER

The first of the ten EPs deals with the subject of project categorisation, which is central to implementation of the remaining principles. Each project under consideration for financing must be categorised into one of three categories according to the degree of risk presented by the project; *Category A, B* or *C* relating to those projects that display high, medium or low environmental and/or social risk, respectively.

- *Category C* projects (i.e. those of low risk) are not subjected to further environmental or social due diligence under the EPs.

- In *Organisation of Economic Co-operation and Development (OECD) High-Income* countries, all *Category A* and *Category B* projects that undertake an assessment process that is in compliance with local or national law are deemed to meet the requirements of *Principles 3, 4, 5* and *6*. In these countries, all *Category A* and *Category B* projects are nevertheless required to demonstrate compliance with *Principles 2* and *8*, while all *Category A* and, as appropriate, *Category B* projects are required to also comply with *Principles 7* and *9*.

- In all other jurisdictions, (i.e. *non-OECD* countries and *OECD* countries designated as *Low-Income* and *Middle-Income*), all *Category A* projects must comply with *Principles 2* through to *9* inclusive. *Category B* projects must all comply with *Principles 2, 3, 4* and *8* and, as appropriate, must also comply with *Principles 5, 6, 7* and *9*.

For *Category A* and *Category B* projects located in countries that are not designated OECD High-Income countries (including the Kingdom of Saudi Arabia), the environmental and social standards mandated under *Principle 3* are those of the IFC and the World Bank Group. In this regard it is noted that the IFC implemented a major overhaul of its environmental and social policy

and standards in April 2006 and it is these revised standards to which *Principle 3* defers as of July 2006.

The JER Project has elected to apply the EPs as if it were designated a *Category A* project. The implications of the JER Project being assigned *Category A* are as follows:

- The Project will endeavour to demonstrate compliance with all five EPs *2* to *6* inclusive.

- This ESIA has (subject to certain specific identified constraints beyond the control of the project) fulfilled the requirements of EP 2.

- In order to meet EP *3*, the project will need to comply with the applicable *IFC Performance Standards on Social and Environmental Sustainability* (as described in *Section 3.4.2* below) and the applicable World Bank Group *Industry Specific and General EHS Guidelines* (as summarised in *Section 3.4.3* below).

3.3.2 The IFC Performance Standards on Social and Environmental Sustainability

The IFC, a member of the World Bank Group, adopted new *Policies on Sustainability and Disclosure* and new *Performance Standards on Social and Environmental Sustainability* in 2006. These policies and performance standards replaced the previous 1988 *Environmental and safeguard Policies* and 1998 *Disclosure Policies* and became effective in April 2006. The Performance Standards define the IFC's clients' roles and responsibilities for managing their projects and the requirements for receiving and retaining IFC support. The standards include requirements to disclose information.

The eight Performance Standards collectively have subsequently been adopted by other institutions and protocols (such as the EPs) and are currently widely regarded as the *defacto* international standard for securing social and environmental sustainability in the planning and life time execution of major infrastructure developments (such as the proposed JER).

The eight performance standards are itemised as follows:

- Performance Standard PS1: Social and Environmental Assessment and Management Systems;
- Performance Standard PS2: Labour and Working Conditions;
- Performance Standard PS3: Pollution Prevention and Abatement;
- Performance Standard PS4: Community Health, Safety and Security;
- Performance Standard PS5: Land Acquisition and Involuntary Resettlement;

- Performance Standard PS6: Biodiversity Conservation and Sustainable Natural Resource Management;
- Performance Standard PS7: Indigenous Peoples; and
- Performance Standard PS8: Cultural Heritage.

Performance Standard PS1 on Social and Environmental Assessment and Management Systems establishes the importance of:

- Integrated assessment (ESIA) to identify the social and environmental impacts, risks, and opportunities of a proposed project;
- Effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them ; and
- The project proponent's management of social and environmental performance throughout the life of the project.

Performance Standards PS2 through *PS8* establish requirements to avoid, reduce, mitigate or compensate for impacts on people and the environment, and to improve conditions, where appropriate. While all relevant social and environmental risks and potential impacts should be considered as part of the ESIA assessment, *Performance Standards PS2* through *PS8* describe potential social and environmental impacts that should be considered and which may as a result require particular attention. Where social or environmental impacts are anticipated, the project proponent is required to manage them through its environmental and social management system (ESMS) consistent with *Performance Standard PS1*.

While careful consideration has been given to the applicability of all eight Performance Standards, Performance Standards PS5, PS6, PS7 and PS8 which deal with involuntary resettlement, biodiversity conservation, indigenous peoples and cultural heritage respectively have been found to have minor or no relevance to the JER project, whereas Performance Standards PS1, PS2, PS3 and PS4 which respectively address ESIA and management systems, labour and working conditions, pollution prevention and abatement and community health, safety and security are all considered to apply directly or contain elements that are directly applicable to the JER project.

Under the IFC's *Sustainability Policy*, in addition to meeting the requirements under the Performance Standards, project proponents must comply with applicable national laws, including those laws implementing host country obligations under international law (as summarised in *Section 3.2* above).

A set of Guidance Notes, corresponding to the Performance Standards, offers guidance on the requirements contained in the Performance Standards, including reference materials and good sustainability practices to help proponents improve project performance.

The requirements of Performance Standard PS1 on Social and Environmental Assessment and Management Systems for the JER Project may be summarised as follows:

- **A Social and Environmental Management System**: The JER Project is required to establish and maintain a Social and Environmental Management System appropriate to the nature and scale of the project and commensurate with the level of social and environmental risks and impacts. The Management System will incorporate the following elements:

    - Environmental and Social Assessment;
    - Management programme;
    - Organisational capacity;
    - Training;
    - Community engagement; and
    - Monitoring and reporting.

- **Environmental and Social Assessment**: The JER project is required to conduct a process of environmental and social assessment (which is consolidated in this ESIA Report) that considers in an integrated manner the potential social and environmental (including labour, health, and safety [1]) risks and impacts of the project. The assessment process should be based on current information, including an accurate project description, and appropriate social and environmental baseline data. The assessment needs to consider all relevant social and environmental risks and impacts of the project, including the issues identified in *Performance Standards 2 through 8*, and those who will be affected by such risks and impacts. Applicable laws and regulations of the jurisdictions in which the project operates (in the case of JER this is predominantly the KSA, although the potential for oil spills from KFIP [2] and shipping operations to impact other Arabian Gulf States has been considered) that pertain to social and environmental matters, including those laws implementing host country obligations under international law, will also be taken into account.

- **Management Programme**: Taking into account the relevant findings of the ESIA and the result of consultation with affected communities, a program of mitigation and performance improvement measures will be established.

- **Organisational Capacity**: An organisational structure that defines roles, responsibilities, and authority to implement the management program, including the Action Plan will be established. Specific personnel,

(1) The safety risks to the work force and the public posed by major accident hazards associated with the JER project have been analysed and are reported separately to this ESIA.
(2) KFIP houses the JER product export facilities, see *Chapter 4* for a full description of these facilities.

including management representative(s), with clear lines of responsibility and authority, will be designated.

- **Training:** Employees and contractors with direct responsibility for activities relevant to the project's social and environmental performance will receive adequate training to ensure that they have the knowledge and skills necessary to perform their work, including current knowledge of the host country's regulatory requirements and the applicable requirements of *Performance Standards 1* through *8*.

- **Community Engagement**: This is an on-going process involving the client's disclosure of information. When local communities may be affected by risks or adverse impacts from a project, the engagement process will include consultation with them. Following discussions with the RC, community engagement has not taken place during the preparation of this ESIA Report. See *Chapter 8* for further details.

- **Monitoring**: This will be incorporated as an element of the Management System. Procedures will be established to monitor and measure the effectiveness of the management program.

- **Reporting**: Internal periodic assessments of the effectiveness of the management program will be produced and submitted to senior management. These will be based on systematic data collection and analysis.

- **External Reporting and Action Plans**: where required the client will disclose Action Plans to the affected communities. In addition, the client will provide periodic reports that describe the implementation of the Action Plan on issues that involve ongoing risk to or impacts on affected communities, and on issues that the consultation process or grievance mechanism has identified as being of concern to those communities.

3.3.3 World Bank Group Environmental, Health and Safety Guidelines

The World Bank Group has developed a set of Environmental Health and Safety (EHS) Guidelines to enable projects to achieve an 'international' standard of performance, based on what is generally achievable by the application of currently available, commercially proven technology and management methods. These guidelines contain both quantitative and qualitative guidelines for achievement of EHS performance. Both the Equator Principles and the IFC Performance Standards defer to these guidelines for establishing acceptable levels of performance in accordance with the broad requirements of these principles and standards.

The EHS Guidelines, both general and industry-specific, are technical reference documents with general and industry specific examples of Good International Industry Practice (GIIP). When one or more members of the

World Bank Group are involved in a project, these EHS Guidelines are applied as required by their respective policies and standards. The industry sector EHS guidelines are designed to be used together with the General EHS Guidelines document, which provides guidance to users on common EHS issues potentially applicable to all industry sectors. For complex projects, use of multiple industry-sector guidelines may be necessary.

The EHS guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the EHS guidelines to existing facilities may involve the establishment of site-specific targets, with an appropriate timetable for achieving them. The applicability of the EHS Guidelines should be tailored to the hazards and risks established for each project on the basis of the results of an environmental assessment in which site-specific variables, such as host country context, assimilative capacity of the environment, and other project factors, are taken into account.

The applicability of specific technical recommendations should be based on the professional opinion of qualified and experienced persons. When host country regulations differ from the levels and measures presented in the EHS Guidelines, whichever is more stringent applies. If less stringent levels than those provided in the EHS Guidelines are appropriate, in view of specific project circumstances, a full and detailed justification for any proposed alternatives is required as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment.

This approach has been applied in the assessment of the JER, where generally (but not always) the requirements of RCER are more stringent than those of the applicable World Bank Group's General EHS guidelines.

The IFC guidelines that have been the principal focus of the design of the JER project are as follows:

- IFC Environmental, Health and Safety General Guidelines (April 2007);
- IFC Environmental, Health and Safety Guidelines for Petroleum Refining (April 2007); and
- IFC Environmental, Health and Safety Guidelines for Thermal Power Plants (2008).

3.4 THE REQUIREMENT TO UNDERTAKE AN ESIA AND TO CONSULT

3.4.1 The Requirement for an ESIA

ESIA is now widely recognised as an essential planning tool to enable decision makers to make informed decisions regarding whether a proposed development initiative should be authorised to proceed. In this regard, most

developed countries, including all OECD "high income" countries now encompass ESIA as a primary decision making tool in the land use planning process.

However, the RC currently takes the view that ESIA is not an essential planning tool in the context of the industrial cities of Jubail and Yanbu, due to the planning and permitting regime that is in place in these relatively modern purpose-built designated industrial conurbations. Instead, as discussed previously, the RC bases its environmental permitting process on demonstration of the project's compliance with RCER standards, the application of *BAT* and a two stage certification process encompassing an ECC and an EPO. This ESIA is, therefore, not expected to play a material role in the permitting of the JER project with the RC.

The EPs and the IFC Performance Standards, however, being international standards, place primary importance on rigorous environmental and social impact assessment, not only as a planning tool for decision makers, but as a communication tool to engage stakeholders and as a management tool for project owners to proactively plan and manage the impacts attributable to their facilities. In this regard, the JER project has elected to undertake a comprehensive ESIA process in accordance with what would be mandated for a *Category A* project under the EPs and IFC Performance Standards. As discussed earlier, in accordance with the PME GERs the ESIA will also be submitted to MinPet for approval.

3.4.2 The Requirement to Consult

Stakeholder engagement and public disclosure are also fundamental tenants underpinning the EPs and IFC Performance Standards, not only within the ESIA process, but throughout the construction and lifetime operation of a development project.

The RC, however, takes the view that the particular situation pertaining to the industrial cities of Jubail and Yanbu are such that engagement with stakeholders is more effectively achieved when channelled via the RC itself (rather than via the project owners). In this regard, the RC has in place an established public communications register which serves to ensure that communications from the public, whether complaints or otherwise, are channelled to the appropriate party and the outcomes communicated back to the initiator.

The approach adopted by the RC is therefore fundamentally different to that of the EPs and IFC Performance Standards.

Consultation as part of the ESIA Process

The JER project, seeking to implement the project to EP/IFC *Category A* standards, mandated a public consultation and disclosure process for the

ESIA, the first stage of which was to commence with scoping as a vehicle to inform and engage with stakeholders.

- A *Scoping Report* was prepared and was tabled before the RC on 13 November 2007. The report described the project, identified potential impacts and proposed likely mitigation measures as a basis for communicating effectively with stakeholders to ascertain their concerns and possible suggestions for enhancement measures.

- This was followed by the preparation of a *Public Consultation and Disclosure Plan (PCDP)* which was issued to the JER project team on 26th November 2007. The PCDP set out a programme for focussed engagement with different groups of stakeholders.

The RC, in December 2007, informed the JER Project that in line with standing RC policy, they would not authorise any direct consultation instigated by the project team and that all communication with the public and interest groups would be via the RC in accordance with their normal protocols.

In this regard, despite best endeavours on the part of the JER Project, this ESIA has not been in a position to incorporate meaningful stakeholder engagement, outside of meeting with the RC itself. While this is not in strict compliance with EP5 in terms of process, it is questionable whether it is material in terms of risk to the project, given the remote location of communities from the JER facilities and the fact that JIC is a purpose-built industrial conurbation whose very rationale and existence is predicated upon co-locating heavy industrial developments (such as the proposed JER refinery) within a context of structured planning controls.

Consultation as part of Project Implementation

EP5 calls for consultation on an ongoing basis throughout the life of a development project. Within the constraints imposed by the RC, the JER project intends to meet the consultation objectives of EP5 throughout construction and operational phases via implementation of two complimentary processes, as follows.

- *The RC's Public Communications Register:* As identified above, the RC does implement a system whereby all communications from the public are recorded, followed up where appropriate, with outcomes communicated back to the initiating party. It is the RC's opinion that this is an established mechanism that is effective in dealing with complaints from the public.

- *JER's Grievance Mechanism:* SATORP is committed to implementing a documented Grievance Mechanism which will be communicated and made available to all staff and contract workers. This will comprise a structured process whereby staff and contract workers will be encouraged

in a culturally appropriate manner to raise their grievances and concerns without any prejudice or penalty and for all such communications to be recorded, considered and responded to by JER. The effectiveness of implementation of the grievance mechanism (and the nature of issues raised) will be subject to ongoing JER senior management review.

In terms of disclosure of the ESIA, SATORP will disclose information about the JER Project by making the ESIA Report Non-Technical Summary available on a SATORP Website in English and Arabic for a period of three months. The ESIA Report will be made available upon written request to SATORP in an electronic format and in English only.

ERM is aware of at least one major development project within JIC (of similar scale to the proposed JER refinery) that is being implemented with project finance provided by OECD ECAs and EP signatory banks, by virtue of a commitment by the project proponents to utilise similar mechanisms to those proposed by JER to achieve the consultation objectives of EP5.

3.5 SPECIFIC ENVIRONMENTAL STANDARDS APPLICABLE TO JER PROJECT

The determination of environmental performance of projects is established with reference to a set of environmental standards that provide the thresholds and limits for environmental performance. As discussed in *Sections 3.2* and *3.3.3*, it is the RCER 2004 Regulations, the IFC 2007 EHS General Guidelines, IFC 2007 EHS Guidelines for Petroleum Refineries, and the IFC 2008 Guidelines for Thermal Power Plants that have been adopted by the JER project. These regulations and guidelines are therefore the basis for evaluating project impacts. As noted earlier, where there is any ambiguity or conflict between any of these standards, the most stringent, specific requirement has been applied unless (i) otherwise stated in the Environmental and Social Management Plan, (ii) the Project is able to demonstrate that the most stringent standard is inappropriate or unattainable or (iii) implementation of such requirement would breach the laws of the Kingdom of Saudi Arabia. The RCER standard will always be met as a minimum.

3.5.2 *Air Quality*

Ambient Air Quality

Atmospheric emissions from the JER project have the potential to impact receptors both within and outside of the RC's jurisdiction. Those ambient air quality standards considered relevant outside of the JIC are established and enforced by the PME. The PME ambient air quality standards (published in the General Environmental Regulations and Rules for Implementation 2001) are identical to the RCs in the context of SO_2, NO_x, CO and H_2S and are less stringent in the context of ozone and PM_{10}. SATORP has elected to apply the most stringent of the two national standards and therefore this ESIA assesses

the projects' impact against the RC ambient air quality standards irrespective of location (i.e. whether considering impacts within or outside of RC designated boundaries).

Table 3-1 below presents ambient air quality standards advocated by the RC under RCER 2004.

Table 3-1 RC Ambient Air Quality Standards (μg/m³)

Pollutant	Maximum Concentration	Averaging Period
NO_x	660	1-hour[1]
	100	Annual
PM_{10}	150	24-hour
	50	Annual
SO_2	730	1-hour[1]
	365	24-hour[2]
	80	Annual
O_3	235	1-hour[1]
NMHC[3]	160	3-hour
CO	40,000	1-hour[1]
	10,000	8-hour[1]
H_2S	200	1-hour[2]
	40	24-hour[2]

[1]: Not to be exceeded more than twice per month
[2]: Not to be exceeded more than once per year
[3]: Non-methane hydrocarbons. There is no RC standard for NMHC, this is a guideline to aid in the control of ambient ozone concentrations

The IFC General EHS Guidance (2007) requires that "*Projects with significant sources of air emissions, and potential for significant impacts to ambient air quality, should prevent or minimize impacts by ensuring that emissions do not result in pollutant concentrations that reach or exceed relevant ambient quality guidelines and standards by applying national legislated standards, or in their absence, the current WHO Air Quality Guidelines, or other internationally recognized sources.*"

As there are national legislated air quality standards (the RCER in this case), WHO Air Quality Guidelines are not a requirement for achieving EP, IFC or OECD Common Approaches compliance for this project. Nevertheless, WHO Air Quality Guidelines are cited in this ESIA Report at the request of the Financing Parties. *Table 3-2* presents the WHO ambient air quality guidelines.

Table 3-2 WHO Ambient Air Quality Guidelines (μg/m³)

Pollutant	Maximum Concentration	Averaging Period
NO_2	200	1-hour
	40	Annual
SO_2	500	10-minute
	20	24-hour
O_3	100	8-hour
PM	50	24-hour
	20	Annual

The IFC General EHS Guidance requires that emissions from the facility do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards. As a general rule, the IFC and USEPA suggest 25% of the applicable air quality standards to allow additional, future sustainable development in the same air shed (IFC PS3 General EHS Guidance 2007). This is considered to represent the project target for emissions from the JER. It is reasonable to exclude upset or emergency conditions from this requirement, as these events are relatively short lived.

Emission Source Standards

The RCER 2004 describes extensive requirements for point source emissions. *Table 3-3* provides key standards applicable to the JER.

Table 3-3 RCER 2004 Emission Source Standards

Regulation / Emission Source	Pollutant	Standard (units)
Fossil-fuel fired steam generating unit or furnaces with a heat input capacity more than 250 MBTU/h (73MW)	NO_x (gas fired) NO_x (oil fired)	43 ng/J (0.1 lb/MBTU) gas fired 69 ng/J (0.16 lb/MBTU) oil fired
	SO_2	340 ng/J (0.8 lb/MBTU)
	PM	43 ng/J (0.1 lb/MBTU)
Industrial / commercial / institutional steam generating units or furnaces with a heat capacity more than 100 MBTU/h (29 MW)	NO_x (gas fired) NO_x (oil fired)	43 ng/J (0.1 lb/MBTU) gas fired 69 ng/J (0.16 lb/MBTU) oil fired
	SO_2	215 ng/J (0.5 lb/MBTU) when <30% heat input derived from oil 340 ng/J (0.8 lb/MBTU) when >30% heat input derived from oil
	PM	43 ng/J (0.1 lb/MBTU)
Sources emitting >100g/h organic Hazardous Air Pollutant (HAP)	HAP	20mg/m^3
Sources emitting >2kg/h or 5t/y non-HAP VOC	Volatile Organic Compound (VOC)	80mg/m^3
Flares: steam assisted(a)	VOC	Ht >=11.2 MJ/scm Vmax <122 m/s if Ht > 37.3 MJ/scm $\log_{10}$ (Vmax) =< (Ht + 28.8) /31.7 if Ht < 37.3 MJ/scm
Flares: air assisted(a)	VOC	Ht >=11.2 MJ/scm Vmax =< 8.706 + 0.7084(Ht)
Flares: non-assisted(a)	VOC	Ht >=7.45 MJ/scm Vmax <122 m/s if Ht > 37.3 MJ/scm $\log_{10}$ (Vmax) =< (Ht + 28.8) /31.7 if Ht < 37.3 MJ/scm
Hazardous and medical Waste incineration	Particulate	34 mg/dscm corrected to 7% oxygen
	Visible emissions	10% opacity except for no more than 6 minutes in any hour
	Sulphur dioxide	50 mg/dscm
	CO	50 mg/dscm
	Chlorinated Organics	>99.9999% destruction removal efficiency (DRE) for each chlorinated organic constituent
	Organics	>99.99% destruction removal efficiency (DRE) for each organic constituent
	Total Dioxins & Furans	0.1 ngTEQ/dscm

Regulation / Emission Source	Pollutant	Standard (units)
	PCB	1 mg/kg PCB feed for a maximum one hour average concentration or >99.9999% destruction removal efficiency (DRE)
	HCl	10 mg/dscm
	HF	1 mg/dscm
	TI + Cd	0.05 mg/dscm
	Sb + Pb + Co + As + Cr + Cu + Mn + Ni + V	0.5 mg/dscm
	Hg	0.05 mg/dscm
Incineration chamber	Minimum post combustion Temperature and Minimum Residence Time	850°C for 2 second OR 1100°C or 2 seconds where incineration of >1% halogenated organic substances (expressed as chlorine) takes place
Petroleum Refineries: Fluid catalytic cracking unit catalyst Regenerator	Particulates	1.0 kg/t of coke burn-off
	Opacity	30 percent
	CO	500 ppm
	SO_2 (b)	50 ppm with an add-on control device OR 9.8 kg/t of coke burn-off without an add-on control device
	Fuel gas combustion H_2S contents of fuel gas	<230 mg/dscm
	SO_2	250 ppm at zero percent oxygen on dry basis if emissions are controlled by an oxidation/reduction control system followed by incineration OR Claus sulfur recovery plants
	Reduced sulphur and H_2S	300 ppm of reduced sulphur compounds and 10 ppm H_2S calculated as SO_2 at 0% oxygen on a dry basis if emissions are controlled by reduction control system not followed by incineration
Process vents	Organic HAP(c)	Reduce emissions of TOC by 98% by wt. OR to a concentration of 20 ppmv on a dry basis corrected to 3% oxygen OR combust the emissions in a flare

Notes:

Compliance with the standards will be determined by comparison with hourly average data, unless otherwise specified, that are corrected to standard temperature and pressure, moisture and oxygen content as specified by USEPA Methods.

(a) The maximum exit velocity of a flare (Vmax) is calculated by dividing the maximum volumetric flow rate at STP by the cross-sectional area of the flare tip. (Ht) is the Net Heating Value of the gas being combusted.

(b) The SO_2 limit shall be considered a seven-day rolling average.

(c) Measured as individual organic hazardous air pollutant or as TOC.

The IFC also provides emission source guidelines, which are in general less stringent than those enforced by the RC (*Table 3-4*).

Table 3-4 IFC Emission Source Guidelines

Regulation / Emission Source	Pollutant	Standard (units)
Boilers and Heaters of less than 50MW thermal input (IFC General EHS Guidelines) [a]	NOx	320mg/Nm^3 gas fired 460mg/Nm^3 fuel oil fired
	SO_2	2,000mg/Nm^3 fuel oil fired
	Particulate Matter	50-150mg/Nm^3
Boilers and Heaters of greater than 50MW thermal input [a]	NOx	240mg/Nm^3 gas fired 400mg/Nm^3 liquid fuel fired
	SO_2	900-1500mg/Nm^3
	Particulate Matter	50mg/Nm^3

Notes:
(a) Dry, 3% excess O_2

In addition, the IFC Guidance Note for Petroleum Refineries (2007) provides two performance guidelines for sulphur recovery units (SRUs):

- Above 97% total sulphur recovery; and
- 150mg/Nm^3 sulphur dioxide concentration exhaust gases.

Compliance with this guideline value for SRUs is discussed further in *Chapter 8 Assessment of Impacts*.

Emissions from Tanks

The RCER 2004 requires that emissions from tanks be controlled on the basis of the True Vapour Pressure (TVP) of the tank contents (*Table 3-5*).

Table 3-5 RCER 2004 Tank Specification Requirements

Tank Capacity (C) (m^3)	True Vapor Pressure (kPa)	Control Devices Necessary for Storage[1]
C < 75	any	None
C => 75	5.2 =< Tvp < 76.6	Fixed roof with internal floating roof OR External floating roof with double seals OR Closed vent system with control device
C => 75	Tvp => 76.6	Closed vent system with control device

3.5.3 Water Quality and Drainage

The IFC EHS General Guidelines 2007 state that discharges of process wastewater, sanitary wastewater, wastewater from utility operations or storm water to surface water should not result in contaminant concentrations in excess of local ambient water quality criteria or, in the absence of local criteria, other sources of ambient water quality. Receiving water use and assimilative capacity, taking other sources of discharges to the receiving water into consideration, should also influence the acceptable pollution loadings and effluent discharge quality. Additional considerations that should be included in the setting of project-specific performance levels for wastewater effluents include:

- Adherence to process wastewater treatment standards consistent with applicable Industry Sector EHS Guidelines (in this case the IFC EHS Guidelines for Refineries 2007);
- Compliance with national or local standards for sanitary wastewater discharges; and
- Temperature of wastewater prior to discharge should not result in an increase greater than 3°C of ambient temperature at the edge of a mixing zone.

The above guidelines are not considered relevant to JER process waste water and oily storm water discharges, as these will be pre-treated and discharged to the RC for further treatment. That is, the JER project will not directly discharge treated process waste water or potentially oily storm water to the environment. Stormwater will only be discharged to the RC stormwater channel (which is connected to the sea) where this is tested and proven to be unpolluted.

RCER provides relevant standards on water quality, which include ambient water quality criteria for the Arabian Gulf and wastewater pre-treatment standards and guidelines at the point of discharge to the central treatment facilities. It should be noted that the JER does not directly discharge any wastewater to the Arabian Gulf or land surface, and therefore 'RCER 2004 pre-treatment' standards are provided only.

Storm Water Runoff

RCER 2004 states that storm water from non process areas may be discharged to the RC storm water drainage system, although the project has elected to retain clean area stormwater for testing prior to discharge.

Both the RCER and the IFC advocate the segregation of contaminated and less contaminated runoff.

The RCER states that the operator of a facility shall provide an impervious storm water management system, independent of the industrial wastewater system, to collect the first flush storm water (30mm) from industrial process areas and hazardous material storage and handling areas.

Any additional rain falling on industrial process areas and hazardous material storage and handling areas may be diverted directly to the RC storm water drainage system.

New facilities outside existing boundaries shall construct a dedicated first flush storm water pond to receive the first 30mm of rainfall from each storm event. This is advocated by both the RCER and the IFC.

The operator of a facility retaining first flush storm water is required to discharge the water according to its chemical analysis as follows:

- If contained in a dedicated storm water pond, first flush storm water that is compliant with the discharge standards in *Table 3-6 / 3-7* may be discharged to the RC storm water drainage system.

- First flush storm water that is not compliant with the water quality standards specified in *Table 3-6 / 3-7* must be pre-treated on-site until compliant or removed offsite by tanker to waste disposal facilities.

The IFC EHS General Guidelines state that runoff from areas without potential sources of contamination should be minimised (by minimising impermeable areas). Where possible, storm water should be managed as a resource; either for ground water re-charge or in meeting the water needs of the facility.

Sanitary Waste

The facility does not discharge sanitary waste water to the Arabian Gulf. All sanitary waste water will be transferred to an RC approved treatment facility for further treatment.

Water Quality Discharge Standards

Tables 3-6 and 3-7 present the RCER 2004 waste water pre-treatment standards at the point of discharge to the central Wastewater Treatment Facilities.

Table 3-6 Industrial Waste Water Pre-treatment Standards at the Point of Discharge to the Central Treatment Facility [(1)]

Parameter[2]	Units	Jubail Maximum Limit
Physical		
Temperature	°C	60
Total Dissolved Solids	mg/l	2,000
Total suspended Solids	mg/l	2,000
Chemical[3]		
Aluminium	mg/l	30
Ammonium (total as N)	mg/l	120
Arsenic	mg/l	1.25
Barium	mg/l	2
Boron	mg/l	2.5
Cadmium	mg/l	0.5
Chloride	mg/l	1,000
Chromium – total	mg/l	5
Chromium – hexavalent	mg/l	0.25
Cobalt	mg/l	2
Copper	mg/l	1.2
Cyanide	mg/l	3.5
Fluoride	mg/l	30
Iron	mg/l	25
Lead	mg/l	0.5
Manganese	mg/l	2
Mercury	mg/l	0.015
Nickel	mg/l	2.5
Oil & Grease	mg/l	120
pH[4]	mg/l	5-11
Phenols	mg/l	150

Parameter[2]	Units	Jubail Maximum Limit
Phosphorus, total P	mg/l	50
Sodium	mg/l	1,000
Sodium adsorption ratio	SAR units	20
Sulphate	mg/l	800
Sulphide	mg/l	6
Total Organic Carbon (TOC)	mg/l	800
Zinc	mg/l	10

1) Facilities owned by the Operator of the Wastewater System including the Wastewater Treatment Plant (WWTP), the sanitary wastewater treatment plant and the associated wastewater sewer and pumping stations.
2) For any parameters not identified, specific standards will be determined on a case-by-case basis.
3) Metals standards represent total metals concentrations.
4) Inclusive range not to be exceeded.
Source: RCER 2004.

Table 3-7 Waste-water Pre-Treatment Guideline Values at the Point of Discharge to the Central Treatment Facilities

Parameter	Pre-treatment Standards (ug/l)	
	Maximum for any one day	Maximum for Monthly Average
Total Volatile Organic Compounds (VOC) in mg/l	10	--
Benzene	134	57
Carbon Tetra Chloride	380	142
Chlorobenzene	380	142
Chloroethane	295	110
Chloroform	325	111
1,1 –Dichloroethane	59	22
1,2 –Dichloroethane	574	180
1,2 – Dichlorobenzene	794	196
1,3 – Dichlorobenzene	380	142
1,4- Dichlorobenzene	380	142
1,1 – Dichloroethylene	60	22
4,6 – Dinitro-O-Cresol	277	78
1,2 –Dichloropropane	794	196
1,3 –Dichloropropylene	794	196
Ethylbenzene	380	142
Hexachlorobenzene	794	196
Hexachlorobutadiene	380	142
Hexachloroethane	794	196
Methylene Chloride	295	110
Methyl chloride	170	36
Nitrobenzene	6,402	2,237
2-Nitrophenol	231	65
4-Nitrophenol	576	162
Tetrachloroethylene	164	52
Toluene	74	28
1,2,4 –Trichlorobenzene	794	196
1,1,1 –Trichloroethane	59	22
1,2 – Trans-dichloroethylene	66	25
1,1,2- Trichloroethane	127	32
Trichloroethylene	69	26
Vinyl Chloride	172	97

Key RCER requirements also include the following.

- The operator of the facility shall not discharge industrial waste water to the waste water system if it exceeds the wastewater pre-treatment standards at the point of discharge from their facility. If necessary the operator shall install a pre-treatment facility to ensure these standards are met.
- All facilities will have a storage capacity of waste water for a minimum of three days (72 hours) operation.
- Sea water utilised for non-contact cooling shall be returned to the seawater cooling return canal only if the chemical characteristics of the water are not altered, except for residual chlorine and temperature.
- The operator of a facility shall undertake effluent and discharge monitoring of all sources prior to their discharge into the RC sewer, seawater cooling canals, drainage ditches, harbour or the Arabian Gulf.

3.5.4 Ambient Noise

RCER 2004 mandates that no person, facility, agency or contractor may operate equipment that creates noise levels at their boundary fence in excess of the environmental noise standards in *Table 3-8*.

The operator of a facility with equipment operating at noise levels in excess of 85 dBA is obliged conduct a perimeter noise survey at their facility at a frequency of at least one per year. The results of the noise survey shall be reported to the RC within thirty (30) days of completion of the monitoring.

The IFC also provide noise level guidelines for both night and day and are slightly more stringent that those advocated by RCER.

Table 3-8 RCER and IFC Noise Level Guidelines

Occupied Areas	**RCER Max Noise Measured at property line – Not to be exceeded >10% of measured time (dBA).**	**IFC Guidelines 1hr LAeq (dBA)**	
Zoning district		Daytime	Nighttime
Residential & Institutional	50	55	45
Small Business and Commercial	65		
Industrial	75	70	70
Roadside Areas[1]	L_{10} (18hours) in dBA[2]		
Residential Areas	70[3]		
Building interior, closed Window	50		

Notes:
1) Roadside criteria based on freely or peak flowing traffic
2) L_{10} (18 hrs) represents the noise level which is exceeded 10% of the time over 18 hrs.
3) Noise level measured at a distance of one meter from the building façade.
Source; RCER, 2004.

The IFC guidelines also suggest a number of noise reduction options that should be considered as part of the design of the installation, these include:

- Selecting equipment with lower sound power levels;
- Installing silencers for fans;
- Installing suitable mufflers on engine exhausts and compressor components;
- Installing acoustic enclosures for equipment casing radiating noise;
- Improving the acoustic performance of constructed buildings, applying sound insulation;
- Installing acoustic barriers without gaps and with a continuous minimum surface density of 10 kg/m^2 in order to minimise the transmission of sound through the barrier. Barriers should be located as close to the source or to the receptor location as possible to be effective;
- Installing vibration isolation for mechanical equipment;
- Limiting the hours of operation for specific pieces of equipment or operations, especially mobile sources operating through community areas;
- Re-locating noise sources to less sensitive areas to take advantage of distance and shielding;
- Sitting permanent facilities away from community areas if possible;
- Reducing project traffic routing through community areas wherever possible; and
- Developing a mechanism to record and respond to complaints.

Monitoring and verification of ambient and operational noise is also advocated to be undertaken by a trained noise professional.

3.5.5 BAT

RCER requires that the BAT assessment be conducted for new, reconstructed and modified facilities as per the procedures provided in Volume II of the RCER 2004. The RC defines 'BAT' as follows:

"Best Available Techniques (BAT) is the application at facilities of the most effective and advanced production processes, methods / technologies or operational practices to prevent and, where that is not practicable, to reduce emissions or discharges and other impacts to the environment as a whole. BAT must as a minimum achieve emission or discharge standards in these Regulations taking into account energy, environmental and economic impacts and other costs to the facility."

3.5.6 Waste Management, Hazardous Waste and Materials

According to the RCER 2004, waste generated shall be classified into one of the following categories:

- **Hazardous Waste**: These wastes are defined as any solid, semi-solid, liquid, or contained gaseous waste, or combination of such wastes, which may because of its quantity, concentration, physical or chemical

characteristics pose a hazard or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of or otherwise managed. These wastes shall also include chemical wastes identified as discarded commercial chemical products, off-specification products / chemicals, container residues and spill residues.

- **Non-hazardous Industrial Waste**: These waste include solid, liquid, semi-liquid or contained gaseous materials or wastes resulting from industrial, mining, and agricultural operations and sludge from industrial, agricultural or mining, water supply treatment, wastewater treatment or air pollution control facilities, provided that they are not hazardous, municipal or inert wastes as otherwise defined in these Regulations.

- **Municipal Waste**: Municipal wastes include garbage, refuse, food waste, office waste, waste vegetation and other decomposable material resulting from operation of residential, commercial, municipal, industrial or institutional establishments and from community activities.

- **Inert Waste**: Inert wastes are those wastes which are not biologically or chemically active in the nature environment, such as glass, concrete and brick materials, broken clay and manufactured rubber products.

Waste generators shall, through testing of the waste or knowledge of the process by which the waste is generated, classify their wastes according to *Section 5.1.1* of the RCER 2004.

No wastes generated within the JIC shall be transported outside the boundary of JIC for storage or disposal. For wastes which are to be recycled, reused or recovered, treatment permission must first be obtained from the RC or the PME (as applicable).

All industrial and hazardous wastes generated within the JIC and not intended for recycling or reuse shall be treated and / or disposed of at the RC approved waste treatment / disposal facilities located inside the JIC, within one hundred and eighty (180) days of the waste being generated, unless otherwise approved by the RC.

All non-hazardous industrial waste and municipal waste generated within the JIC and not intended for recycling or reuse shall be disposed of at RC approved waste disposal facilities located within the JIC. Open burning of waste is prohibited in the JIC.

All inert waste shall be disposed of at RC approved waste disposal facilities located in the JIC. Operators of facilities that collect and deliver inert waste to the RC sanitary landfill shall follow the RC Sanitation Department procedures before disposal of such materials.

The IFC general guidelines provide comparable approaches to the RCER's waste management requirements, and advocate the effective planning and implementation of a waste management.

The IFC guidelines also discuss how waste minimisation and prevention should be a fundamental part of any waste management programme, and should incorporate the following strategy:

- Substituting raw materials or inputs with less hazardous or toxic materials, or with those where processing generates lower waste volumes;
- Applying manufacturing processes that convert materials efficiently, providing higher product output yields, including modification of design of the production process, operating conditions, and process controls. Instituting good housekeeping and operating practices, including inventory control to reduce the amount of waste resulting from materials that are out-of-date, off specification, contaminated, damaged, or excess to plant needs;
- Instituting procurement measures that recognise opportunities to return usable materials such as containers and which prevent the over ordering of materials; and
- Minimizing hazardous waste generation by implementing stringent waste segregation to prevent the commingling of non-hazardous and hazardous waste.

4 PROJECT DESCRIPTION

4.1 INTRODUCTION

The JER project represents the design, construction, commissioning and operations of a grass roots refinery capable of processing 400,000 Barrels per Stream Day (BPSD) of Arabian heavy crude oil to produce gasoline, diesel, jet fuel, p-xylene, fuel oil and petroleum coke for export and liquid sulphur, propylene and benzene products for domestic consumption or further processing.

This Chapter describes the lifecycle of the proposed JER project. The information presented in this section includes:

- The proposed refinery location and setting;
- Description of the refinery design basis;
- Summaries of the construction project, commissioning and operations phases of the JER project; and
- A summary of the wastes, emissions and discharges generated during construction and normal refinery operations.

The information contained in this section has been supplied by TPIT, which at the time of writing was undertaking the Front End Engineering Design (FEED) for SATORP.

4.2 PROJECT LOCATION

The JER project will be located within the Kingdom of Saudi Arabia on the west coast of the Arabian Gulf, within the PLOT 9 area of JIC 2, about 3 km west of the long established JIC 1 (*Figure 4-1 and 4-2*).

Loading facilities and storage for export products will be located within the long established KFIP situated on the Arabian Gulf coast to the east of the refinery.

Figure 4-1 *Project Location - National Context*

Figure 4-2 *Project Location – Local Context*

4.3 DEVELOPMENT SCHEDULE

The following development milestones are anticipated based on the FEED schedule and are potentially subject to change:

- FEED completed by Q2 2008;
- Award of EPC contract Q2 2009, which will be followed by 24 months of detailed design;
- Construction is anticipated to start Q1 2010 and last 42 months;
- Commissioning to commence Q4 2011; and

- Start of operations February 2012.

4.4 *SUMMARY OF PROJECT DESIGN BASIS*

As noted earlier, the project will be capable of refining Arabian heavy crude oil at a rate of 400,000 BPSD. Feed crude, provided by Saudi Aramco, will be imported to the refinery via pipeline and held into storage tanks prior to processing. The refinery will be capable of producing a number of saleable products as described in *Table 4-1*.

Table 4-1 Refinery Production Rates

Product Stream	Volume	Units	Product Destination
SALEABLE PRODUCTS			
Propylene (polymer grade)	181	kt/y	Exported to JIC 1 for use by other industry.
Motor Gasoline (Reformulated Gasoline Blendstock for Oxygen Blending (RBOB) and Regular Grades)	3,656	kt/y	Export by shipping at KFIP.
Jet A1 Aviation Fuel	1,971	kt/y	Export by shipping at KFIP.
Diesel	9,050	kt/y	Export by shipping at KFIP.
Benzene	134	kt/y	Exported to JIC 1 as a feedstock for other industry.
Paraxylene	650	kt/y	Export by shipping at KFIP
Fuel Oil	-	kt/y	The fuel oil will not be exported continuously; transfer will be provided during prolonged DCU shut-down. Maximum Fuel oil export is 5,600 tons/day for 60 days maximum.
Petrochemical Naphtha	-	kt/y	Not normally exported; maximum export is either 4.1 kt/d for 30÷45 days maximum or 7.3 kt/d for 4 days maximum, respectively during CCR planned and unplanned shut-down.
BY-PRODUCTS			
Coke	2,059	kt/y	Export by shipping at Jubail Port.
Sulphur (liquid)	400	kt/y	Exported by pipeline to BERRI Facility.
Fuel Gas	2,300	t/d	Undergoes sulphur removal and used as a refinery fuel.
Liquefied Petroleum Gas (LPG, mixed C3 & C4)	100	m^3/h	Used by refinery fuel gas system and/ exported by pipeline to Juaymah facilities.
The above are based upon 400,000 BPSD feed crude process rate			

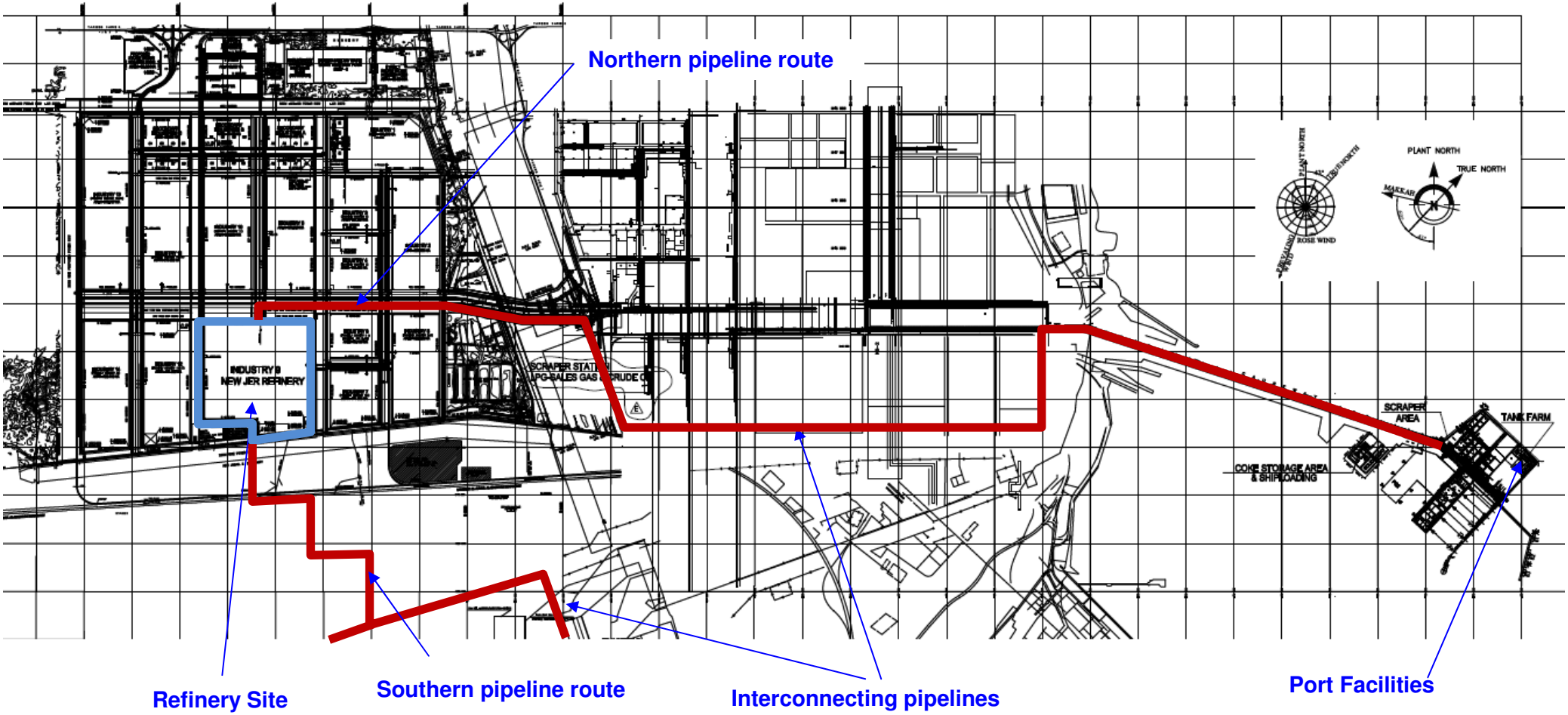
The JER Project can be considered to comprise three elements:

- The refinery (which includes processing units, utilities, and the feed crude / product storage);
- Export facilities, located in the KFIP, which includes buffer product storage and their connection to loading berths; and
- Interconnecting pipelines and coke conveyors from the refinery to either KFIP or the respective tie-in points for local delivery products

(e.g. to the Berri Gas plant approximately 8km to the east of the JER site).

Figure 4-3 presents the major components of the project. The design basis for each of the above components is discussed in further detail below.

Figure 4-3 Project Components and Interconnections



4.4.1 Inter-linkages of the Project with JIC

The following inter-linkages exist between the project and JIC and other utility providers:

- JER will be provided with cooling water (sea water) by the RC through a dedicated pipeline or channel.
- A connection to the cooling water return system will be provided for discharge of blowdown from the seawater cooling system.
- Desalinated water will be provided by Marafiq.
- Electrical power will be provided by Saudi Electrical Company (SEC).
- The facility will be connected to the RC clean storm water system.
- JER Industrial waste water will be discharged to the RC central waste water treatment facility.
- Sanitary waste water will be transferred to the RC sewage treatment facility.
- The JER will use RC and private waste management companies located in the JIC for disposal of both hazardous and non-hazardous wastes.

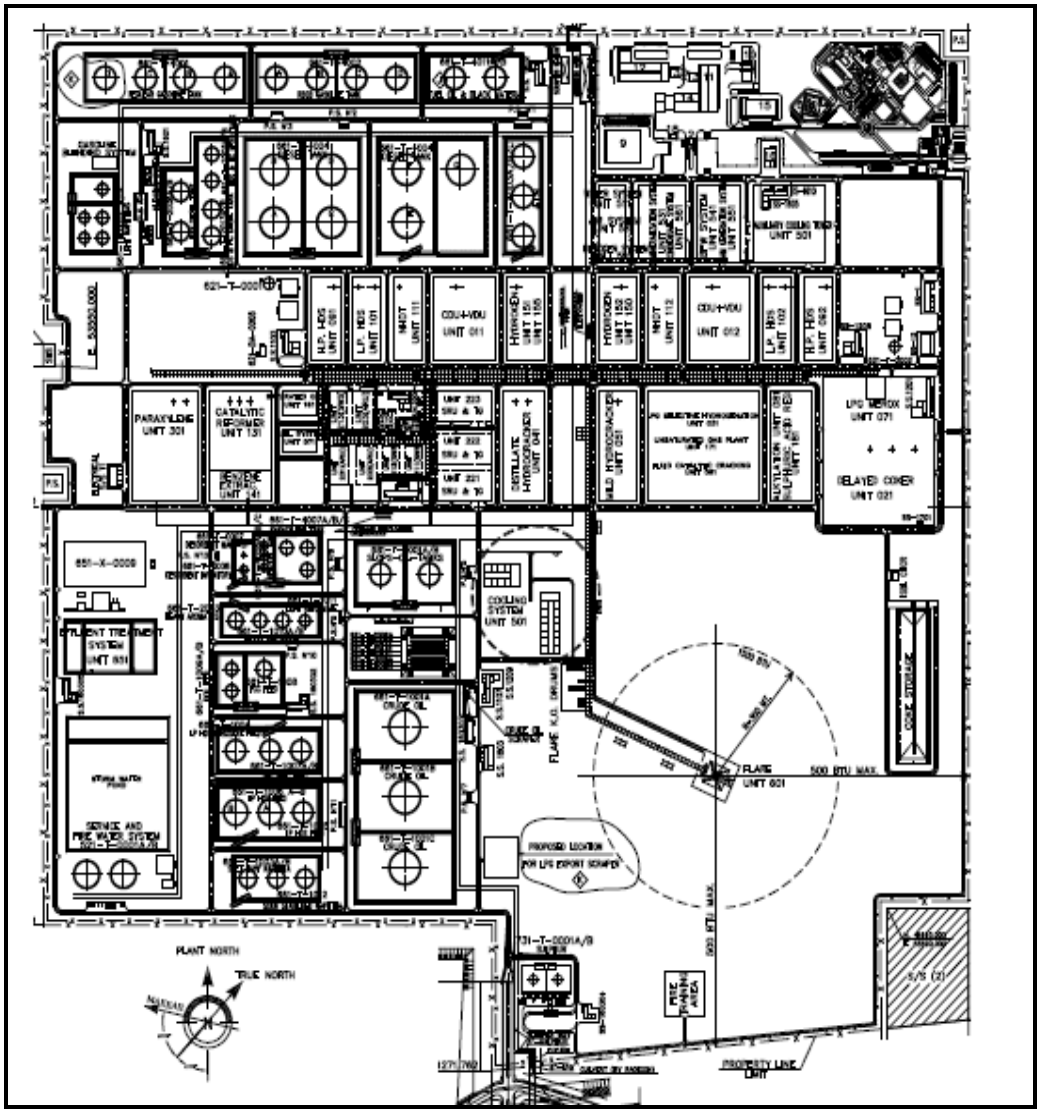
4.5 JUBAIL EXPORT REFINERY COMPONENTS

The refinery site will occupy an area of approximately 500 hectares (Ha) and will include the following components:

- Feed crude, product and intermediate storage;
- Process units; and
- Facilities for generating utilities.

The refinery plot plan is provided in *Figure 4-4*.

Figure 4-4 Plot Plan of the Refinery



4.5.1 Feed Crude, Product and Intermediate Storage

Feed Arabian Heavy Crude Oil will be provided by one pipeline to three identical external roof tanks, individually of 64,500 m^3 capacity.

A total of 68 intermediate and product holding tanks, plus a number of minor chemicals storages, will be located within the refinery. Major storage tanks (i.e. those above 25,000 m^3) are as follows:

- Low sulphur diesel: six 55,000 m^3 tanks;
- RBOB gasoline; four 30,000 m^3 tanks;
- Regular gasoline: four 30,000 m^3 tanks;
- Low sulphur Jet A1: three 30,000 m^3 tanks;
- Fuel oil (for internal use): two 30,000 m^3 tanks;
- LP HDS kerosene feed tank: one 25,100 m^3 tank;
- HP HDS feed tank: one 42,000 m^3 tank; and
- DHC/MHC feed tanks: two 28,600 m^3 tanks.

All tanks holding liquids other than water will be located within a bund wall (or 'dike'), and those over 190m^3 will be bunded as follows:

a) For a single tank case: the dike volume will be equal to 100% tank working capacity plus 110mm (in accordance with API 650 Section 5.2.6.3).
b) For multiple tanks case: the dike volume will be equal to the volume mandated by *Table 4-2* plus the volume occupied by the other tanks within the same dike up to the top of the dike wall.

In both cases a) and b) above, the maximum level of the contained liquid inside the dyked area will be 200 mm underneath the dike top end. (The top 200 mm of the dike is not to be included in the dike capacity determination).

Table 4-2 Dike Capacity

Service of Tanks (Note 1)		Number of Tanks in Common Diked Area		
	Double Wall Tanks	One	Two	Three or More
Flammable Liquid	110 %	100%	100% of larger tank	100% of largest tank
Crude or Other Boil-Over Liquid	110 %	100%	Not Permitted	Not Permitted
Hot Oil, FCC charge, Asphalt, Slops	110 %	100%	Not Permitted	Not Permitted
Flashing Liquid	110 %	100%	100% of larger tank	Not Permitted
Combustible Liquid	110 %	100%	100% of larger tank	125% of largest tank

Tanks in service other than water will be provided with an under-tank leak detection and sub grade protection system in accordance with API STD 650.

4.5.2 Refinery Units

The refinery will operate two identical production trains, each capable of processing 200,000 BPSD. Units associated with the refinery and a brief description of each are provided in *Table 4-3*.

Table 4-3 Unit Listing and Overview of Process

Unit / Utility	Description
Crude Desalting	Washes the feed crude oil prior to atmospheric distillation.
Crude Distillation	Distils crude oil into boiling point 'fractions', including fuel gas, kerosene, naphtha, heavy / light gas oil, and residual bottoms (for vacuum distillation). Each 'cut' undergoes further treatment.
Vacuum Distillation	Further distils residual bottoms after atmospheric distillation to light vacuum gas oil, vacuum gas oil, and vacuum residual bottoms.
Naphtha Hydrotreater	The purpose of the unit is to treat naphtha from the atmospheric distillation and coker units in order to reduce sulphur and nitrogen content to 0.5 wt ppm as well as to saturate olefins of coker naphtha. Feed streams are heated and passed over a catalyst in the presence of hydrogen. This unit includes also a debutanizer which produces LPG and stabilized naphtha. A

Unit / Utility	Description
	further splitter will separate stabilized naphtha into light (to storage) and heavy (to feed the Catalytic Reformer Unit) fractions.
Continuous Catalytic Regeneration Reformer	The purpose of the Catalytic Reformer Unit is to produce, starting from heavy naphtha, heavy reformate, light reformate, hydrogen rich gas (for use in paraxylene and other units) and LPG. Reformate splitter will separate a benzene rich cut and a heavy reformate.
Benzene Extraction	Based on extractive distillation using the Morphylane Process, the benzene rich cut from reformate splitter will be separated into benzene, light raffinate and toluene.
Paraxylene Unit	The unit applies the 'Eluxyl' process to produce high purity paraxylene, with toluene being produced as a side product. The Eluxyl process is based on the adsorption of a mixture of xylenes upon a selective adsorbent with a desorbent carrier.
High and Low Pressure Hydrodesulphurization	Catalytic processes to reduce the sulphur content of feed streams (kerosene, light and heavy gasoil).
Mild and Distillate Hydrocracker	Hydrocracking upgrades heavier fractions into lighter, more valuable products.
Fluid Catalytic Cracking (FCC)	Upgrades heavier fractions into lighter, more valuable products.
LPG Selective Hydrogenation	LPG fraction from FCC and coker is heated with hydrogen in a reactor to selectively hydrogen the diolefins. It will be followed by a debutaniser which will produce LPG and naphtha.
Unsaturated Gas Plant	This unit includes a Depropanizer and Deethanizer Section, followed by Propane / Propylene Splitter Section to separate: o A C4 cut as a product stream going to the Selective Hydrogenation Unit; o Light hydrocarbons (C2s) going to the fuel gas system; o A high purity propylene (polymer grade); and o A propane rich stream going to the fuel gas system. This unit also includes a propylene purification section to remove impurities, water and arsine, in order to reach the required purity for Polymer grade Propylene.
Alkylation	Light olefins (propylene, butylenes and/or amylenes) are reacted with isobutane in the presence of a sulphuric acid catalyst to form alkylate. The alkylate product is a mixture of gasoline boiling range branched hydrocarbons which is blended with the refinery gasoline pool to increase the gasoline octane and reduce the vapour pressure.
Sulphuric Acid Regeneration	Sulphuric acid regeneration involves four steps: (1) Formation of sulphur dioxide by the decomposition of spent acid and the combustion of H_2S gas. (2) Cooling and purification of the sulphur dioxide process gas. (3) Conversion of sulphur dioxide to sulphur trioxide. (4) Absorption of sulphur trioxide in sulphuric acid.
Saturated Gas Plant	Purpose is to fractionate feed from the naphtha hydrotreater into

Unit / Utility	Description
	mixed propane / butane LPG, naphtha and an overhead fuel gas stream for the refinery fuel gas network.
Hydrogen Making Unit	Generates hydrogen by steam reforming of butanes and light naphtha. Produced hydrogen is purified by Pressure Swing Absorption (PSA) prior to use within the refinery. Hydrogen is used in the process of hydrotreatment and hydrogenation of certain product streams.
Sulphur Recovery Unit (SRU) and Tail Gas Treatment (TGT).	Converts H_2S to liquid sulphur in a Claus Reactor, the following TGT will capture residual sulphur compounds achieving a total higher efficiency in sulphur removal.
Amine Regeneration	'Rich' amine, which has recovered H_2S from a fuel gas stream, is regenerated by heating. H_2S generated by this process is transferred to the SRU.
Sour Water Stripper	This unit removes H_2S and NH_3 from various sour water streams.
Delayed Coker Unit (DCU)	Delayed Coking is a thermal process in which a residuum material is rapidly heated in a furnace and then thermally cracked in coke drums. Products from the coking include overhead vapours, unstabilised naphtha, Light Coker Gas Oil (LCGO), Heavy Coker Gas Oil (HCGO), and Petroleum Coke.
LPG Merox	Merox unit treats LPG, kerosene or jet fuel by oxidizing mercaptans to organic disulfides.

Sulphur Recovery Units (SRUs)

SRUs recover elemental sulphur from H_2S waste streams generated by amine regeneration and hydrotreatment processes.

Three identical and independent SRUs will be operated at the facility. Liquid sulphur will be transferred to a heated pit of 440 m^3 (one for each SRU train) prior to export by pipeline to the BERRI facility located approximately 8 km to the south east of the JER site.

Residual tail gas will be oxidised in order to transform sulphur present in the tail gas to SO_2. This will be achieved in an incinerator (one at each SRU) at high temperature with excess of oxygen, using fuel gas to complete combustion.

Process Drains
(The information below is provided at the request of the Financing Parties)

Amine Closed Drain System: each process unit which utilises amine solution is provided with a closed drain system comprising the following:

- Hardpipe drain connections link the equipment/pipe (where amine solution is handled) to an underground header.
- The heater is routed to a dedicated closed drain drum (horizontal vessel, located in a pit, vented to flare).

- A vertical pump is installed on the drum (with spare in warehouse), to recycle back to Amine Treating Unit (ARU) all the recovered amine solution.
- A basket filter is installed on the discharge of the pump, to retain major solid particles that could be entrained in the amine solution.

Sulphuric Acid Closed Drain System: in the Alkylation Unit (081), spent acid flows from the acid after settler drum to the acid blowdown drum, which operates near flare header pressure. Vapours from this drum are routed to the blowdown vapour scrubber.

In the acid blowdown drum, any residual liquid hydrocarbon is separated and pumped back to the Alkylation reactors. Acid from the spent acid side of the drum is pumped to spent acid storage/regeneration section, which comprises one fresh acid tank, one spent acid tank and one acid swing tank, which can serve as either a fresh acid tank or spent acid tank.

Also during a unit shutdown, acid is removed from the reactors, acid settlers and other equipment/piping into the acid blowdown drum, wherein hydrocarbon is removed before the acid is pumped to storage.

In addition to the above, a system has been designed for handling all possible acidic fluids coming from:

- Small equipment leakages;
- Acidic rainwater accumulation in curbed areas; and
- Major leakages due to equipment rupture.

There is a Process Curbed Area and a Storage Curbed Area. The fluids collected in these Curbed Areas are rain water (low acidity), fire-fighting water and process leakages. They are freely drained either to the process area catch basin or to the storage area pit.

4.5.3 Administration and Utilities

The refinery will house an administrative building complex.

Utilities which support the refining process within the JER are typical of crude oil refineries elsewhere. These include the following:

- Fuel gas, pilot gas and fuel oil systems;
- Boiler feed water system;
- Steam & power generation system;
- Condensate system;
- Power supply and distribution;
- Seawater/soft and auxiliary cooling water systems;
- Service and fire water system;
- Potable water system;
- Demineralisation system;

- Services and instrument air;
- Nitrogen system;
- Waste water treatment;
- Storm water system; and
- Flare system.

Each of the above is described in further detail below.

Fuel Gas, Pilot Gas and Fuel Oil Systems

With the exception of start-up, the refining process generates sufficient quantities of fuel gas, fuel oil and LPG (which is vaporised prior to use) and pilot gas (vaporised propane) to meet the demand during normal operations. Fuel gas is generated by certain process units as a by-product, and the H_2S content is controlled by a number of fuel gas sweetening systems (amine stripper) prior to its transfer to the facility fuel gas system. The design maximum H_2S content of fuel gas during normal operations is less than 50ppm, although it is anticipated that the H_2S recovery systems will achieve a lower H_2S content.

Heaters within the refinery will only operate on fuel gas. There are 28 individual heaters, and three tail gas incinerators, with an overall thermal input of 1,275 MW (400,000 BPSD case).

Three tail gas incinerators associated with the sulphur recovery units will require fuel gas at a rate of 27MW each.

The four steam boilers (three in operation and one in stand-by) are operated on both fuel gas and fuel oil with an overall thermal input of 426 MW, of which typically 225MW will be from fuel gas and 200MW from fuel oil combustion. The fuel oil will be generated by the FCC unit, and will have a sulphur content of less than ~0.06% by mass.

High purity sales gas (natural gas) will also be required as a feed stream for the hydrogen production units and as an alternative to vaporised LPG in the fuel gas system. This gas will be imported to the refinery via a sales gas import pipeline.

The pilot gas system (which will comprise more than 90% propane) will be provided for the pilot burners within heaters and boilers.

All heating systems will meet RCER 2004 emission limits. In addition, all stack heights have been appropriately set using an internationally recognised dispersion model (AERMOD).

Boiler Feed Water (BFW) System

The treated water will be de-aerated in a degassing tower, chemically treated and preheated prior to be sent to the steam boilers.

Steam & Power Generation System

Three steam boilers will operate for the generation of HP steam, and a forth will be in 'stand-by'. As described above, the steam boilers will operate on a combination of fuel gas and fuel oil at an individual heat input rate of 142 MW (normal case). The steam generation system will also include two steam turbines for power generation to support the electrical network. Low pressure steam extraction is also provided to support the refinery demand.

Condensate System

This includes hot and cold condensate collection and treatment. Process hot condensate is considered potentially polluted by the process. Condensates are collected, cooled and treated in polishing units before being sent back to treated water storage tanks.

Power Supply and Distribution

The JER will have a normal connected load of 344 MW (max 430 MW), provided by SEC. Emergency backup power will be generated by JER (a steam turbine generates 56 MW, and diesel generators will be able to produce 11 MW).

Cooling Water System

The JER has a significant cooling water demand (approximately 84,000 m^3/h), and therefore will be provided with three independent systems, each one serving specific unit areas of the refinery:

- Two 'soft' (non-saline) cooling water systems. Each system will be reticulated through a closed loop system and heated soft water will transfer heat to a closed loop seawater system (one for each). Makeup seawater demand will be minimised through the use of cooling towers which have been design to have a maximum 0.0005% drift loss. Makeup (approximately 6,100 m3/h for the two systems as the design case) will be provided by a connection to the RC seawater distribution and will be needed to replace blow down and evaporation losses.
- The third system will be a single loop with fresh water. Heated water will be cooled in dedicated cooling towers. Raw water makeup will be provided to JER by Marafiq.

Service and Fire Water System

This system will accommodate water requirements for service and fire water distribution to the JER. The system will be supplied with raw water from Marafiq and stored inside two storage tanks.

Water Supply

Marafiq will provide raw water for industrial purposes through a single 24" dedicated connection. This water will be used for:

- Make-up of the single-loop cooling tower system;
- The refinery service and fire water system;
- The refinery potable water system; and
- As feed water for the demineralisation unit.

Potable Water System

This system will meet the water requirements for administration, process and utility buildings. The potable water will also be used for emergency eyewash and showers inside the refinery. The potable water make up will be generated on site using raw water supplied by Marafiq.

Demineralisation System

The package will produce demineralised water suitable for steam generation. Demineralised water will be produced from raw water supplied by Marafiq, treated using ion exchange resins and collected in storage tanks. Regeneration of ion exchange resins will be performed with sulphuric acid and caustic soda.

Service and Instrument Air

Service air and dry instrument air will be provided for process units, utility and off-site systems. The instrument air system will be designed for a flow of 14,500 Nm^3/hr, while the service air system design capacity will be 3,600 Nm^3/hr.

Nitrogen System

Gaseous nitrogen will be provided to the refinery from an outside supplier (8,600 Nm^3/h). Liquid nitrogen storage and vaporization facilities will be installed for back-up and for peak requirements. The liquid nitrogen will be supplied to the refinery site by truck.

Waste Water Treatment Plant (WWTP)

Two lines inside the WWTP will be provided, each capable of treating the maximum waste water flow rate (560 m^3/h) associated with refinery operations. The treatment system will be based upon three stages of treatment:

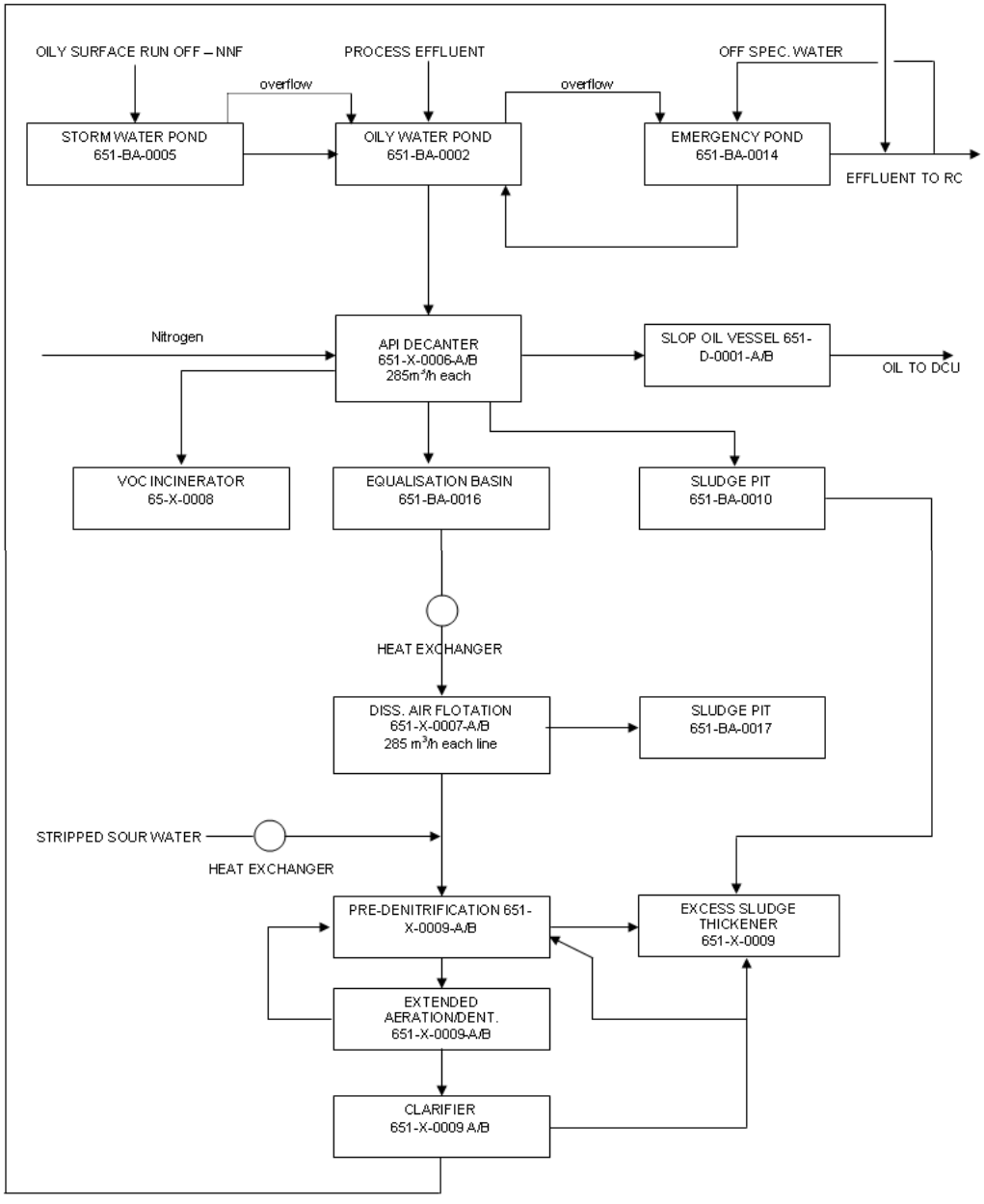
- American Petroleum Institute (API) Separator);

- Dissolved air flotation; and
- Biological treatment.

It should be noted that most of the refinery discharge streams to RC WWTP will meet the requirements of RCER 2004 pre-treatment standards prior to entering the refinery's biological treatment, apart from certain streams containing aromatics. For these streams a simple biological treatment has been introduced to comply with RCER 2004 Tables 3B and 3B1 discharge values. An alternative to biological treatment with aromatic stripping is also being investigated.

These treatment stages will remove suspended solids, free-phase oil, and dissolved phase organics, leading to the discharge of treated water from the refinery which can comply with RCER 2004 pre-treatment standards *(Figure 4-5)*.

Figure 4-5 Schematic of JER WWTP



It should be noted that the WWTP effluent water quality does not need to meet IFC EHS General Guidelines water quality standards as waste water treated in the refinery WWTP is co-mingled with (similarly pre-treated) effluent discharges from other JIC 1 and JIC 2 facilities and is then further treated by the RC in it's central WWTP prior to discharge to the Arabian Gulf.

Storm Water System

Within the refinery, storm water from 'clean' areas, such as roads, office roofs and car parks, will be retained in a dedicated pond and will be tested for appropriate parameters listed in Table 3B and 3B1 of RCER 2004. Based on the results of that testing, water from the clean storm water system will be directed to either the RC storm water ditch or to the JER WWTP. Potential oily storm water will be transferred to a number of ditches for retention of the equivalent of the first 30mm of rainfall.

Water retained within these ditches will be tested for oil content and disposed of either to the JER WWTP or the RC storm water ditch, based on water quality.

Oily and clean storm waters will be kept separate at all stages of collection and holding.

Flare System

Three emergency flaring systems are included in the refinery design basis:

- Emergency hydrocarbon flare for refinery train 1 (maximum flaring rate of 1,585 tonnes per hour);
- Emergency hydrocarbon flare for refinery train 2 (maximum flaring rate of 1,335 tonnes per hour); and
- Acid gas flare for the sulphur recovery units (maximum flaring rate of 68 tonnes per hour).

All three flare tips will be located on a single structure of 220m height.

The refinery design is based on a 'zero flaring philosophy' and therefore these flares will operate only during upset conditions, shutdown or an emergency. The flare height has been determined to be appropriate both on the basis of potential air quality impacts and heat radiation exposure.

4.6 PORT FACILITIES

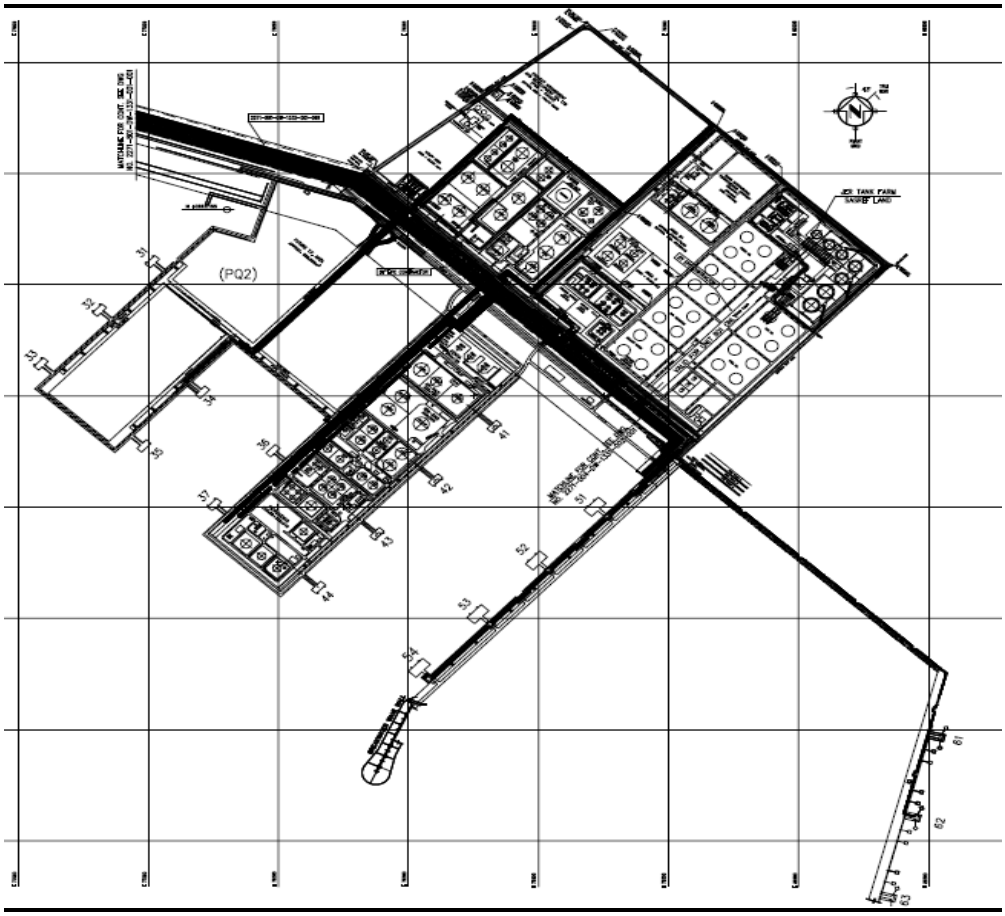
Infrastructure at the KFIP area will be developed to facilitate export of products. The port site will comprise:

- Refined products ship loading facilities;

- Coke Storage and loading facilities;
- Fuel oil, multipurpose/slops and p-xylene storage tanks area;
- Scrapers area;
- VOC collection system; and
- Scraping area.

The site will occupy an area of 0.22 km^2. *Figure 4-6* provides the plot plan for port site area.

Figure 4-6 Plot Plan of Port Facilities



The KFIP will provide the following utilities or services:

- Water to support potable / service water networks;
- Fire water (sea water);
- Service and fire water at the berths;
- Electrical power;
- Clean storm water collection; and
- Oily water collection.

Oily water and sanitary water from septic tanks will be collected via a road tanker (for transfer to an RC treatment facility).

The key components of the port facilities are described further below.

4.6.1 *Loading Facilities*

The loading facilities will comprise ship loading systems which will be installed on existing berths within KFIP. *Table 4-4* presents loading rates and indicates berths site by product.

Table 4-4 Loading Rates to Vessels

Product	Ship DWT (Min. – Max) (Tons)	Loading Rate (m^3/hr)	Berth N°
Regular Gasoline	40,000 – 80,000	2,400	52 /53/54
RBOB Gasoline	40,000 – 80,000	2,400	52/53/54
Jet-A1	40,000 – 80,000	2,400	52 /54/62
Diesel	40,000 – 80,000	4,800	52 /54/62
Petrochemical NPA	40,000 – 80,000	2,400	52/53/54
Fuel Oil	40,000 – 80,000	4,800	54
Paraxylene	40,000 – 80,000	2,500	34
Coke	40,000 – 80,000	-	22

4.6.2 *Port Storage Tanks*

The product buffer tank farm will be located in a free area adjacent to the existing tank farm and will comprise:

- 2 x paraxylene tanks, individually 20,000m^3;
- 2 x fuel oil tanks, individually 42,000m^3; and
- 2 x multipurpose/slop tanks, individually 28,000 m^3.

Tanks at the port will be located within a dike of similar design to the refinery tanks (*Table 4-2*).

4.6.3 *VOC Collection System*

Volatile Organic Compounds (VOCs) are defined by the RC as those volatile organic compounds that contribute significantly to tropospheric atmospheric oxidant (e.g. ozone) formation.

The port facility will include a Vapour Recovery Unit (VRU) for the collection and disposal of VOC vapours generated during the loading of RBOB and regular gasoline.

One common vapour recovery header will be provided in order to collect all the returning vapours coming from the regular and RBOB gasoline ship loading vapour balance arms. This header will be connected to the VRU located in the port tank farm.

In addition, a dedicated VRU will be installed for collection of vapours from p-xylene loading.

4.7 *INTERCONNECTING PIPELINE AND COKE CONVEYOR SYSTEMS*

Interconnecting pipeline systems will be both underground (cross country pipelines) and above ground for the following functions:

- Delivering feed crude to the JER (from tie-ins foreseen on the existing crude pipelines);
- Connecting the JER tank farm to the Port facilities; and
- Other pipelines to specific customers.

Crude Oil Supply

Two new connections for crude oil supply will be provided in the Aramco Royal Commission Interface area (located east of JIC 2 and adjacent to the KRT corridor). Arabian Heavy and Arabian Light Crude will be supplied trough these connections, that will manifold into one feedstock pipeline to JER.

The crude oil pipeline receiving station will be located in the northern side of the JER.

Sales Gas Import Pipeline

The sales gas supply system to JER will be from a new branch of an existing transfer pipeline (KBG-1). One 14″ tie-in will be installed on the pipeline that will enter the northern side of the refinery.

LPG (C3+) Import Pipeline

The LPG (C3+) supply system to JER will be from an existing 8″ transfer pipeline. The LPG (C3+) pipeline will enter the northern side of the plant.

LPG Export Pipeline

The 6″ LPG export pipeline will be routed to the Juaymah Plant. The pipeline will leave the JER from the southern side of the JER and run for approximately 15km up to the Berri Junction within the KRT corridor.

Liquid Sulphur Export Pipeline

The 6″ liquid sulphur pipeline will be connected to the BERRI Gas Plant. It will run from the south of the JER for approximately 10 km. The pipeline will be electrically heated to prevent product solidification.

Refined Products

Transfer pipelines carrying refined products from the JER to the KFIP will be located in the common EW-3 corridor (28.5 km long) connecting the JIC 2 with

KFIP crossing a preliminary 104m Right of Way (ROW) which will be provided by the RC.

Propylene and benzene pipelines will transfer material to local industrial sites at the JIC. The routes of these pipelines will be the common pipeline corridor.

Fuel oil and p-xylene be routed to storage tanks located inside the KFIP area (north east of the existing SASREF tank farm).

Regular and RBOB gasoline, diesel and Jet-A1 will be directly loaded on to ships via pumps located within the JER refinery site, through the respective loading berths located in the KFIP.

The pipelines transferring the refined products are as follows:

- One 24″ regular gasoline product pipeline;
- One 24″ RBOB product pipeline;
- One 24″ Jet-A1 product pipeline;
- One 32″ diesel product pipeline;
- One 6″ benzene product pipeline;
- One 8″ paraxylene product pipeline (which will be electrically traced to prevent solidification);
- One 6″ Propylene product pipeline; and
- One 20″ fuel oil pipeline (which will be electrically traced to maintain a product temperature of between 75-80^{o}C).

In addition, one multi product 10″ return pipeline to JER will transfer products from KFIP multipurpose/slop Tanks (recovered slops, unloaded products from the ships and for refinery start up first fillings) to the refinery. The products will be then diverted either to the refinery slop Tanks or certain units during start-up.

Coke Conveyor and Storage System

Coke from the DCU will be sent for shipping to KFIP via a conveyor system. An enclosed storage area of 138,000 tonne, equal to 23 days of production, is expected to be developed within the refinery site in case the conveyor system is unavailable.

Coke from the refinery storage area will be transferred through a belt conveyor system running along the main EW-2 corridor in JIC 2 at the north edge of the Plot 9 boundary (25 km length). The conveyor will exit the refinery from the east side boundary to reach the NS6 corridor.

Coke will be wetted at designated points prior to entering the conveyor to suppress dust during transit. Coke arriving at the port will be stored in an enclosed rectangular storage area that has the same capacity as the JER storage area. Coke will be delivered to vessels via a belt ship loader.

4.8 RAW MATERIAL CONSUMPTION

4.8.1 Construction

The utilities required for the execution of the project are identified in two categories.

Category A includes the utilities required for construction. These utilities will be supplied by each EPC contractor as follows.

Power: By diesel generators.

Water:

- Up to the end of 2009, the water network will not be available at JIC 2 and therefore water will be tankered to the construction site. The estimated quantities for 2009 are 1000 m^3 per day average, and up to 2,500 m^3 per day during peak construction.
- From 2010 water will be provided to site through the JIC 2 network. The quantities are estimated as follows:
  - needs for civil, hydrotesting and cleaning of the lines: 700,000m^3; and
  - needs for site sanitary and road wetting: 500,000m^3.

Category B includes the utilities required for the temporary camp and site offices. These utilities will be made available to each EPC contractor (excluding power supply).

Power: By diesel generators

Water: Water will be trucked to the worker camp. The estimated quantities for January 2010 are 500 m^3 per day on average with peak consumption reaching 7,500 m^3 per day.

Waste water: A temporary waste water treatment system will be built for the treatment of black and grey water. Treated water will be used for landscaping, road wetting and other construction needs.

4.8.2 Operation

The following raw materials and utility consumptions are foreseen during normal operations of the refinery during a typical year:

Demand	Unit	Average	Peak
Utilities			
Power	MW	344	413
Potable Water (a)	m^3/hr	1,275	1,500
Seawater Cooling	m^3/hr	6,125	7,000
Oxygen Gas	Nm^3/h	9,500	10,500
Nitrogen Gas (b)	Nm^3/h	5,850	12,410
Hydrogen Gas	Nm^3/h	900 (c)	1,000 (c)
Fuel/Feedstock From Saudi Aramco			
LPG	t/h	45 (d)	
Sales Gas	MMSCFD	145 (d)	
Crude Oil	BPD	400,000	

T/h=Tonnes per hour
MMSCFD=Million standard cubic feet per day
BPD= Barrels per day
(a) Peak value required for exceptional major fire situation
(b) 9,050 Nm^3/h maximum operating demand
(c) Normal flow for about 10 hrs for each start-up of Hydrogen Production Unit. Three unit start-ups are assumed as minimum
(d) start-up only

4.9 FACILITIES CONSTRUCTION

The construction activities associated with the refinery project are expected to commence in the first quarter of 2010 and last approximately 42 months. The initial 4-6 months of construction will consist of early civil engineering works, after which the construction programme activity is expected to increase gradually at first, peak at around 30 months and then the extent of works will plateau before project completion. In general the construction programme for the facility is expected to be executed in four main phases as follows.

***Phase 1**: Civil work phase, from Month 1 to Month 26*
This phase covers civil works, including the underground network, foundations for equipment and structures, certain structures, paving and mains roads. In addition it includes:

- The installation of underground cables;
- Construction of sub-stations; and
- Construction of the main control room and permanent buildings.

Pre-dressing of equipment is also planned in the end of this period.

***Phase 2**: Equipment Lifting Programme, from Month 24 to Month 32*

***Phase 3**: Mechanical Phase, from Month 24 to Month 42*
This phase covers the installation of above ground piping, electrical and instrumentation works and insulation, including pre-commissioning activities.

***Phase 4**: Commissioning phase: from November 2011 to April of 2013*
The commissioning is expected to be conducted in a staggered approach as follows:

- Energising the main substation;
- Commissioning of the main control room;
- Commissioning the utilities and required tanks;
- Commissioning the tank farm; and
- Commissioning the process units and required tanks.

Equipment and materials needed for the construction of the refinery project will be transported along existing highways and roads to the site, with large equipment and plant being imported by ship through KFIP. It is not anticipated that any new roads will be laid, with the exception of minor access tracks to and from the TCF area located to the south of the refinery site.

Construction activities associated with the JER development will occur in the following areas:

- Inside the boundaries of the proposed refinery site (PLOT 9);
- Inside the pipeline corridor from the refinery to KFIP;
- Inside KFIP;

- Inside the pipeline corridor from the Refinery to the BERRI Gas Plant; and
- Within the construction lay-down areas (excluding the port construction lay-down area).

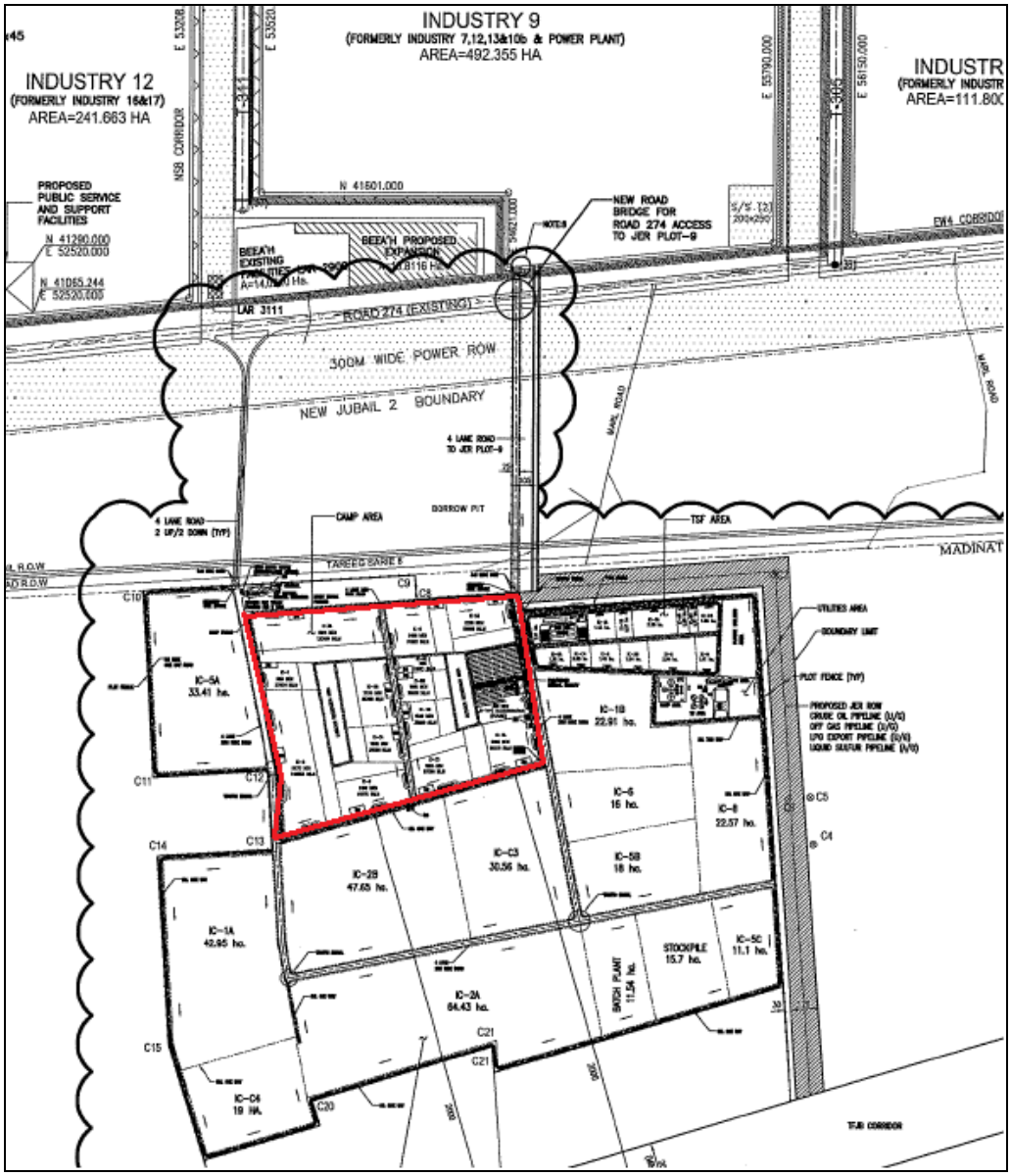
4.9.1 Construction Workers and the Temporary Construction Facility (TCF)

Over the 42-month programme of refinery construction, worker numbers are anticipated to peak at maximum 30,000 (which includes project management), from month 30 to month 42 of the construction programme. This figure includes a contingency of 20 % to accommodate schedule issues. The peak is based on six working days per week, and 10 hours per day. Approximately 15 % of the manpower resources will work outside of PLOT 9 (e.g. at the KFIP, or pipeline ROWs).

As a result of the rapid expansion of the two JICs, significant demand for local accommodation and worker camp accommodation exists. Taking into consideration the number of projects planned in the Jubail area over the next few years, this demand is expected to continue to grow.

Therefore as part of the JER project, 'Temporary Construction Facilities' (TCF) will be established approximately 1.5km south of the JER facility fence line outside of the designated JIC 2 boundary. The TCF will be located within land owned by Saudi Aramco and will be developed over a 600 Ha area. The facilities will be dedicated exclusively to the construction needs of the JER project (*Figure 4-7*).

Figure 4-7 The TCF Area



Note: Accommodation area exists within the red lined area.

The TCF will have four key functions by providing:

- Worker accommodation and recreation, religious and amenity facilities;
- Temporary site offices;
- Laydown / storage areas; and
- Utility infrastructure comprising power generation (to be provided by the EPC contractor), potable water, fire water, waste water, telecommunications, road network, associated lighting and signal lighting, security fencing and security access so that is can operate as a stand-alone facility.

The overall design philosophy for the TCF includes the following, which the various contractors will be obligated to follow:

- Spacious layout to cater for all normal pedestrian, maintenance, evacuation and emergency routes in line with National Fire Protection Association (NFPA) standards;
- Spacious and functional layout of all support buildings such as administration, guard house, storage and maintenance buildings, medical facilities, laundry facilities;
- Spacious and functional layout of all recreation and messing facilities covering both indoor, outdoor (un-shaded) and outdoor (shaded);
- Spacious and functional layout of all amenities such as shops, barbers etc;
- Spacious layout to cater for religious facilities; and
- Spacious layout to cater for applicable landscaping, shaded areas, car parking, safe and spacious walkways and vehicle ways.

Specific details of each of the four key functions are described below.

Worker Accommodation

The camp area will be located in a dedicated area within the overall TCF complex (*Figure 4-7*) and shall be segregated into dedicated zones for each individual contractor involved in construction. Each work accommodation area is expected to include:

- Accommodation quarters;
- Recreation (indoor and outdoor) including outdoor shaded areas;
- Religious facilities, amenities – shops / stores / barber etc;
- Messing facilities and refuse handling, collection and disposal;
- Guard house and administration buildings;
- Storage and maintenance buildings;
- Medical facilities;
- Laundry facilities;
- Dedicated food preparation and storage areas, and kitchen facilities – the TCF will incorporate a spacious and functional layout of all food storage & preparation facilities, kitchen facilities, canteen facilities; Safety and maximum hygiene attainment shall be the first priority factors;
- Landscaping;
- Covered car parking;
- Suitable signage for all facilities and HSE requirements;
- Area fencing and lighting;
- Services / utilities such as power distribution, lighting, fire detection, internet, telecommunications, satellite TV, potable water, fire water, waste water collection piping system and pumping to the common WWTP; and
- Emergency Evacuation routes and dedicated safety evacuation muster points.

The size of worker accommodation areas and related services will be proportional to the estimated workforce requirements for each EPC contract.

As noted earlier, the overall worker accommodation area is sized for a total of approximately 30,000 workers inclusive of direct, indirect and management personnel. This in turn is segregated across 11 areas: one for each EPC contractor.

Recreation

Indoor recreation will include dedicated areas for common seating meeting areas, TV lounges and indoor table games (table tennis, billiards etc). All indoor recreation shall be suitably segregated into two areas, those that require quieter relaxation areas (for reading etc) and those that can accommodate slightly noisier areas such as table tennis etc. Quiet areas have a 35dB design requirement to allow for reading / TV lounges etc.

All recreational facilities either indoor or outdoor will be suitably segregated from accommodation blocks to ensure that all work personnel have first preference for sleep when required. Exterior recreation shall account for spacious public walkways and shaded areas for communal meetings, informal social gatherings etc.

Religious Facilities

Each EPC contractor will provide suitable religious facilities for Muslim personnel within their camp design and ensure that these facilities can be safely populated and exited during and after prayer times in an orderly fashion. The facilities will be provided with suitable ablution facilities.

Amenities – Shops / Stores

Amenities will be provided within the camp such as shops, stores, a barber shop etc, to cater for the camp population. These facilities will be located in dedicated buildings. The amenities shall be accessible from inside the camp only and dedicated to the respective EPC contractor camp. The amenities provisions will take into account the various nationalities resident within the camp.

Office Facilities

The office facilities will be developed for approximately 500 people, and will comprise the following:

- Spacious and functional layout for all closed office, open plan and meeting room work spaces;
- Separate male and female toilet and washroom facilities;
- Spacious pantry area and coffee room facilities;

- Spacious layout to cater for all normal pedestrian, maintenance, evacuation and emergency routes in line with NFPA standards; and
- Spacious layout to cater for religious facilities such as prayer room with suitable ablution facilities.

Temporary Lay-Down Areas

Temporary material and equipment storage areas will be provided within other areas in the camp. In addition, light fabrication works may also take place in these areas.

Each EPC contractor is expected to provide, as a minimum, the following temporary site lay-down/fabrication facilities:

- Warehousing and lay-down facilities;
- Workshop facilities;
- Offices;
- Fuel and maintenance vehicles;
- Asphalted internal roads;
- Suitable signage for all facilities and HSE requirements;
- Dedicated safety evacuation shaded muster points;
- Area fencing and lighting;
- General utilities; and
- Refuse handling, collection & disposal.

Utilities and Infrastructure

The TCF area will essentially be self sufficient with regard to utilities and infrastructure, and will include the following.

- A common WWTP capable of treating all sanitary wastes from the camp. The WWTP system will treat water to a standard suitable for irrigation and dust suppression;
- Power generation, provided by each EPC contractor, will be by diesel generator. The total peak power demand of the TCF is expected to be up to 20MW, with around 15MW being required at the worker accommodation area. It is likely that this demand will be met by 20 x 1MW output diesel generators. Within the accommodation area generators will be housed in brick-walled structures located no closer than 30m from worker accommodation;
- An asphalt road network;
- Camp and perimeter fence and lighting;
- Main TCF security and guard houses;
- Main TCF medical facilities;
- A common fire station facility;
- Camp common recreation facilities; and
- A potable water and fire water system (and its reticulation) to the various EPC contractor worker accommodation areas.

Access to the TCF Area and JER Worksite Site

The main entrance to the TCF will be via a dedicated access road and junction to the existing Highway 274 which runs adjacent to the JER site Plot 9. In addition, a dedicated site access road and bridge over existing Highway 274 will facilitate a direct link between the TCF and the JER Plot 9 site. The self-contained TCF with direct and secure access to the JER Plot 9 site is expected to enhance project safety, security, and traffic logistics whilst avoiding disruption to the existing Highway 274.

4.10 FACILITY COMMISSIONING

Commissioning of the refinery will ensure that all systems have been constructed and installed in accordance with the design and that the system is ready for operation. Commissioning will also ensure that there are no defects in plant and equipment, which could cause problems during start-up or operations. Commissioning activities for the refinery will be carried out in a systematic sequence with exhaustive controls. Commissioning activities are expected to include, but not be limited to the following:

- Preparation of piping network and vessels;
- Hydrotesting, chemical cleaning and water flushing of pipelines and tanks. Water for these activities is expected to be brought by tanker to site. Hydrotest water may be dosed with biocides and anticorrosive agents. It is currently proposed that waste water generated during these activities (construction-commissioning) will be directed to the RC / JIC WWTP for disposal, with an overall objective to recycle, as far as practicable, water to be used for further hydrotesting (and probably directing what cannot be recycled to ponds where analysis can be conducted and subsequent treatment can be decided accordingly). Disposal of hydrotest water is discussed further in *Section 4.13*;
- Functional testing of each instrument, telecommunication, and electrical system;
- Functional testing of all pressure protection and other safety systems; and
- Performing checks & 'live' operational tests of all plant and equipment. During these checks and tests, line steam blowing is expected to take place, which would temporarily generate steam exhaust to atmosphere.

The minimum requirement for the commissioning of the facility is expected to comprise the following:

- Start-up and limited operation of permanent items of equipment and utilities by system (e.g. the firewater system, the cooling water system, communications and control systems); and
- Plant performance trials conducted in accordance with specified performance criteria.

The JER will adopt OPERCOM© methodology and ICAPS© (Integrated Commissioning and Progress System), a dedicated tool used to organise and manage pre-commissioning and commissioning activities; the ultimate goal of these will be to achieve a smooth transfer of the installation from the Construction Team to the Operator, in the shortest possible time, adhering to all necessary safety precautions.

The commissioning process for a new hydrocarbon processing plant consists of a series of verifications carried out prior to the plant being brought on-line.

The aim of these verifications is to ensure, as thoroughly as practicable, that all equipment has been built and will operate as per design. These verifications are also the final critical review of the design before start-up.

Commissioning is separated into two phases: pre-commissioning and commissioning. The distinction roughly corresponds to static and dynamic tests phases respectively. The commissioning activities are followed by the start-up phase itself, corresponding to the introduction of the hydrocarbon feedstock into the plant.

The pre-commissioning phase comprises three main types of field activities:

- Conformity checks: Carried out on each item of equipment or component, such as instruments, packages, motors, cables, vessels, etc., to verify visually the condition of the equipment, the quality of the installation, the compliance with project drawings and specifications, vendors' instructions, safety rules, codes, standards and good practice;
- Static/de-energised tests: Carried out on equipment to ensure the quality of a number of critical components. This 'cold' testing concerns all disciplines, e.g. calibration of emergency shut down instruments, machinery alignments, setting of safety valves, pressure testing of piping, cables continuities etc; and
- Piping Test (Test Pack): Carried out on pipe-work, air or water flushing and pressure tests (hydrotest).

The commissioning phase essentially comprises the three following task categories:

- Dynamic verifications that ensure that for each plant, elementary electrical, telecommunications and instrumental functions perform properly according to their design criteria. Typical examples of such tests are electrical motor uncoupled runs, instrument loop tests and electrical breakers operation. The energisation of the electrical distribution network is part of this activity.
- Running-in and on-line tests for a significant period for plant utilities (electrical, air, HVAC, water, crane, etc.) and, wherever applicable, of the main process equipment with closed loop using inert fluids.
- Piping and vessels preparations (a number of activities including piping drying-out, process leak testing, and inerting, or loading of various chemicals and catalysts).

4.11 FACILITY OPERATION

The refinery has been designed for minimal operational and maintenance intervention. The operating and maintenance requirements for the refinery have been developed to achieve the following objectives:

- Safety of operation for employees and third parties;

- Environmental compliance in accordance with RC, IFC, SATORP and project plan specifications and requirements;
- Continuity of production within design criteria;
- Minimised operational expenditure consistent with meeting contractual obligations and sustaining the design life of the system;
- Maintenance of the system's technical integrity and performance over its design life;
- Full compliance with other statutory and regulatory obligations; and
- Demonstration of the 'fitness for purpose' of the refinery for the length of its design life allowing it to operate at optimum levels during this period.

The refinery will be operated in accordance with international codes and standards. These codes place stringent requirements upon SATORP to ensure that the refinery is:

- Operated safely;
- Operated by appropriately trained staff;
- Covered by a thorough programme of preventive maintenance; and
- Regularly inspected / monitored.

The total JER manpower will be 1,278 workers during normal operations. Among these 1,278 employees, 666 will work on shifts with the following breakdown:

- **Operations (including offsite)**: 123 shift positions representing 524 employees;
- **Maintenance**: 3 shift positions representing around 15 employees;
- **Safety**: 6 shift positions representing 25 employees;
- **Security**: 16 shift positions representing 79 employees; and
- **Laboratory**: 4 shift positions representing 23 employees.

4.11.1 Facility Safety

The design of the JER will comply with all applicable KSA regulatory requirements related to occupational health and safety, process safety and fire protection. Furthermore the refinery project is committed to comply with the following international standards:

- OSHA: Occupational Safety and Health Administration Standards;
- NIOSH: National Institute of Occupational Safety and Health;
- Manufacturing Chemist Association Chemical Safety Data Sheets;
- EEMUA Publ. n°140 Noise Procedure Specification (formerly OCMA Spec No NWG 1 procedural specification for limitation of noise in plant and equipment for use in the petroleum industry); and
- NFPA: National Fire Protection Association.

4.12 FACILITIES DECOMMISSIONING

4.12.1 Approach to Decommissioning

The exact details of how the refinery and associated facilities will be decommissioned will be determined prior to abandonment, agreed with the KSA authorities and the subject of an ESIA. Therefore it is not possible to determine at this stage of the project exactly what techniques will be used, however these will be in accordance with recognised international standards applicable at the time of decommissioning.

Decommissioning is expected to be relatively straight forward, and in general will require:

- Auxiliary equipment conditioning for safe and secure transportation to their final destination ;
- Demobilisation of all surface equipment and units used to support the project activities; and
- Reinstatement of the site and all associated facilities project areas to pre-construction conditions.

4.12.2 Site Abandonment and Rehabilitation Plan (Decommissioning Plan)

The TCF

SATORP will have ultimate responsibility for the demobilisation and removal of all temporary camp facilities at the completion of the construction and commissioning programme. Demobilisation will include the removal of all temporary foundations and buried services that SATORP has installed. Thereafter and in so far as practicable, the ground will be returned to the same condition in which SATORP first received it.

The JER and Associated Facilities

The Decommissioning Plan will address decommissioning and rehabilitation of all project associated facilities and will state the standards to be applied for the decommissioning and rehabilitation. In the absence of specific KSA regulations on this subject, these standards will be consistent with recognised international standards (e.g. IFC) and industry best practice.

The decommissioning ESIA will lead to the development of outline plans which will be consolidated into a single decommissioning plan (the individual plans will be developed at the point of decommissioning). The decommissioning plan will consider the following aspects:

- Reinstatement;
- Waste management;
- BAT studies (where realistic alternatives existing); and
- Decommissioning ESIA studies.

4.13 CONSTRUCTION WASTES AND EMISSIONS

4.13.1 Construction Phase Waste Generation

Prior to the commencement of the construction programme a Construction Waste Management Plan (WMP) will be developed, which will include:

- A minimisation / collection / storage / treatment / re-use / disposal strategy for each waste stream;
- A description of possible locations of landfills or long-term storage sites;
- Methods for properly managing (e.g. training, storing, containerising, labelling, transporting, disposing) wastes; and
- A description of the transition of control from the construction contractors to the operator, including arrangements for waste generated during the commissioning phase.

Relevant aspects of the Construction WMP will be prepared in conjunction with the EPC contractors and will be reflected in their own plans for management of construction wastes. A Framework WMP is included within a *Framework Construction Environmental Management Plan (CEMP)* in *Appendix E – Annex I*.

The waste generated during the construction phase will comprise aqueous wastes (which will mainly be classified as non-hazardous) and solid and non-aqueous wastes (which will comprise non-hazardous, and hazardous waste) and each is discussed below.

Aqueous Wastes

Aqueous wastes and discharges will be generated throughout the duration of the project construction activities, and will include sanitary waste, water used for cleaning purposes and hydrotest water. Estimates of sanitary waste are presented in *Table 4-5* using the following assumptions:

- An average 10,000 workers on site throughout the construction period;
- A construction duration of 42 months;
- Each construction worker will generate 0.22m^3 / day of grey water; and
- Each construction worker will generate 0.10m^3 / day of black water.

.

Table 4-5 Aqueous Wastes Associated with Construction Activities (1,000's m^3)

Black water	1,38
Grey water	3,036
Putrescible canteen waste	1,916
Drum cleaning waste	375
Washdown water	875
Hydrotest water	250

Note that black water refers to sewage, and grey water reflects that from shower and washing facilities

Disposal of Hydrotest Water

It is expected that during the commissioning of tanks, pipe work and other vessels, 250,000m^3 of hydrotest water will be required. Additional water will be required for leak-proof testing of sewers, basins and pits. SATORP has established a procedure which describes the minimum requirements for disposal of hydrotest and leak proof testing water. Each contractor involved in hydrotesting or leak testing will be required to meet the requirements of the procedure. A summary of the disposal requirements is provided below:

- For new pipelines, there will be no need to remove oil / grease from wastewater prior to wastewater discharge/disposal, although a screen will be provided to remove debris prior to discharge.
- Wastewater shall not be discharged to local wadis. Wastewater will be disposed to non-sabkhah areas into lined evaporation ponds.
- As far as practicable, disposal facilities described below will be located within the existing pipeline corridor without negating adequate pipeline access and without causing damage to the existing roadways, pipelines, private entities or other structures.
- Wastewater will never be disposed within or adjacent to wetland or sensitive environments, including specified conservation areas.
- Disposal to an Evaporation Pond: When the wastewater is visibly contaminated with oil, an oil/water separation pond will be provided upstream of the evaporation pond to collect the residual hydrocarbon and improve evaporation in the evaporation ponds.
- Disposal to Industrial Wastewater Treatment Plant: An alternative disposal option will be to dispose of wastewater directly to the RC WWTP if the wastewater flow rate and quality meet the requirement of the wastewater treatment plant. Each contractor wishing to dispose of waste water in this way will obtain prior permission from the operator of the treatment plant prior to its selection of this disposal option.
- Disposal of wastewater offshore to the Arabian Gulf is not permitted. Wastewater associated with the hydrotesting and cleaning of piping and equipment located in facilities adjacent or near the shoreline will not be allowed to leak into the sea. The wastewater will be piped and

disposed at an evaporation pond or alternatively, disposed to the local industrial wastewater treatment plant as described above.

Solid and Non-aqueous Wastes

Wastes generated during the construction period will consist of the following:

- Non-hazardous combustible solid waste such as waste paper, wood and cardboard;
- Non-hazardous, non-combustible waste such as scrap metal;
- Hazardous solid waste such as paint cans and empty chemical containers; and
- Hazardous liquid wastes such as liquid oily wastes.

These waste streams will be disposed of by an approved waste management contractor, and will be handled according to RCER guidelines. Hazardous waste will only be disposed of to a hazardous waste facility approved by the RC.

The estimated annual volumes of solid and non-aqueous wastes generated are presented in *Table 4-6*. It should be noted that uncontaminated soil and rock from construction activities are not considered waste materials as they will be utilised for cut and fill and other construction purposes, either within the JER project or at other nearby locations.

Table 4-6 Solid and Non-Aqueous Construction Wastes

Category/Waste type	Annual Waste Generated			
	<1 tonne	**<10 tonnes**	**<100 tonnes**	**>100 tonnes**
Non-Hazardous Combustible Solid Waste				
Paper and cardboard	♦			
Wood		♦		
Hazardous or Potentially Hazardous Solid Waste				
Sand/shot-blast materials			♦	
Transformers		♦		
Empty drums (metal and plastic)				♦
Batteries (lead-acid)		♦		
Resins		♦		
Oily rags		♦		
Radioactive*	♦			
Clinical waste*	♦			
Capacitors (containing oil)	♦			
Filters		♦		
Hazardous liquid waste				
Greases		♦		
Hydraulic fluid		♦		
Oil				♦
Diesel		♦		
Paints	♦			

Category/Waste type	Annual Waste Generated			
	<1 tonne	<10 tonnes	<100 tonnes	>100 tonnes
Thinners	♦			
Coatings	♦			
Solvents	♦			
Acids	♦			
Alkalis	♦			
Fire fighting agents		♦		

*The quantities of these waste materials are expected to be very small

4.13.2 Construction Phase Releases to the Atmosphere

Atmospheric emissions will be generated during construction of the refinery through the operation of equipment and plant. It is anticipated that the most significant components of such emissions (from an environmental perspective) will be combustion gases, the components of which include:

- Carbon dioxide (CO_2);
- Carbon monoxide (CO);
- Nitrogen oxides (NO_X);
- Sulphur dioxide (SO_2); and
- Fine particular matter (PM_{10}).

The following equipment or activities will lead to emissions to atmosphere during construction:

- Earthmoving operations;
- Construction and delivery vehicle emissions (diesel powered equipment, cranes, excavators);
- Cement batching operations;
- Power generation at the TCF and JER worksites; and
- Welding equipment and paint solvents.

Total releases (tonnes) of emissions have been estimated based on the construction period, type of construction equipment and fuel specification (*Table 4-7*). Values provided are annual figures, referring to the peak year of construction.

Table 4-7 Emissions to Atmosphere from Construction Emissions

	Tonnes Emission / Year	
	Power Generation	Site Vehicles and Equipment
CO_2	242,196	1,723,284
CO	1,009	3,340
NO_x	2,718	3,663
SO_2	76	538
PM	73	399

4.14 OPERATIONAL WASTES, DISCHARGES AND EMISSIONS

4.14.1 Solid and Non-Aqueous Waste

Waste generated by the refinery operations will be classed into one of the following categories and stored in appropriate skips or containers before being sent off-site for disposal (see *Table 4-8*):

- Non-hazardous combustible solid waste such as waste paper, wood and cardboard;
- Hazardous solid waste such as paint cans and empty chemical containers; and
- Hazardous liquid wastes such as liquid oily wastes.

Table 4-8 Solid and Non-Aqueous Operational Wastes

Category/Waste type	Annual Waste Generated			
	<10 tonne	<100 tonnes	<1000 tonnes	>1000 tonnes
Non-Hazardous Solid Waste				
Paper / garbage				♦
Glass / plastics				♦
Clean area storm water sludge		♦		
Wood			♦	
Hazardous Solid Waste				
Sewer Sludge				♦
Sand/shotblast materials			♦	
Absorbents (spill clean-up)	♦			
Batteries	♦			
Transformers		♦		
Capacitors	♦			
Clinical waste	♦			
Radioactive	♦			
Empty drums (metal and plastic)		♦		
Filters		♦		
Rags		♦		
Spent catalysts			♦	
WWTP Sludge				♦
Resins		♦		
Hazardous liquid waste				
Greases		♦		
Hydraulic fluid			♦	
Lubricants			♦	
Diesel		♦		
Paints	♦			
Thinners	♦			
Coatings	♦			
Solvents	♦			
Acids	♦			
Alkalis (spent caustic)				♦
Fire fighting agents		♦		

The majority of waste is expected to arise from maintenance activities (e.g. paint, rags etc.), discarded containers and office waste (e.g. cardboard boxes, paper etc.) and used or spent equipment (e.g. batteries). Waste arisings generated by the crude refining process are limited to spent catalysts spent caustic, molecular sieves, activated carbon, coolants and spent lubricants etc, which are expected to be transported offsite to be regenerated and/or recovered by a third party, as well as slops, which will be stored in dedicated storage tanks prior to disposal through an appropriate third party.

It is anticipated that sludge generated by the wastewater and from oily sewer treatment processes will be sent to DCU to be used for quenching of coke. Sludge from the clean water sewer will be disposed of at a licensed landfill as non hazardous waste.

Spent caustic will be generated by the SWS, the MEROX unit and the FCC unit. Spent caustic will be directed to a common header for transfer to dedicated handling and storage facilities. Equipment will also be provided for the safe transfer of spent caustic to truck for disposal by a third party. Should suitable waste management facilities not exist at the point when refinery operations commence, SATORP may consider transporting this waste overseas for recovery of caustic in line with current practices undertaken in Saudi Arabia by Saudi Aramco.

All wastes shall be stored, collected and disposed of in accordance with the dedicated facility Operations WMP, which will incorporate elements on international best practice and RCER requirements. A Framework WMP is provided in *Appendix E – Annex II*.

The design of a dedicated storage area for wastes at the refinery site will be developed during the detail design phase.

All hazardous waste is to be transported offsite for processing by an approved and fully licensed third party contractor.

4.14.2 Refinery Wastewater Discharges

Wastewater associated with the normal refinery operations includes:

- 'Clean area' storm water;
- 'Potentially oily area' storm water;
- Process waste water;
- Treated sour water; and
- Sanitary / basin waste water (to septic tank and transfer to the RC).

The refinery will be provided with two lines inside the JER WWTP, each capable of treating normal process waste water flows to RCER pre-treatment standards.

The export facilities located at KFIP will also produce potentially contaminated waste water (after storms) which will be transferred to the JER WWTP for treatment if contaminated. *Table 4-9* presents normal operational waste water flows.

Table 4-9 Normal Operational Waste Water Flows (m^3 per day)

Source	Flow (m^3 / day)	Fate
Process Waste Water	6,556 – 8,071 (min – max)	JER WWTP
Sour Water Stripper (SWS)	1,896 – 3,768 (min – max)	JER WWTP
Clean Storm Water Drains	Max flow rate 1,500 m^3/h after rain event	RC storm water ditch if clean. JER WWTP if contaminated
Oily Storm Water Drains	Max flow rate 1,500 m^3/h after rain event	JER WWTP if contaminated
Sanitary (refinery + administration) Waste Water	5 + 200m^3 / day	Septic tank then to RC for treatment
Firewater	Max 2,700 m^3/h during fire event	JER WWTP
Port Oily Storm Water	Max quantity 1,050 m^3 after rain event	Exported to JER WWTP by truck if contaminated
Port Clean Storm Water	Max flow rate 320 m^3/h after rain event	To water pond then pumped to RC drainage system
Port Sanitary water	24	Septic tank then to RC for treatment

Note: Effluent from the JER WWTP is routed to the RC's pre-treated effluent collection system where it is commingled with pre-treated effluents from other JIC facilities and is treated further in the RC's central WWTP.

4.14.3 Releases to the Atmosphere

As noted earlier, atmospheric emissions will be generated through the operation of gas fired plant (heaters and tail gas incinerators) and dual fuelled boilers, but will also be generated through intermittent flaring of hydrocarbons and fugitive losses from process areas, storage facilities and loading (export by shipping) of products.

It should be noted that with the exception of a purge and pilot for the emergency flare, no continuous flaring will take place at the refinery site.

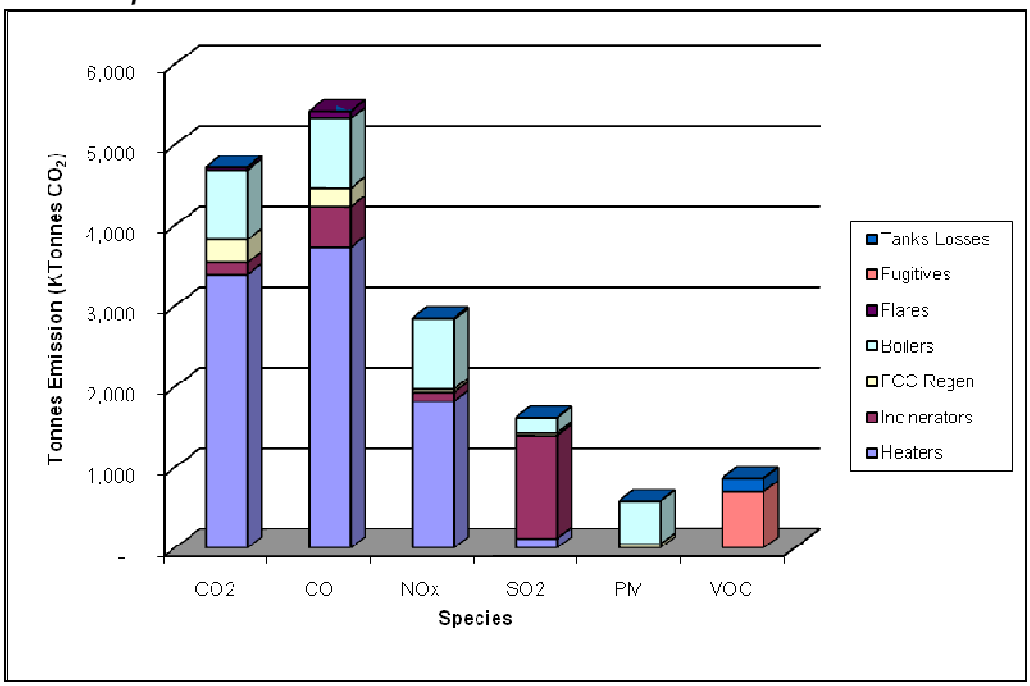
Atmospheric emissions associated with normal operations have been estimated on the basis of the anticipated type of process equipment and fuel gas / fuel oil used at the facility. These estimates are presented in *Table 4-10* and *Figure 4-8* below, which have been prepared using process data provided by TPIT. USEPA TANKS screening model has been applied to estimate tank loss emissions, while E&P Forum emission factors have been used to estimate emissions of CO_2. USEPA factors have been used to estimate emissions that were not derived using the above approaches.

Table 4-10 Annual Operational Emissions (Tonnes per Annum)

	Heaters	SRU Incinerators	FCC Regen	Boilers	Flares	Fugitives[1]	Tanks[2] Losses	Total
CO_2	3,392,596	147,745	285,926	861,278	35,338	-	-	4,722,883
CO	3,728	503	231	866	91	-	-	5,418
NO_x	1,821	109	41	864	17	-	-	2,852
SO_2	117	1,278	32	193	-	-	-	1,619
PM	-	-	46	539	<1	-	-	585
VOC	-	-	-	-	-	700	166	866

[1]*Fugitives includes VOCs from process components, the WWTP and cooling towers*
[2] *Based on theoretical maximum turnovers. Actual turnovers are expected to be significantly lower for those tanks operated with level contents (i.e. running gauge).*

Figure 4-8 Annual Operational Emissions



Note: tonnes emission / year for emissions excluding CO_2, which is provided in kilotonnes/year.

5 PROJECT ALTERNATIVES

5.1 INTRODUCTION

The IFC Performance Standard PS1 indicates the need to consider environmental and social factors where clear strategic or technical alternatives existing for a project. The alternatives analysis for the JER Project has considered the following alternatives concepts:

- The 'no development' option;
- Alternative sites;
- General application of BAT for the design basis; and
- Technology for control of emissions to atmosphere.

The last point is also related to the RC requirement for developers within the JIC to consider technical alternatives in project design that minimise environmental impacts of a new development. This requires developers to undertake an assessment of process design alternatives within a structured framework based on demonstrating the application of Best Available Techniques (BAT).

5.2 THE 'NO DEVELOPMENT' OPTION

As with any significant development, detailed consideration has been given to the feasibility, viability and sustainability of developing a new additional refinery in Saudi Arabia. Many factors are drawn together to ascertain the project viability at a strategic level, including the following questions:

- Is there a suitable site?
- Are crude feed stocks suitably priced and what crude specification will be targeted?
- Which products should be maximised and others minimised?
- What is their long term market demand?
- Should the project be financed?

The JER project is an important milestone in the economic development of JIC and Saudi Arabia, representing greater export diversity and providing supply for the growing domestic demand of vehicle and aviation fuels, and petrochemical feed stocks.

As the demand for refined products is growing domestically and internationally, it is expected that if the project in Jubail does not go ahead, a similar refinery would be established elsewhere, possibly in Europe where there is an acknowledged deficit in refining capacity.

In addition, should the project not be undertaken, it is very probable, given the RC's mandate to continue to develop and expand JIC for performance and petrochemical based production, that a similar size petroleum or

petrochemical based project would be established on the Plot 9 site. Due to its zoning for industrial use, the site could not otherwise be developed for non-industrial purposes. It is also very unlikely that the vacant site would naturally acquire important ecological value without significant intervention (which would be counter to the RC's mandate for development of JIC.).

5.3 *ALTERNATIVE SITES*

Major petroleum and petrochemical industrial developments in Saudi Arabia are typically located within one of two industrial cities: Jubail or Yanbu, which have each been planned, zoned and developed over the past 30 years specifically for this purpose. The industrial cities have been designated and developed specifically to accommodate facilities such as the JER. Key advantages of the project being located with JIC include:

- Well developed and enforced environmental regulations specific to the industrial city;
- No residential areas being located within the designated industrial areas or near to the proposed JER site;
- Certain refined products to be used as feedstock's for neighbouring facilities in JIC;
- Environmental management infrastructure being available to the project, such as waste management facilities, secondary waste water treatment, sanitary waste water treatment, storm water and cooling water discharge channels;
- Easy access to KFIP for product export, provided by the industrial city.

Within the JIC, compliance with RCER 2004, which mandates facility operational performance that is generally in line with USEPA requirements, is a pre-requisite of construction and operations.

Based on the significant benefits provided by JIC, most alternative sites that could be considered for the project, outside the industrial city, are likely to be less well suited to accommodate such a major refinery development.

5.4 *GENERAL APPLICATION OF BAT IN THE REFINERY DESIGN BASIS*

The RC advocates the application of BAT principles during project design. BAT, as defined by RCER 2004 is "*…the application at facilities of the most effective and advanced production processes, methods/ technologies or operational practices to prevent and, where that is not practicable, to reduce emissions or discharges and other impacts to the environment as a whole. BAT must as a minimum achieve emission or discharge standards in these Regulations taking into account energy, environmental and economic impacts and other costs to the facility*".

In addition, IFC Performance Standard PS3 also states that:

"*…the client will consider ambient conditions and apply pollution prevention and control technologies and practices (techniques) that are best suited to avoid or, where avoidance is not feasible, minimize or reduce adverse impacts on human health and the environment while remaining technically and financially feasible and cost-effective*".

The refinery design basis has considered both of these principles in the development of the FEED. *Appendix C* of this ESIA Report presents the BAT analysis prepared specifically in accordance with RCER 2004 requirements.

General application of BAT in the refinery design basis is summarised in *Table 5-1*.

Table 5-1 General Application of BAT in JER Design Basis

Source	Pollutant / Discharge	Control / BAT Principle Applied
Fired heaters and boilers	CO, PM_{10}	Fired heater systems to be operated in a manner that achieves complete combustion of refinery fuel gas. This is an operational control, and no additional technology is required to achieve BAT requirements or legal limits.
Fired heaters	SO_2	A number of amine strippers remove hydrogen sulphide (H_2S) from the refinery fuel gas generated by certain process units. Following H_2S removal, gas is transferred to the refinery fuel gas header. H_2S scrubber systems are expected to achieve a refinery fuel gas with 11ppm sulphur, inferring an emission limit for all fired heaters of less than 40mg/Nm^3. This is considerably lower than both the World Bank limit (2,000mg/Nm^3) and the RC limit (340ng/j versus project target of 1ng/j).
Hydrocarbon Flares	NOx, CO, PM	Tip design to achieve high destruction efficiency (>98%), and heat radiation exposure and dispersion modelling studies to establish appropriate flare height (220m above grade). Air / steam assistance is applied to achieve this destruction efficiency.
Acid Gas Flare	H_2S	Tip design to achieve >98%, destruction efficiency. Flaring is considered the accepted approach within refineries for safe disposal of H_2S during emergency conditions. No technically or economically feasible alternatives exist.
Acid Gas Flare	NOx, CO , SO_2	Zero flaring philosophy during normal operations at the acid gas flare tip.

Source	Pollutant / Discharge	Control / BAT Principle Applied
Process Components	VOCs	SATORP is committed to undertaking annual Leak Detection and Repair (LDAR) programmes to minimise fugitive emissions[1].
Sour water from various process units	H_2S and NH_3 in process sour water	Sour Water Stripper (SWS), which significantly decreases sulphur and ammonia content of waste water. Stripped water is recycled for use in the crude de-salters, which can cause organic compounds to be further removed. In addition, this water will be recycled as wash water in process units or quench water in the DCU. The Mineral Oil and Gas Refineries BREF Note 2001 considers this to be the recommended approach to reducing facility water consumption.
Sulphur Recovery Units (SRU)	Sulphur recovery target	The SRU + Tail Gas Treatment (TGT) units will be capable of achieving a 99.95% total sulphur recovery which is in line with RCER 2004 and is considered to represent BAT in accordance with the EU BREF for Mineral Oil and Gas Refineries.
Cooling Water System	Dosed cooling water discharge	The project has avoided continuous discharge of cooling water, and reduced seawater demand, through the use of two seawater cooling towers. Only discharge of blow-down from these systems will be required.
Waste Water Treatment Plant (WWTP)	Sludge wastes from the WWTP and oily sewer	These represent a significant waste stream which will be used for coke quenching in the Delayed Coker Unit (DCU), rather than be transferred to licensed landfill. The re-use of this sludge stream has resulted in significant waste reduction for normal refinery operations.
Waste water collection system	Dedicated oily sewer	The JER will have a dedicated oily sewer and pit for the aromatics units to contain a large spillage. This waste water stream joins the general oily water sewer and WWT.
Waste water treatment system	API Separator	The JER will have covered API separators that capture fugitive VOC emissions which are then directed to a control device for removal or destruction. It is expected that this system would reduce VOC emissions by 98%.

[1] Initially, LDAR will be on a *semi-annual* basis, starting within 180 days of initial start-up of operations. Following two (2) consecutive *semi-annual* leak detection periods when the number of leaking components is found to be less than 2% of the total, the operator may revert to *annual* leak detection monitoring. If the total number of leaking components ever exceeds 2%, then the facility shall revert to *semi-annual* monitoring (RCER2004).

5.5 NO_X CONTROL FOR FIRED HEATERS AND BOILERS

5.5.1 *Overall Approach*

The project operates approximately 2,500MW (thermal input) of heaters and steam boilers, with significant potential to emit oxides of nitrogen (NOx). Fired heaters will operate on refinery fuel gas, and steam boilers will operate on a combination of refinery fuel gas and fuel oil. A detailed review of technologies for NOx reduction has been undertaken which has considered:

- Performance;
- Reliability;
- Cost;
- Use of energy, fuel or chemicals; and
- Other 'cross media' effects.

The technology selection process has been driven by three key factors:

- As a minimum, all combustion equipment will comply with RCER and IFC emission limits;
- The selected technology should meet the RC's definition of BAT in terms of performance, cross-media effects, safety, raw material consumption etc; and
- Following the application of BAT, the ambient NOx concentration limit down wind of the refinery should be no more than 25% of the RCER ambient standards for NOx (at the refinery fence) during normal operations.

The assessment has focussed on those heaters with the potential to release more than 100 tonnes of NOx per annum (in accordance with RCER2004 requirements).

Several techniques are commercially available and technically feasible for NOx control from heaters and boilers. Those which reduce thermal NOx formation are termed 'combustion controls' and include:

- Low NOx Burner (LNB);
- Ultra Low NOx Burner (ULNB);
- Flue Gas Recirculation; and
- Over Fire Air (OFA).

It should be noted that LNB and ULNBs are approximately 20% less efficient for heaters which include 'air preheating' (necessary to maximise thermal efficiency of heaters).

Techniques which remove NOx (both thermal and chemical, i.e. NOx created from nitrogen present in the fuel) are termed 'post-combustion controls', and include:

- Selective Non-Catalytic Reduction (SNCR); and
- Selective Catalytic Reduction (SCR).

The BAT analysis report (see *Appendix C*) provides a detailed description of each of the above techniques.

5.5.2 Cross Media Effects

There are only significant cross-media effects when comparing technologies based on combustion controls (such as LNBs, or ULNB) with post-combustion control techniques (such as SCR or SNCR). SCR and SNCR have the following cross media effects:

- The continuous supply of ammonia represents a safety risk on the public road networks, although risks associated with ammonia transport can be managed, and certain technology is available for generating ammonia on site from sour water treatment.
- The constant supply of ammonia by road truck itself leads to emissions of NO_x, CO, CO_2, PM etc.
- Ammonia 'slip' represents an additional potential emission to atmosphere (where excess ammonia is unintentionally used).
- These systems require additional electrical energy to operate, which indirectly leads to emissions to atmosphere at the point of generation.
- SCR generates hazardous solid waste (spent catalyst), although most suppliers can be contracted with 'buy back' agreements.

5.5.3 Financial and Performance Analysis

Financial and performance analysis has been conducted for the following NOx reduction techniques or combination of control techniques:

Fired Heaters	*Steam Boilers*
• Conventional Burner	• Conventional Burner
• LNB	• LNB
• ULNB	• ULNB
• SNCR	• LNB + FGR
• SNCR + LNB	• LNB + OFA
• SNCR + ULNB	• SNCR
• SCR	• SNCR + LNB
• SCR + LNB	• SNCRA + ULNB
• SCR + ULNB	• SNCR + FGR
	• SNCR + OFA
	• SCR
	• SCR + LNB
	• SCR + ULNB
	• SCR + FGR
	• SCR + OFA

Financial range data has been based on industry references, vendor preliminary data and TOTAL experience. Where references cite costs for a particular size of boiler or heater, a scaling factor has been applied, which assumes a 30% increase in cost for a doubling of equipment size. The CAPEX repayment window is based on 5 years of operation (i.e. costs presented below represent a five year operating period in which the CAPEX and five years of OPEX are aggregated).

Figure 5-1 provides a summary of performance data for NOx controls on gas fired heaters.

Figure 5-1 Gas Fired Heater Performance and Financial Analysis

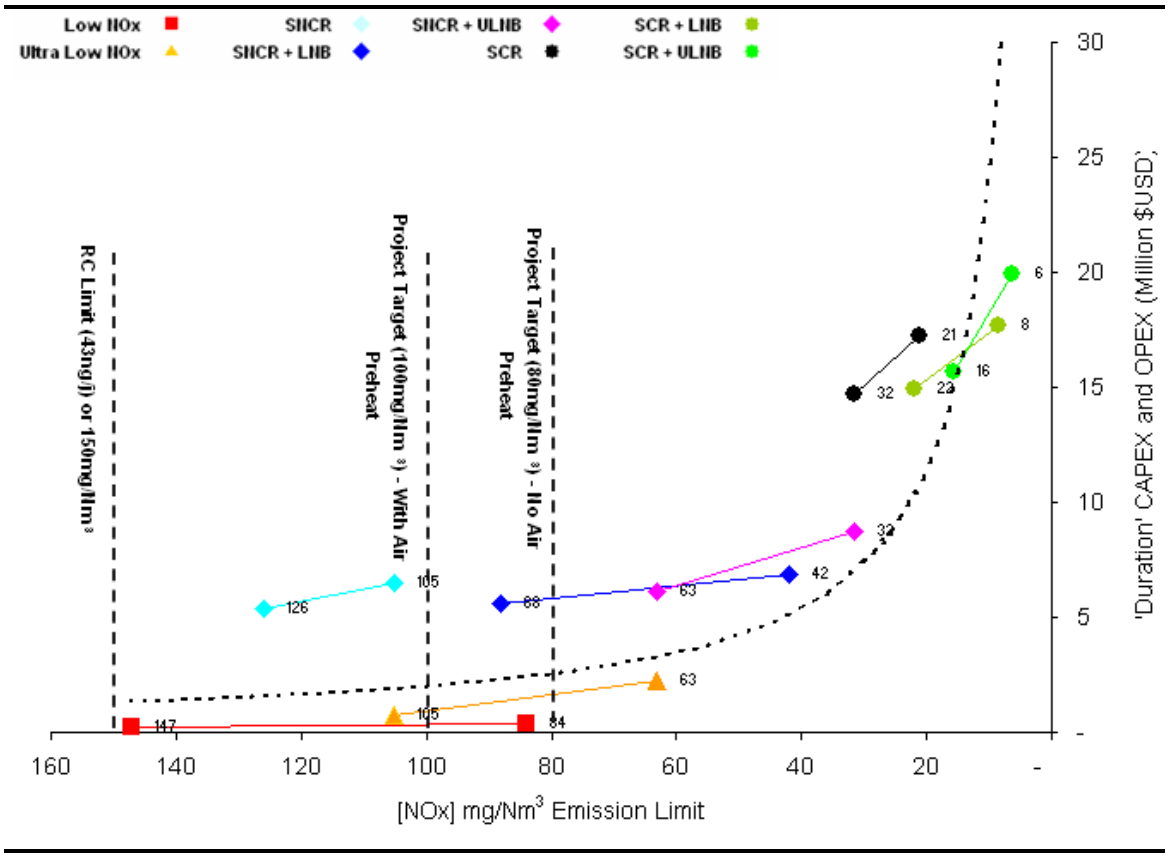
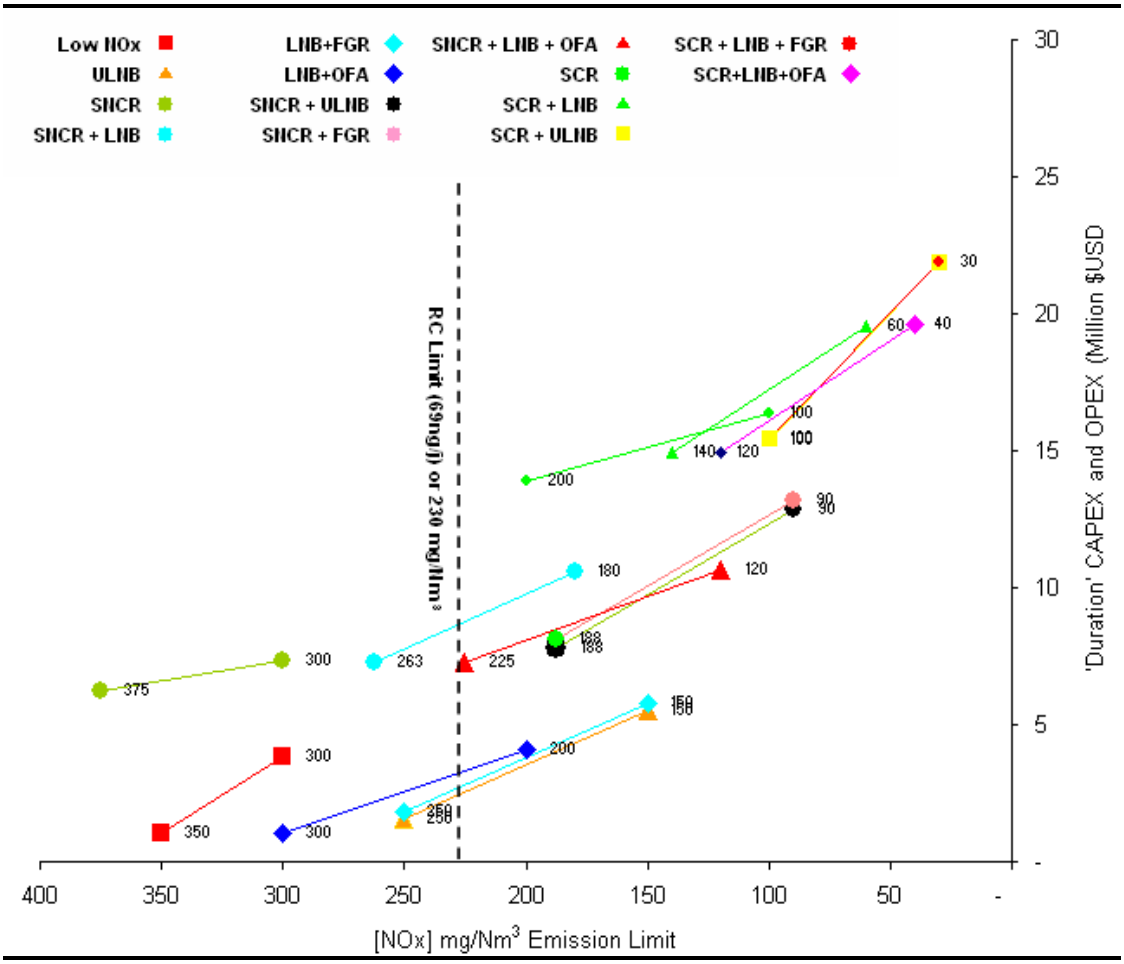


Figure 5-2 presents performance and financial analysis for steam boilers operating on fuel oil. It has been assumed that 100% of the fuel input will be fuel oil, however the normal and maximum fuel ratios will be determined at the detailed design stage.

Figure 5-2 Fuel Oil Fired Boiler Performance and Financial Analysis



5.5.4 *NOx BAT Analysis Conclusions*

Fired Heaters

It is clear from the analysis that significant improvements in NOx emissions can be afforded through the application of proven technology. The project target can be met with modern ULNB technology, the performance of which is comparable to SNCR without the economic cost or cross-media issues associated with post-combustion NOx control techniques.

It is therefore proposed that an 80mg/Nm³ NOx target be assigned for heaters without air preheat, and 100 mg/Nm³ for those heaters with air preheat, both of which are substantially lower than the most stringent emission limit applicable to these emission sources (RCER 2004, at 150mg/Nm³).

These targets will be set for EPC contractors and will be confirmed during detailed design following confirmation from fired heater vendors.

Steam Boilers

This analysis has considered an uncontrolled steam boiler (i.e. the base case) to have a NOx concentration of 500 mg/Nm³. For this base case, achieving an

emission concentration below the RCER 2004 limit is anticipated for most modern combustion control technologies (see below).

The applicable technologies to achieve a cost effective and substantial reduction in NOx are shown below (value in parenthesis indicates the range of costs per tonne of NOx removed)[1].

- LNB plus FGR ($842 – $2,144).;
- ULNB ($824 - $2,137); and
- LNB plus OFA ($769 - $1,679).

Although further reductions of NOx could be achieved with post-combustion controls in addition to the combustion controls listed above, the incremental cost is significant:

- SNCR: ($4,952- $6,745); and
- SCR: ($5,512 - $6,250).

The final technology selection process will be undertaken during the EPC phase, and will primarily focus on proven, cost effective combustion controls (ULNB, LNB+FGR) as these are expected to provide substantial reduction in NOx emissions versus an uncontrolled emission source or LNB. The final selection process should also consider LNB+OFA, however literature and vendor data indicates this technique is less effective than ULNB, LNB+FGR.

This analysis has also included consideration of the impact of differing fuel gas / oil ratios. This is particularly relevant as the RCER 2004 emission limit for NOx is calculated based on fuel gas /oil ratio. This analysis has indicated that both ULNB and LNB+FGR are expected to achieve RCER 2004 compliance on any ratio of fuel oil or gas.

[1] Based on operating costs plus a capital expenditure return of five years.

5.6 VOC CONTROL

The JER process facilities have been designed without open vents, and hence VOCs from crude processing are not expected to be released on a continuous basis (emergency relief is passed to the flare header). The most significant contributors to VOC emissions are anticipated to be:

- Minor leaks from components such as pump seals, compressors, valves and flanges ('fugitive emissions'); and
- Loading and breathing losses from crude oil storage, product and certain intermediate tanks.

The JER design basis incorporates a number of design and management features that will significantly reduce VOC emissions:

- The API separator at the WWTP is enclosed and VOCs will be destroyed or removed by a dedicated control device.
- VOC collection and removal system (carbon absorption) will be installed at the KFIP port for product loading operations.
- An LDAR programme will be implemented in accordance with RCER 2004.
- Appropriate tank roofs will be selected for product, raw materials and intermediate tanks.

Tanks that have contents of greater than 76.6kPa True Vapour Pressure (TVP) include:

- Two Light Naphtha Tanks (TVP up to 90.8 kPa); and
- One FCC LT Gasoline Tank (TVP 94+ kPa).

These high vapour pressure tanks are estimated to represent a significant proportion of fugitive emissions from all tankage (~90%) when considering the 'base case' domed fixed roof tank design for each tank.

A detailed analysis of available control devices applicable to reduction of VOC's for these tanks has been conducted and is presented in the BAT Analysis Report in *Appendix C*.

During the FEED process, the base case design for the high TVP tanks comprised a fixed dome roof. Estimates of emissions associated with this tank configuration were as follows:

- Two Light Naphtha Tanks: 591 tonnes VOC per annum per tank; and
- FCC LT Gasoline Tank: 459 tonnes VOC per annum.

In response to the significant VOC emissions from these tanks, additional consideration was given to the use of single seal internal floating roof tanks. The FEED has confirmed that this tank type can be (and hence will be) used for the high TVP intermediate streams, and consequently VOC emissions have

been substantially reduced (by greater than 98%). The tanks which will be used are:

- Two Light Naphtha Tanks: 8 tonnes/annum per tank; and
- FCC LT Gasoline Tank: 10 tonnes per annum.

A detailed assessment and analysis of available control devices applicable to the vents on these tanks has also been conducted.

The principal options for VOC recovery and treatment considered includes:

- *Recovery of VOC Vapours:*
  - Vapour recovery unit - condensation and recovery of VOCs;
  - Adsorption, for example activated carbon and removal of VOCs; and
  - Wet scrubbing for removal of VOCs.

- *Destruction of VOC vapours:*
  - Thermal oxidation / destruction of VOCs (with our without catalyst); and
  - Routing to flare header.

Table 5-2 summarises the major options for VOC control. Each alternative is considered in terms of high, medium or low relative performance /designation. A full assessment is provided in the BAT Analysis Report in *Appendix C*.

Relatively little data is available on financial costs of each technique, as these are specific to each site and application highly variable. In terms of cost, the following indications are applied:

- High Costs: 301+ Euro/m^3/hr;
- Medium Cost: 151 – 300 Euro/m^3/hr; and
- Low Cost: 1 – 150 Euro/m^3/hr.

Table 5-2 Summary of VOC Vapour Control Technologies

	Performance		Finance		Cross-Media		Safety
	VOC Recovery / Destruction	Max. Recovery Efficiency (%)	CAPEX	OPEX	Emissions / Waste generation	Fuel / Chemical / Energy Use	Safety
Crygenic Condensation	Recovery	99.5%	High	High[b]	-	High	Low
Adsorption	Recovery	99.0%	Med[a]	Med	Med	Med	Low
Thermal Oxidation	Destruction	99.5%	Low	Med	High	High	Low
Catalytic Oxidation	Destruction	99.9%	Med	Med	Med	Med	Low
Flare Header	Destruction	98.0%	Low	-	Med	Low	Med
No Control Device	N/A	0%	Zero	Zero	Med (VOCs)	Zero	High

Notes: (a) Includes regeneration system
(b) Can be off-set by recovered hydrocarbons value

5.6.1 Conclusions on VOC Control

The application of appropriate tank and roof design has resulted in a significant reduction in VOC emissions when compared to the base-case fixed domed roof tank design.

The review of available and supplementary control devices to treat vapour that would otherwise be vented to atmosphere from these high TVP tanks has established a number of technologies that are capable of a control efficiency of 98%. With the reviewed control options, VOC emissions could be less than one tonne per annum for each high TVP tank.

In addition, the 'no additional control device' is also a viable alternative and may be preferred due to:

- The relatively minor VOC release rate from the high TVP tanks when uncontrolled; and
- The cross media effects of the viable alternatives for a control device, which may cause higher emissions of criteria pollutants (either directly or indirectly) than the uncontrolled emission rate.

The final selection will be made at the EPC stage and following a detailed quantitative analysis of each alternative in terms of:

- Cross media effects (in a quantitative context, including direct and indirect emissions);
- Cost;
- Energy; and
- Safety.

5.7 ALTERNATIVES ASSESSMENT CONCLUSION

Besides consideration of the 'no development option' and the rationale for site selection (see *Section 5.2* and *5.3* respectively), the ESIA has included an extensive and highly structured analysis of process alternatives to minimise emissions, principally of NOx and VOCs. This analysis has not only served to meet a discrete requirement of the RC permitting regime, but has also served to fundamentally influence the FEED design process and has led to the establishment of emissions minimisation objectives that will fundamentally drive detailed design. This approach is consistent with provisions and intent of the IFC Performance Standard PS3.

6 ENVIRONMENTAL AND SOCIAL BASELINE

6.1 INTRODUCTION

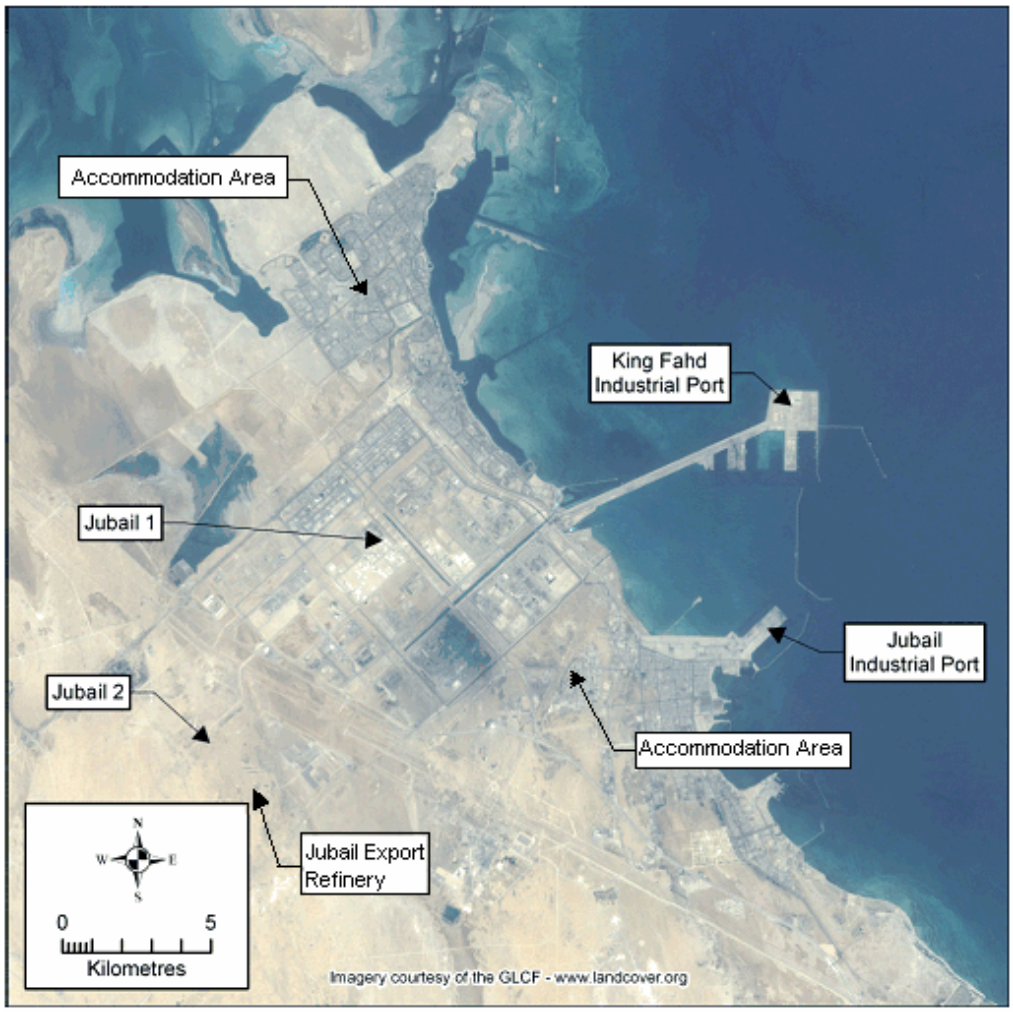
A desktop review of publicly available information has been undertaken in an effort to characterise the existing environmental/socioeconomic baseline quality of the JIC and the surrounding areas. The desktop review has been supplemented with noise, ecology and later in 2009, soil / groundwater quality baseline surveys, in addition to site walkovers by the ESIA team. This chapter summarises the findings of this review by describing the relevant physical, biological, chemical and socio-economic baseline conditions.

6.2 PROJECT LOCATION

The JER will be located in Saudi Arabia on the west coast of the Arabian Gulf, in Ash Sharqiyah Province, 100 km northwest of Dammam. The JER will be within the JIC 2 (about 3 km west of the existing JIC 1) in the PLOT 9 area (*Figure 6-1* and *6-2*).

Figure 6-1 Location of Jubail, Saudi Arabia

Figure 6-2 Project Location - National Context



6.3 BACKGROUND ON JUBAIL

Jubail is a major industrial city and contains an oil refinery, a steel mill, and one of the world's largest desalination plants, which also generates electricity. In addition to refined oil products and steel, petrochemical products such as plastics and fertilizers are manufactured and exported. Other industries have been created to manufacture consumer goods and support the activities of the primary oil and gas based ventures. Jubail is the site of a naval base and one of the Kingdom of Saudi Arabia's most important seaports.

6.4 CLIMATE AND METEOROLOGY

The Kingdom of Saudi Arabia forms part of the Arabian Peninsula and is one of the driest countries in the world. The main influence on temperatures in Jubail is the proximity to the Arabian Gulf. Daytime temperatures at inland locations are typically higher than temperatures along the coast and the Jubail mean monthly temperatures range between a minimum of 14.9 °C during winter months to a maximum of 35.5 °C during summer months.

Table 6-1 provides detailed temperature data for Jubail (recorded at 10 metres (m) above sea level. Temperatures at or near the ground surface can be more extreme).

Table 6-1 Meteorological Data Summary (1988-2001) Jubail Industrial City

Atmospheric Temperature (°C)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Years
Absolute Max.	28.6	34.6	37.9	43.2	45.2	47.3	49.7	48.6	46.2	45.4	37.6	31.8	14
Mean Daily Max.	19.2	20.9	24.8	33.2	36.7	40.3	41.6	41.2	38.3	34.0	27.2	22.0	14
Monthly Mean	14.9	16.4	19.9	25.4	30.8	33.1	35.5	34.9	31.7	27.7	21.9	17.4	14
Mean Daily Min.	10.7	12.2	15.5	20.4	25.3	27.8	29.8	29.2	25.8	22.0	17.0	13.1	14
Absolute Min.	5.6	2.9	7.6	10.6	19.3	20.5	25.8	25.7	20.3	16.8	7.8	6.4	14
Relative Humidity													
Mean Relative Humidity (%)	70.5	70.2	19.5	53.9	45.0	41.1	42.2	52.1	53.7	61.4	65.1	65.8	14
Rainfall													
Mean (millimetres)	23.3	3.8	6.8	1.8	0.8	0.0	0.0	0.0	0.0	0.6	24.1	10.0	14
Wind Speed (m/s)													
Max. Gust	19.0	19.2	21.4	20.2	29.9	22.1	17.5	16.4	16.0	24.6	42.7	38.3	14
Max. 1 Hr Avg.	12.7	12.3	15.8	12.5	13.5	13.9	12.2	11.2	11.5	11.9	17.2	11.4	14
Monthly Mean	4.3	4.3	4.4	4.3	4.5	4.6	4.1	3.8	3.7	3.8	3.9	4.2	14
Wind Direction													
Prevailing	WNW	NW	N	NNW	N	NNW	NNW	N	NW	NW	NW	WNW	14

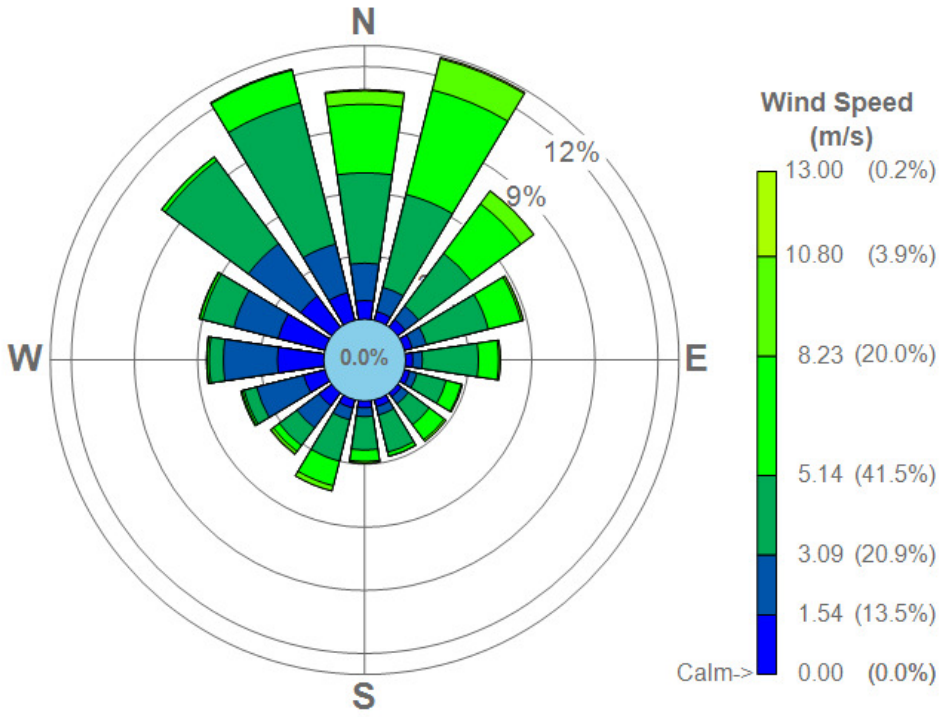
Source: The RC

The proximity to the coast also influences the relative humidity; the greatest differences between coastal and inland locations occur mainly in summer. Summer relative humidity is 20 to 30% lower a few kilometres inland as compared to the coast. The recorded Jubail mean relative humidity ranges between 41 % and 70 %. At Jubail and the coastal area of the Eastern Province, during the summer months, the humidity range is large, with night time humidity values of 90 % or more.

The Jubail rainfall season extends from November to April, but precipitation has been known to occur in October and May. *Table 6-1* presents fourteen years of records (1988 – 2001) and indicates that the mean annual rainfall is 71.2 mm. It is important to note that much of the annual rainfall often occurs over relatively short periods of time during intense storms. Data indicate that rainfall intensities of less than 4 mm/hr occur 90 % of the time and the maximum intensity of approximately 46 mm/hr occurs less than 1 % of the time. Daily rainfall intensity of 9 mm is exceeded approximately 20 % of the time and the maximum daily rainfall recorded is 114 mm.

Prevailing wind directions at Jubail and near-by locations are primarily in the north quadrant (see *Figure 6-3*). Strong winds frequently occur during winter frontal passages (known as winter Shammals) and during summer Shammals. Winter Shammals have higher wind speeds but summer Shammals have longer duration. As indicated in *Table 6-1*, monthly mean wind speeds at Jubail are between 3.7 and 4.6 m/s throughout the year. Winds equal to or greater than 13 m/s occur frequently which results in sand particles being lifted a metre or more above ground level. Blowing sand can reduce visibility to less than 50 m. High PM_{10} values with low visibility are a feature of Saudi Arabia and the eastern province with apparently increasing frequency and severity.

Figure 6-3 Jubail Wind Rose (2002) (m/s)



6.5 AIR QUALITY

The project site is located within a largely vacant industrial zone (JIC 2) where there is currently limited probability for air quality to be significantly deteriorated. It is likely that downwind of the long established JIC 1, however, existing industrial operations may lead to deterioration of air quality. This is particularly likely in context of NO_x, SO_x, CO and particulate matter, although high PM concentrations may also be recorded through wind-blown dust.

The RC has for a number of years continuously monitored air quality and meteorological conditions at nine locations within the wider JIC area (*Figure 6-4*).

Figure 6-4 Location of RC Monitoring Stations (Source, RC)

The measurement location considered to be most representative of the JER plot is Station 6, which is located within JIC 2, several kilometres to the west of the proposed refinery site. Monitoring data from this station is provided in *Table 6-2*.

Table 6-2 Station 6 Ambient Air Quality Data (source: RC, all units ug/m³)

Pollutant	Averaging Period	RC Standard	(Percentile)	2006 Measurement	2007 Measurement	Average
SO_2	1-hour	730	(99.7th)	24	75	50
	24-hour	365	(99.7th)	9	23	16
	Annual	80	N/A	2	6	4
NO_2	1-hour	660	(99.7th)	123	102	113
	Annual	100	N/A	23	21	22
CO	1-hour	40,000	(99.7th)	2,519	1,800	2,159
	8-hour	10,000	(97.8th)	2,176	1,715	1,945
PM_{10}	24-hour	150	N/A	ND	ND	N/A
	Annual	50	N/A	ND	ND	N/A
O_3	1-hour	235	(99.7th)	71	59	65
H_2S	1-hour	200	(99.9th)	9	10	10
	24-hour	40	(99.9th)	1	6	4

ND – Not Detected or Unreliable Data

Note: None-methane hydrocarbons, although regulated in JIC, is not currently measured

When comparing the pollutant concentrations with the various ambient standards, all measurements appear to comply with the RC standards. Concentrations of PM_{10} (particulate matter with a diameter below 10 microns), although unreliably recorded at Station 6, are on occasion in excess of the RC standards at other stations; however this is likely to be a result of natural wind-blown dust rather than being of anthropogenic origins.

6.6 NOISE

The baseline noise survey was undertaken in accordance with best practice as specified in ISO 1996 6-3 '*Description and Measurement of Environmental Noise*'. A complete baseline report is provided in *Appendix B - Annex I*, and a summary of the assessment is provided below.

A series of short-term measurements were recorded during the day and evening period between 29th-31st March 2008. Measurements were taken at a standard height of 1.5 and 3.0 m away from any reflecting services. No night time measurements were recorded due to the remoteness of the site and security permit limitations.

The proposed refinery site was observed as being affected by a number of noise sources, including the continuous presence of road traffic noise to the southeast and a distant hum from JIC 1 to the northeast. The road to the northeast of the JER site had the occasional truck and car passing and there were some rollers levelling the site northwest of the central area during a few measurements.

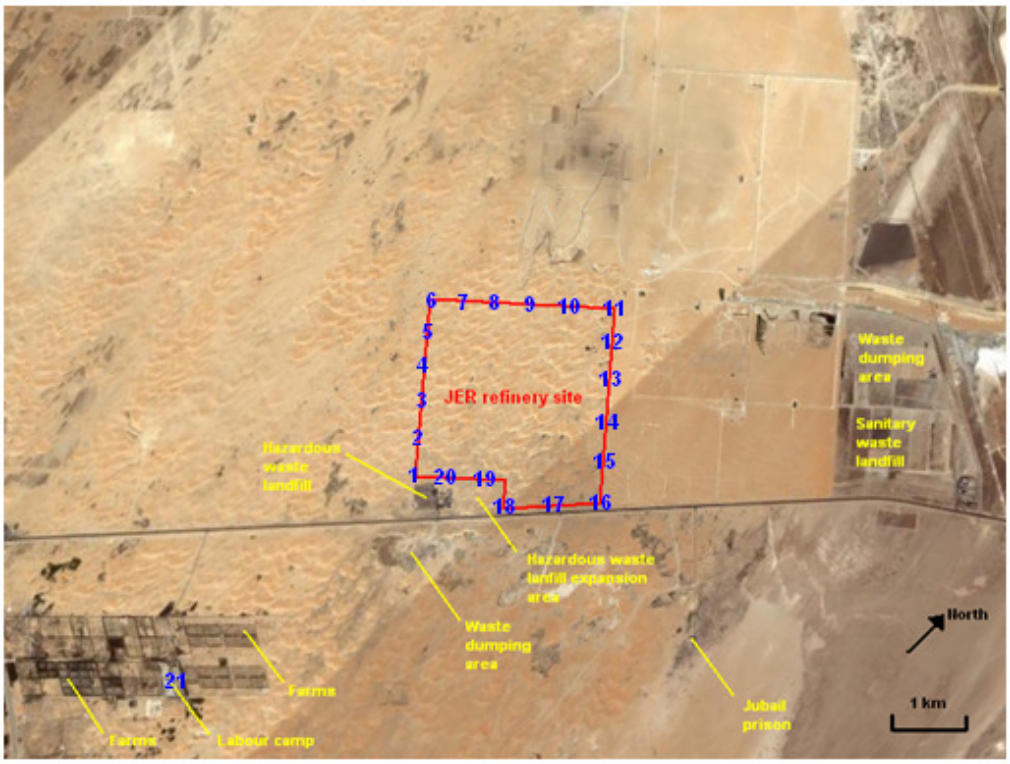
A Rion NA-28 Type 1 Sound Level Meter (SLM) (Serial Numbers: 01260182) and electret condenser UC-59 ½ inch microphone (Serial Numbers: 00260) and a Rion NC-74 Type 1 field calibrator (Serial Number: 34172640) were used for the short-term measurements. The SLM was calibrated before and after each measurement day and no significant calibration drift was detected.

The selected sound level meters automatically log environmental noise measurement parameters including LAeq, LAFN, T and LAFmax and 1/1 and 1/3 octave bands (see *Appendix B – Annex I*).

Meteorological conditions during the measurement period were observed as sunny. An average air temperature of 34 °C was recorded, while a Kestrel 2000 anemometer recorded an average wind speed of under 5m/s during the short-term measurements. Where gusts of wind greater than 5 m/s were observed these were noted in the field data sheet. The dominant wind direction was from the north.

Short-term measurements were recorded at a total of 21 locations in and around the project site as detailed in *Figure 6-5.* Measurements were recorded for 10 minute intervals at each location around the site boundary and at the proposed labour camp located approximately 1.5 km southwest of the facility. Two sets of measurements were recorded at each of the site boundary locations during am and pm hours. A 1/3 octave band analysis was also conducted for two minutes at each location for both am and pm hours.

Figure 6-5 Baseline Noise Measurement Locations



Results

Table 6-2 summaries the baseline noise measurement results recorded at each of the twenty site boundary locations.

Table 6-2 Summary of Ambient Noise Levels across the Project Site

Noise Metric	Decibels (dBA)	Measurement Location
Lowest LAeq (10 mins)	36	1
Average LAeq (10 mins)	53	-
Highest LAeq (10 mins)	63	9
Lowest LAS_{min}	31	3
Highest LAS_{max}	84	9
Lowest LA_{90}	34	1

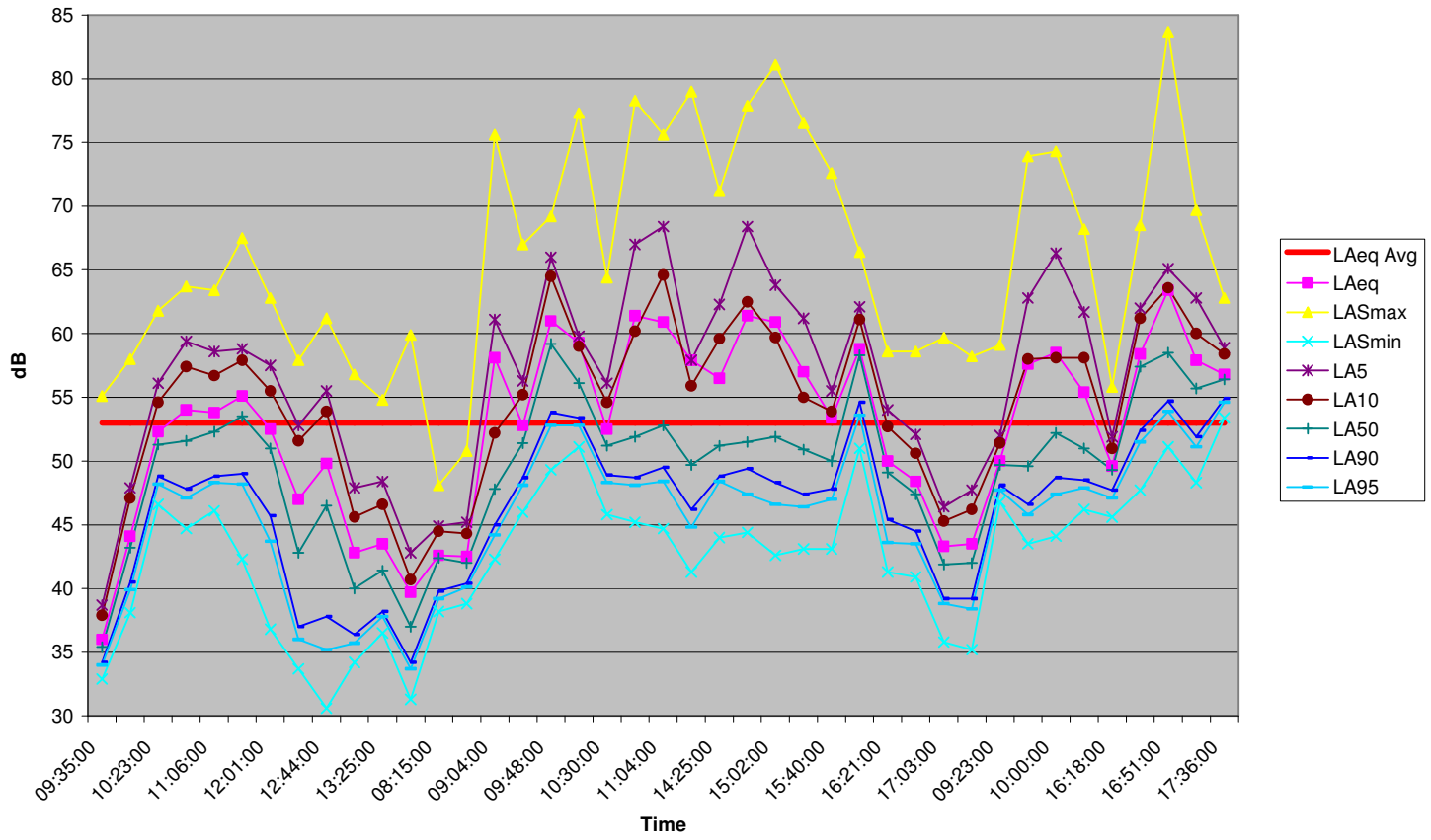
Table 6-3 summaries the noise data collected at the nearest potentially sensitive receptor, the TCF location, 1.3 km south east from the proposed JER facility's site boundary. The dominant noise source at this location was from road traffic noise and was similar in levels recorded at the project site.

Table 6-3 Summary of Noise Data collected at the Proposed TCF

Noise Metric	Decibels (dBA)
LAeq	57
LAS_{min}	53
LAS_{max}	63
LA90	55

Figure 6-6 presents the timeline noise spectrum over the three-day measurement period. This Figure illustrates the fluctuation in noise levels across the project site as a result of changes in the volume and type of road traffic.

Figure 6-6 Time History Baseline Noise Spectrum



6.7 GEOLOGY

From information supplied by the Saudi Arabian Geological Survey, rocks of the Kingdom of Saudi Arabia range in age from the Precambrian to the present period and form part of a unit that includes the Arabian Peninsula. This geological formation is known as the Arabian Plate. The Kingdom of Saudi Arabia is located on the southern part of the Arabian Plate.

The Arabian Plate is underlain by Precambrian continental crust. It originated as chains of volcanoes along spreading centres and subduction zones in a Neoproterozoic ocean and against ancient continental margins, and were folded and uplifted toward the end of the Precambrian as a large belt of mountains. By the end of the Precambrian period, the mountains had been eroded and today only their roots are preserved, exposed in western Saudi Arabia in the Arabian shield.

The younger rocks in Saudi Arabia belong to the Paleozoic, Mesozoic, and Cenozoic eras and crop out as relatively flat lying beds of sedimentary rocks such as sandstone, siltstone, limestone, salt deposits, and volcanic rocks. The rocks were deposited on the underlying Precambrian basement, in riverbeds, glacial valleys, and shallow seas, or were extruded from sub-aerial volcanoes.

The rocks north and east of the Arabian Shield are referred to as the Arabian Platform.

6.7.1 *Seismic Activity*

Jubail is in an area of low earthquake activity; however Saudi Arabia is at risk from seismic activity because the Arabian Plate is small in comparison to other surrounding geological plates, whose boundaries are in relatively close proximity to the project site.

Earthquakes are predominantly initiated at the plate margins. In terms of the Arabian Plate, these boundaries are the Dead Sea transform on the northwest, the Red Sea spreading centre on the west, the Gulf of Aden spreading centre on the south and the Zagros subduction zone on the northeast. Jubail has ahigh potential for being affected by an earthquake along the Zagros subduction zone. Danger of serious damage to this region is reduced because the subduction zone is across the Arabian Gulf from Jubail, and because shock absorption is provided by the relatively thick sediment deposits at Jubail.

6.7.2 *Site Geology*

JIC is situated on a coastal plain and lowland landform along the Arabian Gulf. This site is part of a coastal plain that is mostly saline sediments, sand and gravel, and is relatively flat. The coastal plain and lowland landform continues inland for approximately 60 km where it eventually meets the Al Hasa Plain. Base rock would not be expected at shallow depths (0 to 3 m)

within the project site or along the Arabian Gulf coastline around the Jubail area.

The coastline itself is extremely irregular, merging sandy plains, marshes, and salt flats with the edge of the Arabian Gulf waters. As a result, the land surface is unstable; in places water rises almost to the surface, and the sea is shallow, with shoals and reefs extending far offshore. It is understood that JIC surface features have been altered by grading and filling with imported fill material from the original surface features.

6.7.3 Soils

Soils in this area are quaternary deposits, having been formed by glacial action, water sedimentation and windblown elements of predominantly sand, gravel, silt and clay.

Successive layers of sediments have been overlain by windblown sand and gravel, with a build-up of evaporated salts within the layers. The formations will be non-conformed in thickness, composition, density and pH.

6.8 EXISTING SURFACE WATER ENVIRONMENT

To the east of the proposed project site is the Arabian Gulf, a shallow marine body characterised by warm water temperature, high salinity, and co-oscillating tides. The Gulf is an extremely shallow sea, with large areas near the coast being less than 10 m in depth. The high salinity of the Gulf is the direct result of seawater evaporation rates exceeding fresh water inflows. Less than 250 mm annual rainfall occurs on the surrounding land mass, and very few rivers (none from Saudi Arabia) contribute a consistent inflow of fresh water.

The Jubail area receives less than the national average rainfall, typically recording approximately < 80 mm annually. Most rainfall is of high intensity and short duration, producing a large volume of surface run-off that gathers in wadis (stream beds that are normally dry).

No significant perennial rivers or surface water bodies exist within the region. Reclaimed wastewater is an increasingly important resource and its national reuse is estimated to be approximately 200,000 m^3/year and constitutes approximately 2 % of the country's total water demand. Reclaimed wastewater is used for irrigation of non-cash crops, landscape irrigation and industrial cooling.

6.8.1 Desalinated Water

In Jubail the predominant water source is desalinated seawater. Currently, Jubail is home to the world's largest desalination complex producing nearly 1,000,000 m^3 fresh water each day. Some of the water is chlorinated and demineralised for use as potable water, and the remainder is used for

industrial purposes. The proposed Marafiq Independent Water and Power Project (IWPP) will produce 300,000m^3 of desalinated water, adding to the desalination capacity of the area.

6.8.2 Irrigation Water

Treated wastewater is used to irrigate non-edible crops and landscape areas within the Jubail area.

6.8.3 Cooling Water

Cooling water is currently provided to JIC via a 25 km open-canal system that is supplied by two pumping stations operated by the RC. In the region, approximately 60 % of the seawater passing through the main pumping station in Jubail supplies process cooling water for industry; the remainder supplies electrical power stations and desalination facilities.

The open canal method for cooling process water used for JIC is not practical for Jubail 2 due to limitations posed by the new site's elevation. Cooling waters at Jubail 2 will be handled by a network of four-metre-diameter pipelines with an initial flow of 200,000 m^3 per hour.

6.8.4 Wastewater

Industrial effluents

Industrial wastewater from Jubail 2 will be collected within an RC industrial sewer prior to a tertiary level treatment within a RC IWTP.

After treatment, the effluent will be utilised for irrigation within the Jubail area including Sabkhat Al Fasl Lagoons, to the north of JIC.

Sanitary wastewater

Sanitary wastewater from JIC is collected and transported via an existing sanitary sewer system for treatment within the Marafiq Sanitary Wastewater Treatment Plant (SWTP), in accordance with discharge permits. The plant provides tertiary treatment yielding high quality effluent which is reused for the irrigation of planted areas adjacent to the Industrial City.

Non-contact cooling water

The JIC cooling seawater is returned to the sea via gravity to the RC seawater cooling canal which discharges adjacent to the KFIP. The canal discharge point into the Gulf is approximately 1 km southeast of the intake point. The typical water temperature at the seawater cooling canal intake is approximately 35 ºC and the typical canal water temperature at the outfall is approximately 38 ºC.

6.9 ECOLOGY

6.9.1 Overview

Saudi Arabia is situated in an area of great ecological significance. Even though a large area of the country is desert, there is nevertheless significant biological diversity. Certain plant species, such as Rimth saltbrush, have adapted to the arid climate whilst others that require more water, such as date palms, are supported by oases.

Eighteen percent of Saudi Arabia's invertebrates, 80% of its amphibians, and all of its freshwater fish are not found anywhere else in the world. There are an estimated 3,500 species of plants, 79 species of terrestrial mammals, and 413 recorded species of birds.

There are 16 protected areas in Saudi Arabia which account for about 4% of the country's total land area. These protected areas serve as in-situ seed banks that are strategically located for regeneration of overgrazed rangelands. A system of 103 protected areas that cover 10 % of the country 's land area are planned and under consideration. These areas would be important for conservation of biological diversity and protection of existing viable populations of key taxa of flora and fauna.

The only potentially designated (1) area which is of relevance for the JER project is the Jubail Wildlife Sanctuary, focused on Abi Ali Island to the north of Jubail.

6.9.2 Terrestrial Ecology

This section provides information on the predicted impacts of the proposed development on terrestrial ecological resources. The assessment presented follows field work (two discrete surveys) and data review and has been conducted by experts familiar with the ecology of Saudi Arabia and the Jubail area.

General Ecological Status

This section sets out those factors which influence the ecology of the area and the state of ecologically sensitive areas within and near to project areas.

The arid conditions, followed by winter rains, which occur in normal years has resulted in distinctive plant communities whose composition has been shaped by the survival strategy of the individual plants. Life form analysis along the lines of the Raunkiaer system shows that the most dominant life form in the eastern province is Therophytes (annuals). Perennial species are either drought tolerant shrubs or grasses which survive the dry summer periods in a desiccated state.

(1) As described in Section 6.9.2, the Jubail Wildlife Sanctuary has been proposed for formal designation, but this has not been notified by the Government of Saudi Arabia.

Normal winter rains produce a significant flush of annuals both in terms of biomass and diversity as noted above. Mandeville (1984) suggests that two floristic groups exist in Saudi Arabia, these being the Saharo – Arabian and the Sudanese groups. Mandeville's proposed line of the frontier passes through the Jubail region.

Much of the total footprint of the project will take place within an area which has been significantly disturbed through historical industrial development. The Jubail area is crossed in many places by pipeline corridors and power cable right of ways (ROWs). In many areas of Saudi Arabia where there has not been significant human disturbance, overgrazing has been a significant problem, including in parts of the wider Jubail area. However, evidence from the field surveys suggests that heavy grazing does not occur in areas near to the JER sites where semi-natural vegetation exists.

Faunal biodiversity is influenced by the distribution and quality of the habitats present. Given the generally poor quality habitat and high levels of disturbance within the study area, the faunal value within the designated JIC 2 is therefore also relatively low.

Saudi Arabia does however have a good faunal community. Of particular note are breeding and passage birds. These are perhaps the best studied group of animals within Kingdom of Saudi Arabia as a whole and certainly within the Eastern Province. It is likely that some 150 species of birds breed in the Kingdom, with the Eastern Province also being a valuable migratory route for this group.

Estimates of faunal species diversity are shown below, in terms of numbers of species in the key groups. (1) The variation in values reflects the lack of systematic study of species demography within KSA:

- Mammals: Total known species: 79;
- Reptiles: Number of Total Known Species: 103;
- Amphibians: Number of Total Known Species: 7.

As noted above, little is known about the distribution of species within the Kingdom of Saudi Arabia. It is therefore often difficult to ascribe rarity to species within Saudi Arabia at a regional level. Species which are restricted in numbers within the Arabian Peninsula are, however, generally listed within the UN Red Lists.

Legislation and Policy

Whilst Saudi Arabia has a well developed system of Protected Areas for ecological purposes, its legislation on species protection is generally poor. There are no legislative statutes which set out the species which are protected.

Saudi Arabia is, however, a signatory of the United Nations Convention on Biodiversity. As such, the Kingdom is obliged to list species which it considers are of 'High Conservation Status'. Saudi Arabia provided such a list and the rationale for species inclusion in its First response to the UN. This list is used within the current assessment as a de facto protected species list.

Designations

There are no national designations within the immediate area of the proposed JER. The Jubail Wildlife Sanctuary, proposed by the National Commission for Wildlife Conservation and Development (NCWCD), the KSA agency responsible for wildlife protection, includes some terrestrial habitat around Jubail. The designation has not been formally approved by the Government.

Sabkhat Al Fasl Lagoons is the area where JIC discharges its treated effluent during winter months to support habitat creation. This has created a valued wetland habitat for birds and has been identified as an Important Bird Area (IBA) by Birdlife International.

There are no other known designations or important areas within the location of the JER project.

6.9.3 Terrestrial Ecology Surveys

Two ecology surveys were undertaken during March 2008 and March 2009. The month of March would normally be considered optimum for ecological survey at this location. The annual flora would normally be well developed and breeding and migratory birds would be present. However, due to an exceptionally dry winter over the 2007/8 period, the presence of annual flora was limited at the time of undertaking the March 2008 Survey and hence the findings of the survey were acknowledged at the time to be somewhat constrained.

For this reason, the survey was repeated in March 2009 when a representative flora bloom had developed and hence a reliable baseline assessment could be undertaken.

The surveys were commissioned by ERM and conducted by Arensco, each over a two day period. Vegetation was surveyed visually with 30 m transects recorded in identified distinct vegetation communities. A total of four transects were recorded per survey. Faunal records were made, based either on direct observations or indirect evidence encountered during the walkover survey. Indirect evidence that was recorded included footprints, faecal droppings, holes and signs of feeding.

Spatial Scope

The study area for the terrestrial ecology surveys has included the JER site, the pipeline route corridors and the TCF area. Initial review of these sites has shown that the northern pipeline route corridor (presented in *Figure 4-3, Chapter 4*) is, for the most part, already constructed or in the process of being constructed as part of the wider JIC 2 development (ie not specifically for the JER project). This will be a common corridor for the JIC 2 facilities (including the JER) which will be under the direct control (in terms of access and upkeep of the RC). It is established RC policy for such corridors to be maintained clear of vegetation for operational and safety reasons, hence this route corridor is not considered further as part of this survey description.

This section focuses mainly on the findings of the second (more representative) March 2009 survey, which was conducted during a period where representative conditions were prevalent. This survey is considered to address the ecological baseline for the project areas. Where relevant, findings from the first survey (March 2008) are integrated with the description provided below. Further details can be found within the Arensco Survey report (March 2009), provided in *Appendix B – Annex II*.

Summary of Survey Findings – Southern Pipeline Route

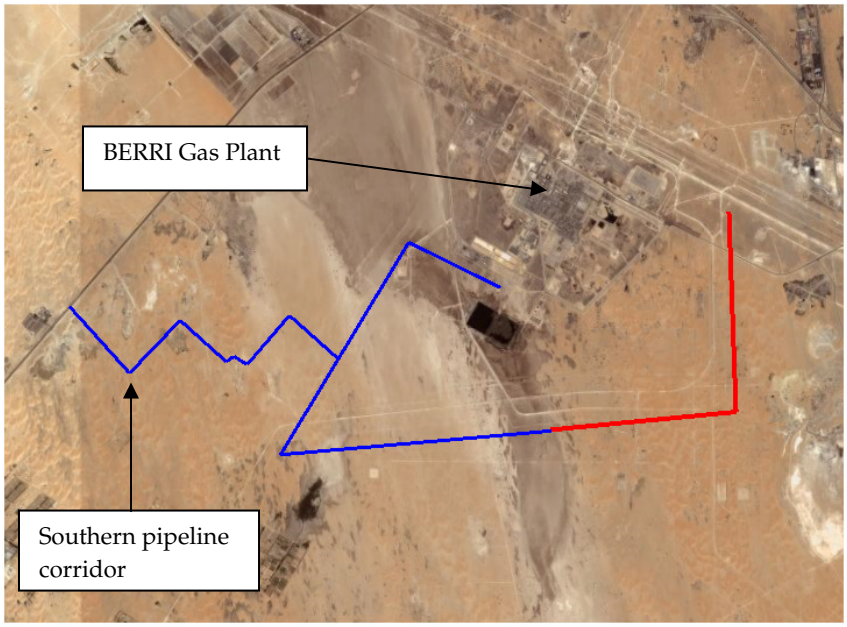
The majority of the southern pipeline corridor is of low to moderate sensitivity, comprising either fairly natural habitat recorded in areas with shallower flat sandy areas, or large salt flat areas('sabkah').

Natural habitat areas have a sparse vegetation cover and reduced plant biodiversity with higher percentages of the more saline tolerant *Zygophyllum qatarense*.

Sabkah forms in flat areas where the water table is close to the surface and due to the high evaporation rates saline deposits build up on the surface often forming a crust of salt. This high salinity substrate is generally too hostile for the development of plant communities.

The surveys did establish one section of the proposed pipeline route (to the south east of the BERRI Gas Plant that was of relatively high sensitivity (*Figure 6-7*).

Figure 6-7 Southern Pipeline Route



Note: Blue route sections - low to moderate sensitivity. Red route section – high sensitivity.

The habitat within this route corridor is formed where aeolian sand develops over sabkah. The deeper sands form into dune systems and were well vegetated during the survey. The vegetation contains a high proportion of 'wild' date palm (*Phoenix dactylifera*) along with a shrub layer including *Calligonum comosum*, *Haloxylon salicornicum* and *Zygophyllum qatarense*. The latter species were more common in the shallower sand between dunes. *Cyperus conglomeratus* was present, again in the deeper sands with a range of grasses dominated by *Panicum turgidum*.

Vegetation percentage cover was good in this habitat type with limited bare ground being present. In addition little evidence of grazing was recorded; only small amounts of camel droppings were noted within this area.

Wild date palms are restricted in distribution and are a feature of the coastal lowlands around Jubail and Dhahran. Mandeville (1990) suggests that the species is able to establish only in areas where the water table is high, not too saline and often in sands over sabkah.

The deeper sands and shrubs provide suitable habitat for small mammals, nesting birds, reptiles and invertebrates. Evidence of foxes (probably *Vulpes vulpes*) jirds and jerboa was also found. Such areas may also contain the protected Spiny tailed lizard (Dabb).

Summary of Survey Findings – JER and TCF Areas

Flora and Habitats

In general, the undisturbed areas of the JER and TCF were found to contain scrub vegetation dominated by three main species, identified on the basis of the dominant woody perennial present:

- Harm (*Zygophyllum qaterense*);
- Rimth (*Haloxylon salicornium*); and
- Tarfa (*Tamarix Arabica*).

Percentage cover of this scrub community, where present, varied from 5 % to almost 80 %. The more dense cover is associated with sections of the pipe line corridor (discussed above), particularly where impeded drainage areas provide additional ground moisture for plant growth (*Figures 6-8* and *6-9* show typical views).

Harm, which dominates the second type of community, shows the highest percentage cover within the study sites. In some areas Tamarix species are present and locally dominant.

Rimth saltbrush shrubland is considered common within the north east of Arabia. The composition of this species at the TCF lacks the presence of some other shrubby species typical found within this region.

Tarfa is present within the deeper sands of the JER site and the northern edge of the TCF site along the line of the eastern access route for the TCF. It contains a much higher percentage of *Artimisia monosperma* associated with Cyperus conglomerates and more frequent annual cover.

The date palm or Nakhl (*Pheonix dactylifera*) is another woody species also present throughout the study site and is present in 'wild' form as opposed to cultivated. This wild form is only commonly recorded within 30km of the coast and most frequently between Dharhan and Jubail; it therefore has limited geographical extent.

Figure 6-8 Typical Salt Bush (Harm) Community

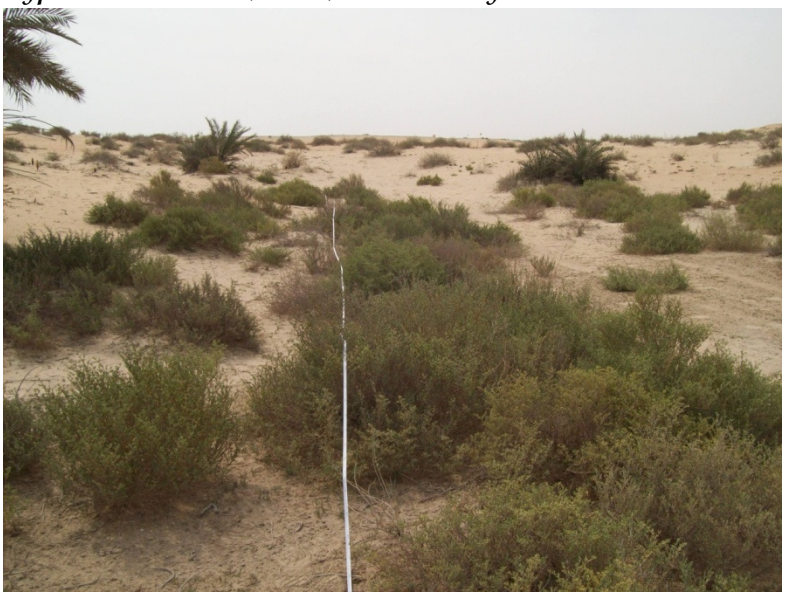


Figure 6-9 Vegetation within Aramco Pipe Line Corridor

Towards the south of the TCF site there are a number of rocky outcrops, an example of which is presented within *Figure 6-10*. These provide a diversity of habitat and whilst having very limited associated vegetation, they provide a focus for bird breeding and use by larger mammals, especially foxes.

These rock areas have in some locations been subjected to mining and areas of piled up waste rock have provided an artificial habitat for foxes and birds.

Figure 6-10 Rocky Outcrop Example

Fauna

The survey showed that the study area, and in particular the TCF site, supports good populations of fauna with reasonable biodiversity. Evidence of the presence of the following species was recorded:

- Small mammals (common), likely to be restricted to jerboa but other species may also be present;
- Foxes, assumed to be the Common Fox (*Vulpes vulpes*) were recorded as being present and likely breeding within the study area;
- The honey badger (ratel) may also be present on the TCF site; and
- A population of reptiles, with evidence of both snakes and lizards, was recorded.

A subsequent survey of foxes suggests that a significant population is present within the rock areas of the TCF site. An evening survey suggests that at least 12 individuals are present, at two locations.

Of significance is the breeding bird population. As well as evidence of breeding of a number of common local bird species, evidence of breeding of the desert eagle owl (*Bubo ascalaphus*) was also found, since this species was recorded as nesting in two locations. Whilst this is an internationally widespread species, its status is unknown in the eastern province of Saudi Arabia and is likely to be declining due to habitat loss and fragmentation. Evidence suggests that it has extended its breeding range in northern areas of the country recently.

Conclusions - Flora, Habitats and Connectivity

The habitats surveyed are, in general, typical of those found within the Jubail area. Notwithstanding this, the study sites represent a significant area of habitat. The deeper sands of the JER site appeared to have good biodiversity within the limited areas that have not been disturbed through site preparation works. These deeper sands provide excellent habitat for smaller mammals and reptiles.

The TCF site and pipeline routes also have good habitat present in some areas, depending on the substrate - in particular, the depth of underlying sands. In the pipe line corridor some areas with impeded drainage had excellent plant coverage.

The JER site is now somewhat isolated with much of the surrounding land having being cleared and a major road to the south of the site. The TCF and pipeline corridors have better ecological connectivity. Open areas of similar habitat to the south and west are accessible by more mobile species.

Certain areas of the project area host habitats that are considered have local to regional value.

Conclusions – Fauna

Each of the sites contains a range of fauna typical of the Jubail area. In particular, the sands contain smaller mammals such as jerboa and mice as well as reptiles. Ground nesting birds such as desert lark are also likely to utilise such habitats.

The focus for the larger species present is the rocky outcrops within the southern area of the TCF site. Both fox and potentially honey badger are present. It is also likely that the desert hedgehog is present within these areas. In addition, the rocky outcrops within the TCF area were observed as providing nesting sites for a range of bird species, most notably the desert eagle owl.

Certain areas of the TCF are considered to have regional importance for fauna.

6.9.4 Freshwater ecology

On the southwest edge of JIC there is an area of approximately 500 hectares (ha) hosting the Sabkhat al-Fasl Lagoons. These are three man-made evaporation lagoons that use treated wastewater supplied from JIC. The site is a key foraging and roosting site for water birds, predominantly shorebirds.

The site is situated in a sabkah (salt-flat area), shaped by landfill with banks to divide up the area. The depth of water is typically between 0 to 30 cm. Waste water is only supplied to the site from October to May, and therefore the lagoons often dry up during the summer months unless there has been some rainfall.

Rainwater increases the volume of water, sometimes dramatically, and the surface can increase up to a maximum recorded of about 2,500 ha. In addition to these lagoons, three large (about 100 ha) concrete reservoirs are included in the site.

The treated water results in the production of a huge biomass of microflora and microfauna, which in turn provides the basis of the food chain for large flocks of feeding birds. The concrete reservoirs and some areas of the lagoon edges are fringed with Phragmites reeds and Tamarix scrub.

The lagoons have been identified as an 'Important Bird Area' by Bird Life International. This site is part of the larger coastal area designated as the Wildlife Sanctuary for the Gulf Region. The area surrounding the lagoons is principally occupied by industrial and commercial properties as well as a golf course.

The area is used by considerable numbers of shorebirds on passage, with some over-wintering and several species remaining to breed. The site supports the only breeding colony of avocet *Recurvirostra avosetta* in Saudi

Arabia, with 45 breeding pairs and up to 420 birds in winter. The Kentish plover *Charadrius alexandrinus* is common throughout the year, with 70 breeding pairs, up to 2,800 birds in winter, and up to 3,500 birds passing through as migrants. Up to 1,800 lesser sand plover *C. mongolus*, over 3,000 broad-billed sandpiper *Limicola falcinellus*, more than 2,500 ruff *Philomachus pugnax* and 650 ruddy turnstone *Arenaria interpres* have been recorded on spring passage; in late autumn, nearly 5,000 little stint *Calidris minuta* have been recorded. Dunlin *C. alpina* pass through on migration in early autumn in huge numbers (over 11,000), but also some stay for the winter, with a maximum of nearly 6,000.

Other shorebirds present in reasonable numbers on passage include sanderling *Calidris alba* (about 650 in spring) and marsh sandpiper *Tringa stagnatilis* (almost 200 in early autumn). The peregrine falcon *Falco peregrinus* occurs regularly, both as a passage migrant (with up to 20 in one season) and winter visitor (6-3 birds). Greater flamingos *Phoenicopterus rubber* have unsuccessfully attempted to breed, but do over-winter in large numbers, with up to 1,200 recorded. More than 5,000 ducks winter in the area, including 800-900 common shelduck *Tadorna tadorna* (the largest wintering concentration of this species in the Kingdom), eurasian wigeon *Anas penelope*, gadwall *A. strepera*, common teal *A. crecca*, mallard *A. platyrhynchos*, pintail *A. acuta* and shoveler *A. clypeata*. Reed warbler Acrocephalus scirpaceus is suspected to breed in the areas of denser vegetation.

Inland a number of artesian springs occur, forming important oases whose relatively fresh water sustains large areas of cultivation, particularly date palm groves. These have been supplemented by numerous wells that draw upon underlying aquifers. These oases and areas of water outflow result in the growth of reeds such as phragmites and mace (*Typha* spp.) and favour other planted vegetation such as *Tamarix aphylla* and *Prosopis juliflora* which in turn creates important habitats for birds and other wildlife, including marsh frogs (*Rana ridibunda*) and Caspian pond turtles (*Clemmys caspica*).

6.9.5 Inter-tidal ecology

In shore areas between the low-tide and high-tide can support a diverse community of animals. In the muddy channels of the seashore, the black mangrove *Avicennia marina* can be found.

The ghost crab *Ocypode samtari*, land hermit crab *Coenobita* sp. rock crab *Eriphia sebana smithii* and Sally-lightfoot crab *Grapsus tenuicrustatus*, as well as sea slugs *Onchidium peronii* and blenny fish *Istiblennius lineatus* can be found in the intertidal areas.

The coastal zone with its intertidal mudflats and offshore islands is important for breeding sea birds and other migrating species. One site at Tarut Bay is considered to be the most important site on the Saudi Arabian Gulf Coast for wintering and migrating waders and other water birds, with a total of about

58,000 water birds in 1991/92, and more than 20,000 present in April-May 1991.

The Gulf coastline in this ecoregion is especially important for the black-necked grebe *Podiceps nigricollis*, great crested grebe *P. cristatus*, socotra cormorant *Phalacrocorax nigrogularis*, broad-billed sandpiper *Limicola falcinellu*s and Saunders' little tern *Sterna saundersi*. The breeding population of *Phalacrocorax nigrogularis* in this area, which is thought to be over 95% of the world population, exceeds 220,000 pairs.

6.9.6 Marine ecology

The Arabian Gulf supports valuable ecological features such as coral reefs and mangroves. The Jubail Wildlife Sanctuary lies to the northeast of the site and includes the ad-Daft and Musallamiya Bay areas. It includes productive salt marshes and seagrass beds and supports invertebrate and fish assemblages, breeding colonies of several species of seabirds and is also an important sea turtle nesting area.

There are six islands in the Arabian Gulf off the coast of Jubail. South to north, they are; Jurayd, Jana, Kurayn, Karan, 'Arabiya and Harqus. Karan is the largest, at 1.3 km^2 and Harqus the smallest at 0.2 km^2.

All the islands are coral-reef islands and birds are the most prominent inhabitants. Nesting seasons on the islands vary somewhat according to weather and food availability, however, depending upon the bird species, they generally run from late winter to late summer. During this period, huge numbers of birds inhabit the islands. The Socotra cormorants *Phalacrocorax nigrogularis* are the first nest-builders to arrive; they usually form only one modest colony of several hundred birds on Kurayn and arrive during the winter to create nests, which are scooped out depressions in the sand surrounded with small pebbles cemented into quasi-permanence by deposits of excreta. Several large, chalky blue eggs are laid in each nest, and incubation and the rearing of the young may continue for many months.

Four species of tern commonly nest on the islands: swift terns *Sterna bergii*, lesser crested terns *Sterna bengalensis*, bridled terns *Sterna anaethetus* and white-cheeked terns *Sterna repressa*. Individuals of this species normally arrive at the islands at slightly different times in spring and early summer and tend to form separate nesting colonies since each species favours slightly different areas of the islands.

The Hawksbill turtle *Eretmochelys imbricata* is an endangered species that gathers around the Gulf islands in late spring to begin mating activities. By mid-May the females begin coming ashore at night to deposit eggs in large pits they dig on the upper beach. Within a month after the first hawksbills appear, green turtles *Chelonia mydas* (also endangered) arrive at the beaches.

Endangered loggerhead turtles *Caretta caretta* occasionally nest on Gulf islands. To a limited extent, sea turtles also nest on the Saudi mainland, but predation and increasing competition for habitat have driven most turtles off mainland beaches. Well in excess of 90 % of the Saudi sea-turtle population nests on offshore islands, and of the six offshore islands, Karan is the favoured nesting ground for these endangered marine reptiles.

6.10 ARCHAEOLOGY

Historically, Jubail was an ancient centre of the Eastern Province and a caravan junction famed for pearling. Prior to the mid 1970's it was a small fishing village. It is our current understanding that the nearest protected historical sites are 65-80 km from this site.

Field investigations have not established the presence of remnants of archaeological importance, which is understandable as the majority of project areas have either been previously graded or significant disturbed.

6.11 SURROUNDING LAND USE

The JER refinery site lies between a sanitary waste landfill to the north east and a hazardous waste landfill immediately to the south. The hazardous waste landfill is currently undergoing an expansion to the north east. To the south are a number of farms. The Jubail prison lies to the south east. *Figure 6-11* presents a land-use map in two parts for the Jubail area. *Figures 6-12 to 6-20* are photographs of the surrounding land uses. In addition, *Table 6-3* provides a summary of the nearest sensitive receptors to the refinery and construction activities. These receptors have been integrated into quantitative impact assessment studies for both air quality and noise.

Figure 6-11 Land Use Surrounding the JER Refinery site

Figure 6-11 Land Use Surrounding the JER Refinery site (cont.)

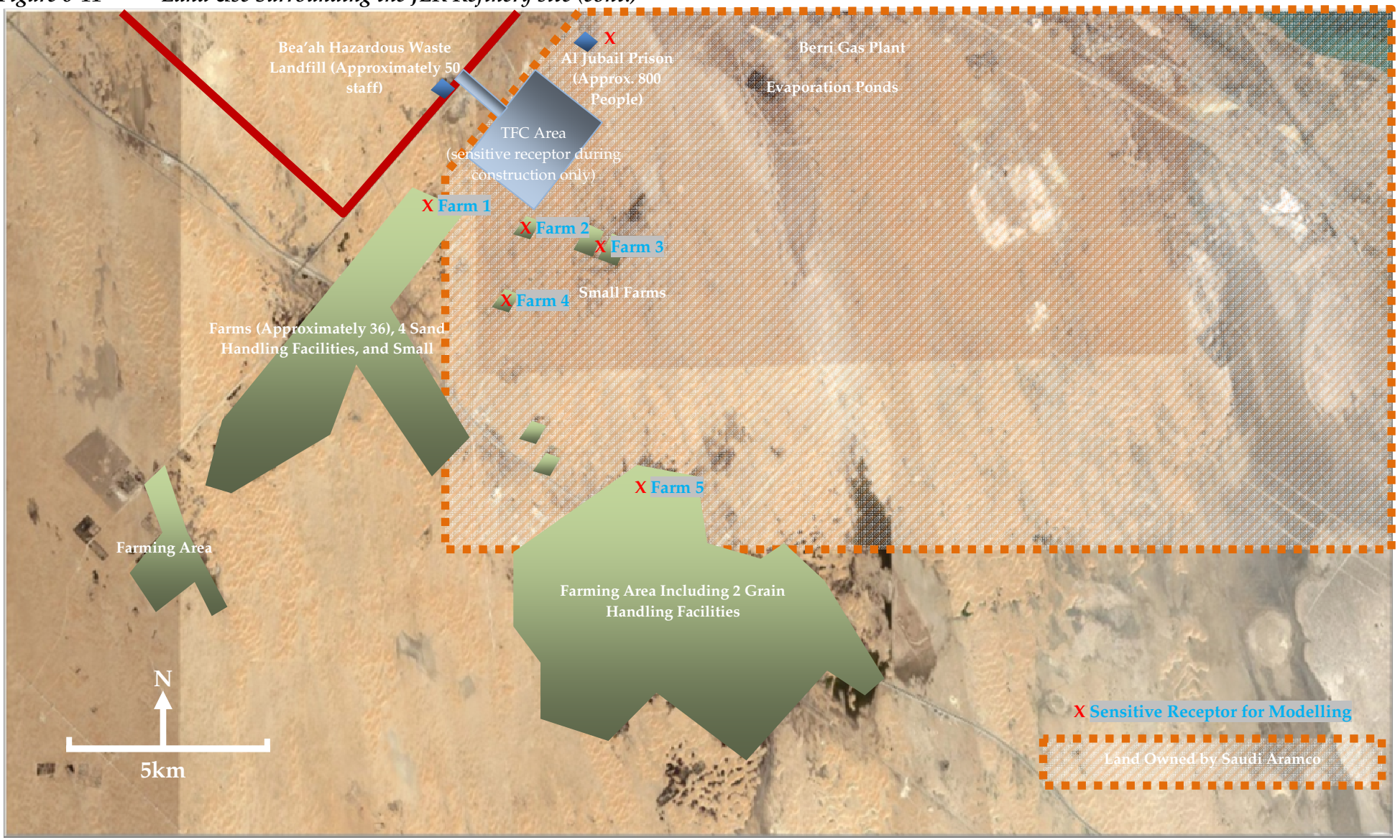


Table 6-3 Summary of Sensitive Receptors Near to the Refinery and TCF Area

Receptor Name	Description	Approximate Location	Distance from the JER Boundary	Distance from TCF Boundary
Farm 1	Cultivation Area	315127e x 2977833n	2.9km	1.3km
Farm 2	Cultivation Area	317397e x 2977013n	4.4km	0.5km
Farm 3	Cultivation Area	319202e x 2976986n	5.6km	1.5km
Farm 4	Large Cultivation Area	316604e x 2975509n	5.4km	2.2km
Farm 5	Large Cultivation Area	320323e x 2970914n	11.1km	7.0km
Prison	800 staff and inmates	318792e x 2981689n	2.1km	1.1km
Jubail Old Town	Residential Area	329102e x 2986967n	13.3km	12.1km
Jubail Housing Community	RC Developed Residential Area	320241e x 2999520n	16.5km	18.6km
Sabhkat al-Fasl	Man-Made Lagoon and Important Bird Nesting Area	314608e x 2993613n	7.6km	11.0km
Bedouin Camps	As most locations outside the JER boundaries could in principle be occupied by Bedouin throughout the project life cycle, such locations are considered 'sensitive receptors' and relevant modelled data compared against project ambient air quality standards.	All locations outside of JER worksite	N/A	N/A

Figure 6-12 The JER Refinery Site (view to the north) - the site has been graded

Figure 6-13 Drums at the Hazardous Waste Landfill (view to the east)

Figure 6-14 The JER / Hazardous Waste Boundary (view to the east)

Figure 6-15 Filled and Covered Pits of Hazardous Waste

Figure 6-16 The Hazardous Waste Expansion Area (view to the northwest)

Figure 6-17 Waste Dumping Area opposite the Hazardous Waste Landfill (view to the south)

Figure 6-18 Drums at the Sanitary Waste Landfill (view to the south)

Figure 6-19 Waste at the Sanitary Waste Landfill (view to the south)

Figure 6-20 The Farm Area (view to the south)

The JER refinery site shows evidence of being affected by human activity as follows:

- Windblown waste entering the site (plastic bags, cardboard and paper);
- Continuous presence of noise from road traffic to the southeast;
- Continuous presence of noise from JIC;
- Night lighting from the road to the southeast; and
- Night lighting from JIC.

6.12 SOCIO-ECONOMIC ENVIRONMENT

6.12.1 Overview

Saudi Arabia is divided into 13 provinces or mintaqat: Al Bahah, Al Hudud ash Shamaliyah, Al Jawf, Al Madinah, Al Qasim, Ar Riyad, Ash Sharqiyah (Eastern Province), 'Asir, Ha'il, Jizan, Makkah, Najran, Tabuk. The JER project is located in the JIC in Ash Sharqiyah province on the eastern coast.

The national language is Arabic and the national religion is Islam, consisting mostly of Sunnis, with a minority Shiite population mainly concentrated in eastern Saudi Arabia and along the coast of the Arabian Gulf. Historically and even into recent times there have been strong regional identities and ethnic diversity, but there are no populations that could be characterized as 'indigenous groups' (i.e. those outside the cultural and economic mainstream of the country).

The Kingdom's total population was approximately 23.5 million in 2002 increasing to an estimated 28.7 million in 2009 (CIA World Fact Book for Saudi Arabia). Saudi Arabian nationals accounted for approximately 80 % of the population; the remaining 20 % of total population are most notably from South Asia.

In spite of the recent surge in its oil income, Saudi Arabia continues to face long-term challenges including high rates of unemployment (estimated at between 9 and 25 % in 2008, (CIA World Fact Book for Saudi Arabia). These trends are partly associated with the high population growth; Saudi Arabia has one of the world's fastest growing populations (approximately 2.4 % per year).

Of the 28.7 million people now living in Saudi Arabia, approximately 5.5 million are non-nationals, and 4.7 million people live in the capital Riyadh. As of 2006, the median age is 21.6 years.

Saudi Arabia has a policy known as 'Saudisation,' the goal of which is to increase employment of its own citizens by replacing 60 % of the foreign workers in the country. To accomplish this, the Saudi Government has stopped issuing work visas for certain jobs and has moved to increase the

training of Saudi nationals. It has also established minimum requirements for the hiring of Saudi nationals by private companies.

6.12.2 Jubail Industrial City

In the mid 1970s, Jubail was designated as a new industrial city. JIC comprises a group of major companies which produce petrochemicals, chemical fertilizers, industrial gases, steel, iron and oil. The JIC was built from 1975 onwards on some 1,016 km^2 of land.

JIC 2 is the new industrial city located approximately three km to the west of the existing city. The RC was established to plan and administer the development of Jubail. JIC 1 has been divided into five zones:

Zone 1: The Industrial Zone has the main factories and ancillary installations. These include steel, aluminium, plastic, and fertilizers under the supervision of the Saudi Basic Industries Corporation (SABIC). This zone covers an area of 8,000 ha, or approximately 80 km^2. In catering to diverse needs, SABIC leases fully developed and fully equipped industrial sites at nominal rents.

Zone 2: The Residential Area is composed of eight localities built on an adjacent island linked to the mainland. The area has the capacity to accommodate 375,000 people in modern housing.

Zone 3: The Airport Area, covering an area of 250 km^2, has the capacity to receive several types of aircraft and handle the transportation of passengers and freight.

Zone 4: The Picnic Zone, situated to the west of the Industrial Zone, covers an area of 204 km. To the residents of the city, it is an invaluable recreation area. It encompasses verdant sites, playgrounds and facilities for water sports. The zone is set among abundant trees and rare plants.

Zone 5: Al-Batwah Island is affiliated with JIC. It is a picnic site with a park and a zoo, and also features plant nurseries, fishing sites, and a marina.

6.12.3 Demographics and Migration Patterns

The official Saudi Arabia census was carried out in 2004 and identified 222,544 inhabitants in the JIC. Currently it is estimated that more than 250,000 people live in the city. This rapid population increase is attributed to ongoing industrial development notably associated with economic migration (both temporary and permanent).

Residential areas will be added to the existing community to accommodate up to 50,000 new residents by 2024 (Arab News, December, 06 2006).

6.12.4 Indigenous populations

As noted earlier, there are no Indigenous Peoples in Saudi Arabia and as such none are impacted by the JER Project.

Most of the native residents of Jubail are of the Al-Buainain tribe, and records trace their origin to 626 CE. Traditionally they practiced fishing and pearl diving and were closely allied with the al-Saud tribe and most other Sunni tribes in the Eastern Region.

With regards the land to be occupied by the JER, Plot 9 and JIC has been under the control of the RC for over 30 years. If the area had been inhabited, social relocations or land right claims would have been managed by the RC earlier.

With regards the TCF area, which is outside of the RC jurisdiction, the land is owned by Saudi Aramco. During the FEED stage of the project, prior to SATORP agreeing to locating the TCF in this site (see the Letter of Understanding which was signed on 18/02/2009, *Appendix A*) for the use of this land, part of the site was illegally occupied by approximately 80 Bedouin. The local municipality notified the Bedouin of the future plans for the area in July 2008, and they relocated thereafter in a cooperative manner. During the process of relocation, although their occupation of this land was illegal, SATORP offered the possibility of employment to the Bedouin; however the offer was declined.

As the occupation of the land was illegal and relocation was coordinated exclusively by the local municipality prior to signing of the Letter of Understanding for use of the land by SATORP, relocation of the Bedouin is not considered to trigger any special provisions with regard to IFC Performance Standard PS5 and hence is not considered further in this ESIA Report.

6.12.5 Economy

Saudi Arabia is an oil-based economy with strong government controls over major economic activities. It has the largest reserves of petroleum in the world (26 % of proven reserves) and the petroleum sector accounts for roughly 75 % of budget revenues, 45 % of Gross Domestic Product (GDP) and 90 % of export earnings. Saudi Arabia's real GDP is estimated to be $286 billion (2003); 45 % of which is derived from the private sector. GDP growth was estimated at 6.1 % in 2004 and GDP per capita (the purchasing power parity) was $11,800 (2003 estimate).

The total value of exports was $56.7 billion (1996) of which petroleum and petroleum products were 90%. The petroleum sector accounts for roughly 75 % of budget revenues, 45 % of GDP, and 90 % of export earnings. Key export partners include US 17.1%, Japan 16.3%, South Korea 9.7%, China 8.1%, Taiwan 4.7%, Singapore 4% (2007) (CIA World Fact Book for Saudi Arabia).

Saudi Arabia's industries other than crude oil production, petroleum, petroleum refining, and basic petrochemicals include cement manufacture, two small steel-rolling mills, construction, fertilizer and plastics. It also produces a number of agricultural products.

6.12.6 Agriculture and fisheries

Small-scale natural wetlands have had a pivotal role in the subsistence economics of many inland areas; such oasis areas have a long history of date palm cultivation. Agriculture products now include wheat, barley, tomatoes, melons, dates, citrus fruits, mutton, chickens, eggs and milk. Saudi Arabia is one of the world's wheat growing nations. The majority of irrigation water comes from boreholes and the impact of overuse on wetlands in the aquifer source areas has yet to be assessed.

Both inshore and coastal waters and those surrounding offshore islands support major fisheries. Until recently, most fishing was done on a subsistence basis by local communities, which is relatively sustainable. More recently, two commercial fisheries have appeared: the state-owned Saudi Fisheries Company (industrial fishing, often with large trawlers) and Investor Fisheries. In some coastal lagoons, fish (usually prawn) farms are beginning to develop.

6.12.7 Accommodation

The existing JIC has approximately 17,000 residential units (Arab News, December 06, 2006).

The RC has been constructing housing facilities in the Jalmudah residential complex for future workers of Jubail 2. This will have additional facilities including health, education, recreational and security.

6.12.8 Utilities

Utilities such as electric power, potable water, seawater for cooling, sanitary and industrial wastes in the JIC fall under the responsibility of Marafiq.

Electricity is provided by the Saudi Electricity Company (SEC), desalinated water is partially provided by the Sea Water Conversion Corporation (SWCC) and the RC desalination plants provide supplementary quantities, natural gas is provided by Saudi Aramco and telecommunication services are provided predominantly by the Saudi Telecommunications Co. (STC). The STC operates fixed lines and mobile lines. Another company, Mobily, also provides a mobile telephone network.

6.12.9 Transportation

JIC has access to various modes of transportation including roads, seaports, airports and railroads.

Roads

JIC has a modern road and street network. It includes divided motorways to local port facilities, and main roads to the port facilities in Dammam and to the national highway network.

The Causeway is a road and bridge system which connects Saudi Arabia with Bahrain. It is 25 m wide and extends for 26 km.

Seaports

The largest commercial port in the vicinity is King Abdul Aziz Port in Dammam, 95 km to the south. It ranks second to Jeddah in size and traffic. In 2005 it discharged 12.5 million tons of cargo including almost 5 million tons of construction materials. It loaded 4.1 million tons of cargo including almost 3 million tons of petrochemicals. It, along with the two other ports addressed below, is operated by the Saudi Ports Authority.

Jubail itself has two ports. KFIP is designed to handle export and import of solid and liquid cargos and bulk goods. It has 23 quays and a maritime station for tankers. The port handled 33 million tonnes of cargo in 2000/2001. Jubail Commercial Port is located 3 km south of the industrial port. It is equipped to handle general cargo and handled 2 million tons in 2004.

Airports

The major three international airports are: Riyadh's King Khalid International airport, Jeddah's King Abdulaziz International airport and Dammam's King Fahd international airport.

Jubail has a private airport just to the northwest of the industrial area. The King Fahd International Airport at Dammam is the most modern of the three Saudi international airports. It is located 80 km south of Jubail. Additional small facilities nearby include Ras Tanura within 38 km and Ras Tasnajib, 60 km that are mainly used by Saudi Aramco.

Railroads

The current railway system in Saudi Arabia is mainly limited to a single track from Damman to Riyadh.

A large rail expansion program is underway to create 2,700 km of new lines, including a rail Land Bridge connecting the Gulf to the Red Sea port at Jeddah. Part of that expansion program includes a 90 km line from Dammam to Jubail.

It is unlikely that this proposed programme will have any bearings on the JER Project.

The East-West Pipeline

The East-West Pipeline is a double pipeline and runs from east to west across the Kingdom and transports oil and gas from Jubail to Yanbu. It is 1,170 km long and was completed in 1982. It supplies energy for the industrial projects in Yanbu and facilitates the export of oil and gas products from the Red Sea coast.

6.12.10 Human Rights and Labour Issues

The Saudi Arabian Constitution guarantees a number of human rights. For example, Article 27 reads: "*The State guarantees the rights of each citizen and his family in cases of emergency, illness, disability and old age*." Article 28 imposes on the State the duty of providing a "*job opportunities for whoever is capable of working*". Article 30 obliges the State "*to provide education and fight illiteracy*". Article 31 provides for universal healthcare in the Kingdom. Article 35 guarantees that "*no one shall be arrested, imprisoned or have their actions restricted except in cases specified by the law*". Article 37 proclaims the sanctity of the home. Article 40 declares; "*The state protects human rights in accordance with the Shari'ah*".

These obligations on the State, underpinned by the teachings and the beliefs of Islam, provide the basis for the protection of human rights in the Kingdom of Saudi Arabia.

Administered by the Ministry of Labour, labour law in Saudi Arabia is based on the International Labour Organization's model. Saudi Labour Law governs most aspects of employer/ employee relations, such as hours of work, leave, termination rights, medical benefits and repatriation.

The Labour Law is protective of employees in general and overrides conflicting contractual provisions agreed under another jurisdiction, unless they are beneficial to the employee. The Ministry of Labour issues a model form of labour contract in Arabic which is widely used, but other forms of contract are enforceable, provided they comply with the Labour Law.

End-of-contract gratuities are equivalent to 15 days' salary per year for the first five years of service and 30 days for every year thereafter.

6.12.11 Education in JIC

There are two colleges, one technical institute and 68 schools and kindergartens in the JIC area (Arab News, December 06, 2006).

The Institute of RC for the Development of Human Research trains its students in a number of skills required for employment in its industries. The

Institute enrols 650 students annually in its lecture halls, training classrooms and laboratories, and provides residential quarters for students and professors alike. There are also kindergartens, general schools and language schools where Arabic is taught to non-native speakers at a pre-secondary level. To cope with the special nature of the industrial cities, the RC prepares a tailored syllabus for its students, which reinforces the syllabus issued by the Ministry of Education.

6.12.12 Health care in JIC

There are 3 hospitals, 4 polyclinics and 3 primary care centres in the JIC with a total bed capacity of 496.

The RC has established hospitals, primary care clinics (10), centres for environmental health, vocational health, and health awareness, and training schools for first-aid and epidemic control. Juwailan Hospital in Jubail, with its 200 beds, is capable of dealing with all aspects of health care. Fully computerised, it contains specialist dietary and alternative medicine clinics in addition to quarantine wards. The medical needs of the community can therefore be said to be adequately met through the medical services available.

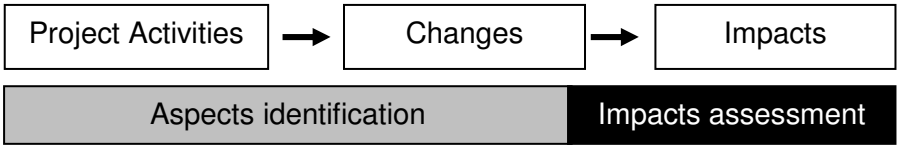
7 ENVIRONMENTAL AND SOCIAL ASPECTS

7.1 IDENTIFICATION OF ENVIRONMENTAL ASPECTS

The International Organisation of Standardisation (ISO) 14001: 2004 'Environmental Management Systems' standard defines environmental aspects as those elements of the project that interact with the environment. These interactions and their effects may be continuous in nature, periodic, or associated only with events, such as emergencies. The aspects include interactions of the project with the biophysical, social and economic environment.

The identification of environmental aspects is an important process step towards determining the impacts of the project. In a change-effect relationship between project activities and the receiving environment, the aspects determine the changes and the impacts identify the likely effects.

Figure 7-1 Causal Chain of Activities and Impacts



Project activities have been identified through the review of project design documentation and consultation with the project proponents and their FEED contractor (SATORP and TPIT respectively). Following the identification of all project activities (consistent with the current level of project design), environmental and socio-economic receptors have been established. The key input for the identification of receptors includes the Environmental and Social Policy and Regulatory Framework outlined in *Chapter 3* and the Environmental and Social Baseline presented in *Chapter 6*. *Table 7-1* lists the identified environmental and socio-economic receptors with a brief explanatory comment for each.

Table 7-1 Identified Environmental and Socio-economic Receptors

RECEPTOR	COMMENT
Physical Environment	
Atmosphere	The air quality at and surrounding the refinery site, pipeline routes and port area.
Soil	The soils of areas in which construction and operational activities will take place. This includes temporary facilities, such as the TCF.

RECEPTOR	COMMENT
Hydrogeology	The hydrogeology (i.e., groundwater) in the area in and around where construction and operational activities are to occur.
Landscape / Topography	The geomorphological landforms and terrain on the JER site and areas cleared for the TCF.
Biological Environment	
Vegetation	Plant species and the habitat that they form in areas where the construction and operational activities will occur.
Birds	Birdlife that relies on the area as a habitat and food source.
Other local wildlife	Local wildlife inhabiting the areas around the refinery and construction areas.
Socio-economic Environment	
Population in the vicinity of the Project	The population inhabiting the areas near to the refinery and construction facilities. This includes the TCF.
Land use	Existing land uses (e.g. residential, commercial establishments, herding / grazing, farming) of the areas surrounding the refinery and on which the construction and operational activities are to occur.
Utilities and infrastructure	The utilities (e.g. power supply, water, sewage services) and social infrastructure (e.g. schools, hospitals provided by Government for use by the local community) in areas where the construction activities are proposed to occur.
Noise	Disturbance and nuisance to nearby sensitive receptors.
Transport	The road, waterways and air transport systems (i.e. physical network and vehicles that use them) that may be impacted by construction or operations.
Other	
Liability / Reputation	The legal liability and the reputation of SATORP, Saudi Aramco and TOTAL and those contractors responsible for construction and commissioning activities.

7.2 *DETERMINATION OF ENVIRONMENTAL AND SOCIO-ECONOMIC ASPECTS*

Identified project activities and environmental and socio-economic receptors have been integrated into a matrix *(Table 7-3)* that cross-references the project activities that are likely to impact on the environment and society.

The project activities are listed on the vertical axis and include site clearing, levelling, building construction, water and energy supply, material storage, emissions releases, noise, waste treatment and disposal, and transportation.

The environmental and social conditions are listed on the horizontal axis and are divided into four major groups:

- Physical conditions: atmosphere, soil, noise, hydrogeology, topography.
- Biological conditions: vegetation, birdlife, marine / coastal ecology.
- Social and cultural conditions: demography, land use, utilities and infrastructure, transport.
- Others: liability on, and perceptions of SATORP and its principal stakeholders (Saudi Aramco and TOTAL).

A comprehensive list of project activities (consistent with the current level of project design) and their environmental and socio-economic receptors is presented in *Table 7-2.* The environmental and social aspects have been considered and presented in *Table 7-3*.

Table 7-2 List of Activities / Aspects and Associated Interactions with Environmental and Socio-economic Receptors

Project Activity / Environmental & Socio-Economic Aspect	Environmental Receptor/Potential Impact
Site Preparation and Construction	
General: The site preparation and construction activities will entail the construction of the refinery, pipeline corridors, and buffer storage and export facilities at the KFIP.	• Increased employment for predominately expatriate workers • Increased level of activities for local ancillary businesses and service providers • Complements the future industrial growth of the Jubail area and promotes economic development • Increased demand for social support infrastructure such as health care facilities • Inappropriate conduct of JER construction staff and disturbance / interference with the local socio-economic environment
Haulage: This entails the transportation of construction materials and equipment by road from the supply base to the construction area. It also includes the transportation of personnel from the TCF to the construction site (approximately 1.3km).	• Dust emissions from vehicle movement particularly for haulage over unpaved access roads • Potential spill of load, waste, or fuel • Noise and vibrations from movement of vehicles and heavy equipment • Generation of hazardous wastes (lead acid batteries, tyres, waste oil, filters, etc) • Increase load of heavy good vehicles on the local road network and disturbance to residents of the Jubail
Preliminary site survey: This involves geotechnical and topographical evaluations of the site in order to establish ground conditions for construction and to determine the need for cut / fill of the worksite. In addition, pipeline routes will be marked out, and where applicable existing buried services will be excavated by hand.	• Dust emissions from vehicle movement • Noise from vehicle movements
Civils and earthworks: This activity consists of general area preparation to create a level surface on which to safely operate vehicles and construction equipment. Grading involves the removal of topsoil and of surplus subsoil / sand, grading the surface with bulldozers or graders and placement of hardcore (crushed rock or angular gravel). Displaced materials will be used for earth filling in other areas of the site. This construction activity also includes civil engineering works.	• Disturbance to local wildlife due to noise • Dust generation from disturbing topsoil and grading activities • Removal of vegetation or disturbance to local floral community • Short-term visual impact of the construction site • Localised noise emission from heavy equipment used in earth-moving • Permanent landscape modification • Risk of fuel spill and impact to underlying groundwater

Project Activity / Environmental & Socio-Economic Aspect	Environmental Receptor/Potential Impact
Establishment and operation of the TCF: This includes a worker camp, temporary office facilities and laydown areas used during the construction programme.	• Inappropriate treatment or disposal of treated sanitary waste water • Generation of solid waste that include municipal and recyclable waste • Operation of power generators may pose risk of oil and fuel contamination, and will result in noise and emissions to atmosphere
JER Erection: This includes the construction of vertical structures and buildings. The activity encompasses the civil works, cabling, steelworks, welding, ducting, and finishing works.	• Generation of inert and recyclable waste from construction scraps and trimmings • Localised noise emission from the use of mechanical tools and equipment
Pipeline Installation / Trenching and backfilling: This activity includes the excavation of product distribution pipelines associated with the refinery with the use of mechanical excavators. The trenches will be backfilled with aggregates.	• Dust emission from excavation and earth moving • Localised noise emission • Potential fuel spill from excavating machines and equipment • Generation of solid waste • Potential damage or loss of existing utility lines
Commissioning	
Commissioning: This includes the testing of facilities prior to start-up or normal operations. Light servicing of equipment will take place as adjustments and fine-tuning is considered necessary.	• Generation of recyclable waste from packaging materials such as plastics, fibreboard, metals and wood • Risk of oil and fuel spill from commissioning of equipment • Operations of the refinery may be 'upset' during commissioning phase leading to increased emissions to atmosphere (e.g. from flaring)
Operations	
General: This involves the normal operations of the refinery.	• Employment generation for national and expatriate workers • Increased activities for local businesses and service providers • Increased demand for local social services such as healthcare and education
Refinery Operations: This activity includes process of refining Arabian Heavy Crude oil at a rate of 400,000BPSD. .	• Deterioration of local ambient air quality from the operation of heaters, boilers, SRU tail gas incinerators and flaring • Contribution to secondary pollutant formation (e.g. ozone) from VOC and NOx emissions • Noise generation from refinery units • Generation of waste water, storm water, and sanitary waste water • Generation of hazardous and non hazardous waste

Project Activity / Environmental & Socio-Economic Aspect	Environmental Receptor/Potential Impact
Materials storage: This includes the storage of service parts, materials, and chemical consumables such as paint, lubricant and coolant.	• Risk of contamination of soil and groundwater from accidental spill of materials and chemicals including improper storage and disposal
Operation of the Export Terminal: This involves operation of the port facilities, including buffer storage of refinery products and their export to vessels.	• Contamination of the site and the Arabian Gulf through accidental release of product • Discharge or wash water, bilge water or sanitary wastes from vessels docking at the KFIP and contamination of the coastal environment • Contamination of site of wash water due to improper drainage
Facility Maintenance: The activities include the maintenance of the process units, tanks, pavements, drainage etc. This also includes pigging of crude import pipelines.	• Contamination of site from the accidental spills and releases of fuel, oil, and chemicals due to improper storage, hauling, disposal or breakdown of containment structures • Localised noise emission from maintenance and service activities • Generation of waste from maintenance activities such as filters, service parts, consumables and spent oil • Accidental release of liquid and solid waste from improper storage, handling and transport
Decommissioning	
Site Clearance: Includes the clearing and removal of temporary and permanent structures associated with the refinery. The demolition and clearing will also include the removal of all utilities, storage and containments, fencing, and pavements. It will entail the use of specialist equipment for this purpose. Pipelines would most probably be cleaned and left in-situ.	• Generation of waste (mostly inert waste, aggregates, and recyclables) • Emission of dust from demolition and site clearing activities • Localised emission of noise from heavy equipment use • Potential contamination from accidental oil and fuel spills
Site clean-up: Includes the clean-up of the site to its original state with the removal of possible contamination and waste if applicable. If necessary, the site will be revegetated with indigenous plant species common in the area.	• Localised dust and noise emission from use of heavy equipment • Generation of waste collected from site

Table 7-3 Environmental and Socio-Economic Aspect Matrix

Note: The project activities that are likely to impact on the environment and society are identified as blue dots in the appropriate cells

Receptor / Activity		Physical				Biological					Other			
		Atmosphere	Noise	Soil	Hydrogeology	Flora (habitats)	Birds	Reptiles / Mammals	Marine / Coastal	Population	Land Use	Utilities	Transport	Liability / Reputation
Construction	Haulage / Road Transport / Use of Port	x	x							x			x	
	Preliminary site survey											x	x	
	Site Preparation & Civils	x	x	x	x	x	x	x			x	x	x	
	Establishment and operation of the TCF	x	x			x	x	x				x	x	x
	JER Erection	x	x											
	Pipeline Installation Trenching / Backfilling	x	x	x								x	x	
Commissioning	Facility Commissioning	x	x		x									
Operations	Normal JER operations	x	x	x	x					x	x	x		x
	Flaring / upset	x	x							x				x
	Port Facilities	x							x				x	x
	Waste Management	x		x	x								x	x
Decommissioning	General Decommissioning	x	x	x	x							x	x	x

8 ENVIRONMENTAL IMPACT ASSESSMENT

8.1 INTRODUCTION

This chapter of the ESIA Report discusses the potential occurrence and significance of environmental and social impacts arising from the construction and operation of the JER project. This chapter also outlines, where appropriate, the strategies and measures for their control and mitigation.

The approach to the environmental and social impact assessment follows the methodology presented in *Chapter 2*, and considers those significant project / environment interactions (or 'aspects') noted in *Chapter 7*. In summary, the Chapter is considered to assess:

- Construction Impacts;
- Operations Impacts; and
- Unplanned Events (upset conditions).

8.2 CONSTRUCTION IMPACTS

Key issues associated with the construction phase are expected to include:

- Air Quality;
- Noise;
- Soils and groundwater;
- Waste;
- Ecology;
- Marine environment;
- Socio-economics; and
- Transportation.

8.2.1 Air Quality Impacts during Construction

Impacts

Potential impacts to air quality during the construction phase include:

- Dust generation during land preparation and construction; and
- Exhaust emissions from construction equipment and off / on-road vehicles.

Dust Emissions during Construction

Dust generated during construction will result from site clearance and earthworks, levelling, and foundation works. The major dust source will be the movement of soil during levelling and foundation works.

Where working in uncontaminated soils, dust normally represents only a nuisance (rather than a health or environmental hazard) to those exposed.

Airborne soil dust is typically coarse and therefore remains airborne only for short periods. US EPA research shows that in excess of 90% of total airborne dust returns to the earth's surface within 100 m of the emission source and over 98% within 250 m. However, under strong wind conditions, these effects could extend further.

Sensitive receptors are identified in *Chapter 6 Environmental and Social Baseline*.

- The nearest sensitive receptors to the JER PLOT 9 site (where the vast majority of the sustained construction effort, and hence dust generation, will take place) are (i) the worker camp within the TCF (at a distance of 1,300 m) and (ii) the prison (at a distance of 2,100 m).
- The nearest sensitive receptors to the TCF site (where significantly less construction earthworks and hence dust generation will occur) are (i) the Farm 2 cultivation area (500m distant) and (ii) the prison (1,100m distant).

While under windy conditions it is conceivable that wind-blown dust will be carried further than 250m, it is unlikely that it will be carried in significant quantities to the nearest sensitive receptors identified above (and in any event such dust is unlikely to be distinguishable from other dust that is not of JER origin). Nevertheless, dust suppression will be undertaken at both the JER and TCF sites during earth works activities to minimise the potential for nuisance.

The TCF itself is unlikely to be a significant source of soil dust following completion of installation of site facilities on the TCF site, as major roads within the facility will be asphalted. However, concrete batching will be undertaken at the TCF site throughout the period of JER civil works, although no cement stockpiling is envisaged on the TCF site.

Dust generated from vehicle movements on unpaved roads, soil excavation, earth works and concrete batching has been included in the construction phase dispersion modelling assessment (discussed below).

Vehicle and Construction Equipment Emissions

Operation of construction equipment and vehicles will result in the emissions of CO_2, CO, SO_2, NO_x and PM_{10}. However, emissions will arise over a relatively large geographical area (mainly at JER PLOT 9) over the entire construction period, therefore any deterioration in air quality is expected to be minor and transient. Nevertheless, these emissions have been included in the construction phase dispersion modelling assessment (discussed below).

Emissions from Power Generating Equipment during Construction

The peak electrical power demand during the construction phase will be approximately 40MW. Forty individual one-MW output diesel-fuelled power generators may be utilised to meet this demand. Generators are expected to be located as follows:

- 20 generators within the JER worksite;
- 15 generators within the TCF accommodation area; and
- 5 generators within other areas of the TCF.

Although the generators represent relatively small (1 MW output) combustion equipment, SATORP will endeavour to source units that comply with the IFC EHS General Guideline emission limits for small combustion equipment (3MW – 50MW thermal input).

Construction Phase Dispersion Modelling Assessment

A dispersion modelling assessment has been undertaken in order to predict the potential impacts to air quality associated with the construction of the proposed JER development (*Appendix D – Annex I*). This assessment has

included, at the request of the Financing Parties, significant equipment such as diesel fired generators and concrete batching operations as point sources.

Construction phase emissions are expected to arise predominately from the operation of non-road vehicles (such as graders and backhoes) and stationary equipment (such as generators and cranes). *Table 8-1* provides a summary of dispersion modelling data.

Table 8-1 Dispersion Modelling Data for the Peak Construction Phase (ug/m³)

Pollutant	Averaging Period	Offsite Modelled Value[1]	Background Value	Cumulative Value	RC Standard
NO_2	1-hour	570	44	614	660
	Annual	57	22	79	100
PM_{10}	24-hour	18	ND[2]	18	150
	Annual	2	ND[2]	2	50
SO_2	1-hour	41	32	73	730
	24-hour	10	16	26	365
	Annual	2	4	6	80
CO	1-hour	134	2,159	2,293	40,000
	8-hour	47	1,945	1,992	10,000

[1] Values anticipated outside of worksite areas (JER PLOT 9 and TCF) at periods of peak construction activity. Values will be lower for the majority of the construction period. Modelled and background values are provided as percentiles where the RC standard permits a number of exceedances per year

[2] Not detected or unreliable data

All modelled maximum concentrations comply with RC ambient air quality guidelines and are predicted to occur downwind of the TCF accommodation area. Long term modelled data indicates that the impact associated with construction emissions on ambient air quality is, in general, anticipated to be marginal at nearby receptors during the construction programme.

The project is also broadly expected to comply with RC standards when considered in a cumulative context with existing air quality. It should be recognised that this assessment is based on peak construction activity; impacts for the majority of the construction programme are anticipated to be less than those presented in *Table 8-1*.

Mitigation and Management

To minimise impacts from dust, the following measures will be applied, particularly where visual observation confirms the possibility of causing nuisance to a nearby facility or receptor:

- Regular inspection and wet suppression of stockpiles where necessary (including wind shielding or complete enclosure, storage away from site boundaries and restricted height of stockpiles);
- Face masks will be provided for construction staff where necessary;

- Provision of wheel cleaning facilities at exit points from site to public roads;
- Covering vehicles carrying dry spoil and other wastes;
- Restricting vehicle speeds on haulage routes and other unsurfaced areas of the work site;
- Watering of unpaved roads daily; and
- Where possible, use will be made of uncontaminated 'grey water' from the TCF WWTP for dust suppression.

Although no specific mitigation measures are proposed for vehicle emissions, all vehicles and equipment will undergo regular maintenance, equipment will be operated to manufacturers' guidelines, and where appropriate, idling of engines will be avoided. Where black smoke is observed, the equipment or vehicle will be safely shut down and maintenance measures undertaken.

Impact Significance

Aspects	Impact	Duration	Mitigation	Severity	Probability	Significance
Emissions to air [a]	Deterioration of air quality from stationary and mobile combustion sources	Short-term associated with the construction activities only.	Cited in preceding sub-section	(1) Negligible	(3) Likely	**Low**
Emissions to air	Deterioration of air quality due to dust	Short-term associated with the construction activities only	Cited in preceding sub-section	(1) Negligible	(2) Unlikely [(b)]	**Low**

[a] Associated with peak construction activity. Construction activities at other times (the majority of the construction phase) are expected to have a negligible severity, yielding an impact of low significance.
[b] Probability is unlikely since sensitive receptors are largely considered to be located beyond the range of windblown dust from JER construction sites.

The environmental impact of dust and of emissions from vehicles, machinery and generators generated during the construction phase of the project are considered to be low, assuming that the identified good practice measures are rigorously applied by SATORP and that the generators meet the emissions performance set out in the IFC EHS General guidelines for small combustion plant.

8.2.2 Noise Impacts during Construction

Impacts

Construction of any development will inevitably lead to the generation of noise. However, construction noise cannot be assessed in the same way as operational noise due to the short-term duration of the noisy activities and the impulsive noise characteristics. The public's perception of construction noise may also be different to that of operational noise, with many people willing to accept higher noise levels if they know it is for only a short duration.

None of the standards or guidelines discussed in *Chapter 3* (RCER 2004, PME's GER 2001, IFC EHS General or Refinery guidelines or the WHO guidelines) provide specific limits or guideline values for construction noise. United Kingdom (UK) standards indicate construction noise levels should not exceed 70dBA at sensitive receptors in rural locations and 75dBA in urban locations (Department of Environment Circular Advisory Leaflet 72, '*Noise Control of Building Sites*').

In order to establish the potential for nuisance to the nearest sensitive receptors (described in *Chapter 6 Environmental and Social Baseline*), a screening assessment of construction activities has been undertaken based upon guidance presented within the British Standard BS 5228: 1997 "*Noise and Vibration Control on Construction and Open Sites*".

BS 5228 provides guidance concerning methods of predicting and measuring noise and assessing its impact on those exposed to it. The standard also provides recommendations for basic methods of noise and vibration control relating to construction and open sites where work activities/operations generate significant noise and/or vibration levels.

The screening assessment (provided in *Appendix D – Annex II*) has demonstrated that predicted noise levels at nearby sensitive receptors are well below the 70dB UK based recommend construction noise limit in rural sensitive receptor locations (*Table 8-2*).

Table 8-2 Summary of Construction Noise Assessment at Peak Activity

Receptor Name	Description	Boundary Distance from JER Worksite	Boundary Distance from TCF Worksite	Peak Receptor Noise Level (dBA)
Farm 1	Cultivation Area	2.9km	1.3km	52
Farm 2	Cultivation Area	4.4km	0.5km	51
Farm 3	Cultivation Area	5.6km	1.5km	52
Farm 4	Large Cultivation Area	5.4km	2.2km	49
Farm 5	Large Cultivation Area	11.1km	7.0km	42
Prison[1]	800 staff and inmates	2.1km	1.1km	43

[1]: Includes 15dBA attenuation by prison walls and structures

It should be recognised that the approach that has been adopted to noise screening is conservative since it is based on peak construction activity and the typical noise levels outside of the worksites (for example, at times other than peak construction) will be less than that present in *Table 8-2*.

As noted earlier, it is anticipated that as many as 15 × 1MW (output) diesel fired generators will provide power to, and be located within, the accommodation area within the TCF site during peak construction. These generator units are likely to dominate the noise climate at the TCF worker accommodation area and therefore an additional assessment of noise nuisance

to workers has been conducted. Findings of this assessment indicated that the interior noise level within worker accommodation associated with generator operation will be within the 30dB range cited by BS 8223 as being necessary for 'good' resting conditions.

Appendix D, Annex II provides the calculations applied for this screening assessment.

Mitigation and Management

Whilst mitigation measures (such as the use of sound absorbing barriers) are not considered necessary during JER construction, a number of measures are proposed as 'best practice' for minimising construction noise:

- Machinery and equipment should always be used in accordance with the manufacturers' instructions;
- Power generators will be housed in a noise reducing shelter at the TCF accommodation area to promote good sleeping conditions for workers;
- Plant and equipment used on an intermittent basis should be shut down between work periods or throttled down to a minimum. No plant should be left running unnecessarily; and
- Acoustic covers to the engines (where applicable) should be kept closed when the engines are in use.

In addition, regular and effective maintenance by trained personnel for plant will also reduce noise from machinery.

Impact Significance

Aspect	Impact	Duration	Mitigation	Severity	Probability	Significance
Noise generation	Nuisance to sensitive receptors and exceedance of standards	Short-term associated with the construction activities only	Measures cited in the preceding sub-section	(2) Marginal	(3) Likely	**Moderate** [1]

[1] In recognition that noise from construction may on occasion be audible at nearby receptors, although outside of peak construction the impacts are expected to be less than that forecast.

The impact from noise that is expected to occur during construction is considered moderate given the mitigation measures proposed. Further, the impact is expected to be localised and temporary. It is likely that the severity of impacts will be negligible, and hence the impact significance will be low for periods of construction outside of peak activity.

8.2.3 Soils and Groundwater Impacts during Construction

This section of the assessment addresses potential impacts to soil and groundwater associated with construction of the JER facility. As such, it does not address the potential for impacts to soil and groundwater at or in the vicinity of the proposed JER site that arises from operations and activities at

neighbouring sites and facilities. The potential for impacts from such sources is addressed in *Chapter 6 Environmental and Social Baseline*.

As discussed in *Chapter 6*, SATORP intends to commission a soil and groundwater survey of both JER PLOT 9 and the TCF site prior to commencement of construction work. This survey will cover selected parameters defined in RCER 2004 Table 3C.

Impacts

Due to limited rainfall in the region, the potential for soil erosion at the worksites (JER PLOT 9, the TCF and along the pipelines corridor) will, during construction, largely be confined to episodic intense rainfall events resulting in surface water run-off. The potential for impact from wind erosion during construction will be of concern in terms of the generation of dust (see *Section 8.2.1* above).

Groundwater exists at an estimated depth of between four and five metres below ground level, inferring a high risk of contamination where fuel or lubricant spillage occurs. Water requirements during the construction phase will be met through road tanker supply, and no groundwater water abstraction is planned at either of the two sites.

Potential impacts to soils and groundwater during the construction phase can therefore be summarised as follows:

- Spillage of fuel or lubricant leading to contamination of soil or groundwater;
- Inappropriate storage of hazardous wastes such as waste oils at the two sites (discussed above); and
- Inappropriate disposal of hydrotest water (see below).

Mitigation and Management

In general, the topsoil at the site is considered to be of poor quality and therefore its unplanned loss is considered to be of low significance.

Site contamination will be prevented through the use of appropriately designed storage tanks and adoption of strict fuelling and spill control procedures, as well as appropriate spill response measures. All fuel storage areas will be bunded to 110% of the total tank volume.

As part of construction activities the JER and associated facilities at PLOT 9 will be hydrotested. The potential disposal routes of the hydrotest water are discussed in *Chapter 4 Project Description*. It is likely that hydrotest water will either be disposed of in a lined evaporation pond or in the RC's central WWTP (in such a case prior permission will need to be granted by the RC in response to a formal application by SATORP). Hydrotest water will not be discharged to either local wadis or to the Arabian Gulf.

Impact Significance

Aspect	Impact	Duration	Mitigation	Severity	Probability	Significance
Accidental releases and spills	Contamination of soil and groundwater	Temporary, only for the duration of the construction phase	Measures cited in sub-section above	(3) Critical	(2) Unlikely	**Medium**

The impacts of a large spill or extended leak of fuel or other hazardous material (in the unlikely event that such an accident were to occur) during construction could be of medium significance. SATORP will work with its EPC contractors to ensure appropriate spill prevention measures are in place, and that appropriate response capabilities (equipment and procedures) are in place throughout the construction programme.

The disposal of hydrotest water will be subject to permitting by the RC, should the disposal route be to their WWTP. Hydrotest water will not be discharged to either local wadis or to the Arabian Gulf, therefore the discharge of hydrotest water is regarded as an insignificant impact.

8.2.4 Waste Impacts during Construction

Impacts

Estimated construction waste types and volumes are detailed in *Chapter 4 Project Description,* and include waste oil from the servicing of vehicles, tyres, packaging waste, spent welding rods, used drums, wood, scrap metal and building rubble. Domestic waste will be generated mainly at the TCF construction camp established throughout the construction phase for a peak of 30,000 workers.

The potential impacts arising from such wastes include those associated with inappropriate storage on site (resulting in a release to soil and groundwater), air and noise impacts associated with transportation of waste from the site by the waste management contractor, inappropriate practices or insufficient capacity of the waste management contractors and possible impacts associated with the selected third party disposal route. Some of these potential impacts could in principle have a 'transboundary' connotation where wastes are transported outside of Saudi Arabia for disposal (due to insufficient local capacity in KSA), although this is not anticipated for wastes generated from the JER construction programme.

Mitigation and Management

The overall approach to waste management during construction and operations will be to apply the principles of the 'waste hierarchy'. These principles are underpinned by the so-called '3Rs' of reduce, reuse and recycle, which classify waste management strategies according to their desirability.

The overall aim of this waste hierarchy is to extract the maximum practical benefits from raw materials, to generate the minimum amount of waste and to seek a beneficial end-use of waste materials wherever practicable.

The priority for the project will be the prevention / minimisation of wastes at all times. Secondary to this, the JER construction team will temporarily store, handle, label, and segregate wastes types to facilitate reuse of waste within the project and, where this is not feasible, to seek a solution whereby the waste is reused / recycled by Third Parties. SATORP will also keep abreast of existing and emerging opportunities for re-use or recycling of wastes within Jubail and the wider KSA. The overall prerogative will be to seek to reduce waste disposal to landfills, so long as the selected reuse / recycling approach conforms at all times to the legal requirements applied within and outside of JIC.

Hazardous, non-hazardous and domestic waste that cannot be reused or recycled will be transported offsite by appropriately licensed contractors to an RC-approved landfill for disposal. Septic waste from portable toilets installed on site will be collected and disposed off-site by an RC-approved contractor.

Procedures to segregate, store, handle, transport and dispose of all waste streams will be addressed through the implementation of the project-specific outline Waste Management Plan (WMP), a component of the project's Framework Construction Environmental Management Plan (CEMP) (see *Chapter 9 and Appendix E - Annex I*). The appointed construction contractors will be required to commit to and execute the requirements of the WMP, as part of their CEMP, for their specific elements of construction.

The outline WMP presented in *Appendix E (Annex I)* will be further developed by each major contractor into a set of detailed implementation procedures that will be subject to SATORP's prior approval and subsequent audit. Each contractor's WMP implementation procedures will need to include detailed provisions with respect to the following:

- Development a programme to minimise, re-use and recycle the different waste streams under the contractor's control. The programme will need to identify a collection, storage, treatment, re-use, and disposal route for each waste stream and identify potential third party re-users (where such waste cannot be reused within the Project). It is expected as a minimum that tyres, batteries, waste oil, paper, cardboard, wood and scrap metal will be transferred to third parties for reuse or recycling, to the extent that such facilities are available (or become available) within and outside of JIC and it is legally acceptable to use such services.
- Description of the contractor's work programme for good site practice and identification of the contractor's waste management personnel, including centres of responsibilities and the reporting structure.
- Identification of all third party waste haulage contractors, waste management contractors, locations of landfill and other waste

management/disposal sites and their applicability for the waste types to be transferred.
- Details of the contractor's waste management system (i.e. training, storing, containerising, labelling, transporting, disposing).

In addition, each EPC contractor will be required to have housekeeping team(s) to ensure that the areas of the site under their responsibility are orderly maintained and are free of clutter and litter.

Impact Significance

Aspect	Impact	Duration	Mitigation	Severity	Probability	Significance
Generation of waste	Release of pollutants contaminating soil and water receptors	Temporary, only for the duration of the construction phase	Measures described in the outline Waste Management Program (WMP)	(2) Marginal	(2) Unlikely	**Low**

The environmental impact of wastes, both hazardous and non hazardous, generated during the construction phase of the project are considered to be low, assuming that a high level of duty of care is applied by SATORP in relation to storage on site, transportation offsite and appropriate disposal.

8.2.5 Terrestrial Ecology Impacts during Construction

Impacts

It is during the construction stage of the project that the potential for terrestrial ecological impacts to occur is greatest. Based upon general requirements of the project and recent survey findings (from March 2009), the broad activity types which have the potential to affect the habitats considered valuable:

- Clearance of ROWs for a certain section of the pipeline routes;
- Clearance of the proposed TCF site (particularly the southern area of the site);
- Encroachment of construction vehicles onto better quality habitats; and
- Contamination of soils through spills of fuel and oils (discussed earlier).

The greatest sensitivities identified within the project worksites exist at the southern area of the TCF, where a number of rocky outcrops provide habitat for bird breeding and use by larger mammals and in deeper sands along the southern pipeline corridor. With regard to the ROW, certain sections do contain better plant coverage, particularly where deeper sands have accumulated or where drainage is impeded, both features existing as a result of the existing pipelines presence. The JER plot and RC pipeline corridor is of little ecological value and therefore is unlikely to be significantly impacted.

Table 8-3 provides a summary of predicted impacts, their significance and proposed mitigation measures to reduce or remove the risk of a significant effect. This assessment focuses on those important habitat areas identified mainly during the March 2009 and March 2008 surveys and described in *Chapter 6*. Areas of low or very low sensitivity have not been considered further.

Table 8-3 Summary of Predicted Effects

Receptor	Ecological Value	Potential Impact	Duration	Severity	Likelihood	Significance of Effect without Mitigation	Mitigation Measures	Residual Significant Impact
Avifauna	Local – based on the overall size of nesting bird habitat included in the overall land take, considering the size of available habitat outside of the project areas. Presence of notable species (Desert Eagle Owl) breeding.	Direct impact on breeding site. Loss of foraging habitat. Indirect impacts through disturbance to species present in the project areas.	Permanent	(3) Critical	Very Likely	Moderate	Attention will be given to timing of clearance, grading and construction works in the area of the TCF where nesting birds have been identified. The period of restricted site activity will be established based on observations of actual nesting birds. Staff will be notified that this area of the TCF site is 'off limits'. An exclusion zone will be established to prevent disturbance at the nest sites for the estimated 12 weeks needed for the chicks present to fledge and not be reliant on the nest location. Further, SATORP has agreed that machinery activity within these areas will continue to be prevented and other access to the nest locations for non essential visits will be stopped. A qualified ecologist will attend the site on a regular basis during this period to monitor the efficacy of the mitigation measures and determine when the young are no longer dependent upon the nest site and that works can proceed. Development of monitoring program during construction works and post construction monitoring. An experienced ecologist will be engaged for this purpose.	Low
Fauna	Regional	Direct loss of suitable lair habitat and fauna. Loss of foraging habitat	Permanent /5 years	(3) Critical	(2) Likely	Moderate	The discrete area which has more varied topography with rock outcrops and known fox den will be protected from development for about 14 weeks giving time for exclusion of larger faunal species. Development of monitoring programme during	Low

Receptor	Ecological Value	Potential Impact	Duration	Severity	Likelihood	Significance of Effect without Mitigation	Mitigation Measures	Residual Significant Impact
							construction works and post construction monitoring. An experienced ecologist will be engaged for this purpose. Training of the workforce to avoid harming fauna and unnecessarily removing areas of habitat. When construction of the JER is completed, the TCF area is expected to be cleared which will allow natural recolonisation of plant species. Consideration will be given to measures that encourage recolonisation by native species at that time (creating bird nesting habitat, fencing, occasional ecological monitoring etc.	
Plant communities	Local/regional	Direct loss of habitat and impact to associated faunal species. It should be recognised that most of the project areas have limited ecological value. The loss of plant communities along the proposed southern pipeline corridor is considered permanent.	Permanent for the JER and ROWs, five years for the TCF	(2) Marginal	(5) Certain	Moderate	Minimisation of disturbance to fauna and flora by limiting contractor's access to non-work areas. When construction of the JER is completed, the TCF area is expected to be decommissioned which will allow natural recolonisation of plant species. Consideration shall be given to measures that encourage recolonisation by native species at that time (creating bird nesting habitat, fencing, occasional ecological monitoring etc.) Reducing ROW width along sensitive route sections of the south corridor is not possible due to safety and security constraints. Where practicable, off-ROW access will be minimised to avoid disturbance to plant communities to the extent possible.	Low

8.2.6 Marine Environment

Direct impacts to the marine environment during construction are not anticipated. However these may arise indirectly through discharge of potentially contaminated groundwater during site dewatering operations. Normal practice within the JIC involves discharge of such water to the RC's clean storm water ditch which in turn discharges directly to the marine environment.

The quantities of water that will need to be discharged from the sites as a result of site dewatering activities during construction will be relatively small (compared to that which would be discharged to sea via the RC's clean storm water channel during a major rain event). However, the quality of groundwater so discharged has the potential to be contaminated as a result of contamination of the underlying aquifer from leakages and spills of hazardous materials from nearby and remote industrial and waste management sites located within JICs 1 and 2 (see *Section 8.2.3*).

Mitigation and Management

As discussed in *Section 8.2.3*, SATORP will undertake a comprehensive site groundwater monitoring survey prior to commencement of construction, with the list of parameters to be monitored to include as a minimum those listed in RCER 2004 Tale 3C '*Water Quality Standards for Direct Discharges to Coastal Waters'*. The results of this survey will be reported to the RC prior to commencement of construction and discharge to the stormwater ditch. A permit will be sought (if necessary) from the RC prior to discharge of any groundwater from the site. Where necessary, the discharge will be passed through silt traps to reduce sediment load to the RC storm water ditch.

Impact Significance

Aspect	Impact	Duration	Mitigation	Severity	Probability	Significance
Ground water de-watering	Impact to the marine environment should groundwater be contaminated	Temporary, only for the duration of the early construction phase	Measures cited in preceding sub-section	(2) Marginal	(2) Unlikely	**Low**

8.2.7 Socio-Economic

Impacts

During construction of the JER and associated infrastructure, it is expected that the local and national economies will be beneficially impacted, primarily through increased employment opportunities and diversification of skill base within the existing workforce.

As well as enhanced employment opportunities, the project will create considerable potential for local enterprises to secure contracts for the provision of goods and services. During the construction phase, local firms will be considered for contracts to provide food, building materials, earthmoving equipment, etc.

This project will be constructed largely with an imported workforce, which is common practice in the industrial city and the region. The city of Al Jubail and JIC are accustomed to accommodating large temporary foreign workforces.

Managing the welfare, health and safety of a significant number of workers is inevitably a major challenge, and the co-existence of multiple EPC Contractor crews of foreign workers from diverse ethnic and geographic backgrounds can be problematic.

Mitigation and Management

The following will be required of all EPC Contractors to protect the welfare, health and safety of the construction workforce:

- Application of a grievance mechanism, which will be developed prior to the construction programme, to encourage concerns of workers to be recorded and addressed. The likely framework for the grievance mechanism is as follows:
    - Mechanism Scope.
    - Company Policy.
    - Informally Raising a Grievance by Workers.
    - Formally Raising a Grievance by Workers.
    - Procedure for Complaints Outside of the Company.
    - Record Keeping.
    - Confidentiality.
- All contractors will be required to uphold the requirements of the 2005 Saudi Labour Law which regulates the relations between employers and workers. This is will be subject to SATORP or third party audits.
- SATORP requires that each EPC contractor must have a clinic and medical personnel on staff for the health and welfare of their workforce. Additionally, and in accordance with Saudi Labour Law, workers may

undergo medical examinations to identify (and hence prevent spread of) occupational or communicable diseases.

- A Code of Conduct has been prepared to which all EPC contractors must comply.
- The TCF accommodation areas will also provide recreational facilities for the workers, prayer rooms and mosques as described in *Chapter 4 Project Description*.
- Kitchens and food halls will be required to meet national hygiene requirements.

Worker facilities within the TCF and the work place itself will be regularly audited by the SATORP HSE team to ensure that the social mitigation measures are effective in achieving the project's objectives of meeting the substantive requirements of the IFC Performance Standard PS 2 on Labour and Working Conditions. Where shortfalls are identified, corrective measures will be implemented to ensure that objectives are met.

Impact Significance

Aspect	Impact	Duration	Mitigation	Severity	Probability	Significance
General construction	Loss of future land use	Long-term	JER development considered in local land use planning	(1) Negligible	(3) Likely	**Low**
Employment	Employment generation	Temporary, only for the duration of the construction phase	None	(+)	(3) Likely	**Positive**
Presence of major workforce provided by various contractors	Worker health, safety and welfare	Temporary, only for the duration of the construction phase	See preceding subsection	(2) Marginal	(3) Unlikely	**Low**
Presence of major foreign (multi-ethnic) workforce(s)	Impact on permanent residents of Jubail City and conflicts within the workforces	Temporary, only for the duration of the construction phase	See preceding subsection	(2) Negligible	(3) Likely	**Low**
Regional economic development	Promotion of ancillary business	Temporary, only for the duration of the construction phase	None	(+)	(3) Likely	**Positive**

An impact of low significance is expected with respect to the loss of future land-use of the site. Low significance impacts are also expected during the construction of the JER with regard to health and welfare of the large temporary workforce and with regard to multiethnic conflicts within the workforce and between the workforce and local permanent residents.

Positive impacts will occur through the generation of additional employment and with increased local business activities providing services to the workers and to the project as a whole.

8.2.8 Transportation

Impacts

The construction of the refinery will generate road traffic through the movement of workers, raw materials for construction, construction equipment, process plant and piping and waste. Specifically, these are expected to include:

- Trucks exporting/importing excavated material /backfill, although each worksite is expected to be 'balanced' in terms of cut and fill;
- Trucks delivering raw materials for the construction programme, including cement, structural steel, welding gases, brick / kerbs, asphalt etc;
- Trucks delivering consumables such as water, cleaning chemicals, paint, fuel and maintenance equipment (e.g. vehicle spare parts);
- Buses for transporting the construction workers from the TCF to the worksites (peak estimated to be 30,000 per year);
- Construction plant and machinery such as graders, bulldozers, backhoes and cranes (delivery/collection from site);
- Trucks and heavy load carriers transporting process plant, equipment and piping to site;
- Tanker trucks collecting and transporting sanitary wastewater from temporary septic tanks to RC treatment facilities, TCF treatment facilities or an RC pumping station;
- Trucks transporting other waste materials (such as empty drums, dismantled crates, used oils and lubricants etc) to local waste treatment/disposal/recycling facilities.

Delivery of large equipment, process units and pipe sections may also take place to a nearby port (including KFIP) with final delivery to the JER PLOT 9 site via truck or heavy haulage vehicle.

Construction traffic has the potential to cause road congestion within the industrial city and surrounding area, potentially creating an inconvenience to the local population and an increased risk in terms of traffic safety.

Mitigation and Management

The single greatest source of traffic is represented by worker pick-up and drop-off between the JER PLOT 9 worksite (and pipeline R0W) and the TCF worker camp (up to 800 trips per day). The impact to the local traffic network associated with this flow is expected to be marginal, given the

proposed location of the TCF (1,300m to the south of the construction site) and that the TCF will be connected to the JER worksite by a new dedicated road.

The Jubail area and industrial city has a modern road network built to international standards and planned specifically to handle construction traffic for major process plant developments. Local access roads are multi-lane and an integrated feature of the JIC. Designated residential, commercial and recreational areas of Jubail are bypassed by the industrial city road system. Therefore the severity of the impact to the JIC and Jubail area from traffic using the existing highway is expected to be marginal.

Nevertheless, each EPC contractor will be required to submit a Traffic Management Plan to SATORP (for prior approval) detailing their proposals for the appropriate use of the local transport network and ports. The Traffic Management Plans will need to incorporate the following requirements:

- Traffic flow and site access will be managed such that tail-backs onto public roads will be avoided;
- Delivery of heavy loads will be timed to avoid peak traffic flows;
- Vehicles will only be permitted to refuel outside of dedicate refuelling areas in an emergency;
- Drivers will be fully trained in road safety and a transport management plan has been prepared for the construction phase;
- Transport will only take place on roads approved by SATORP. No route deviations or off-road driving will be permitted outside of the work and laydown areas without prior approval;
- All national and industrial city speed limits will be observed;
- Licensed contractors only for waste and fuel transportation will be used, and spill response training and equipment will be made available for fuel and hazardous liquid waste transport; and
- Where vehicles accessing site operate within the site on unpaved roads that are watered, appropriate wheel cleaning facilities will be provided prior to the vehicle returning to a public road.

The above measures are anticipated to minimise congestion and inconvenience to other industrial city users and people living in the Jubail area.

Impact Significance

Aspect	Impact	Duration	Mitigation	Severity	Probability	Significance
Worker Transport to / from the worksite	Congestion from additional road vehicles	Temporary, only for the duration of the construction phase	Worker camp to be located adjacent to worksite	(1) Negligible	(5) Certain	**Low**
Materials Transport to / from the worksite	Congestion from additional road vehicles	Temporary, only for the duration of the construction phase	Traffic Management Plan	(2) Marginal	(3) Likely	**Moderate**

In view of the dedicated access road that will be built between the main construction site (JER PLOT 9) and the TCF, the impact of transporting workers to and from the construction site is anticipated to be of negligible severity, resulting in an impact rating of low significance. Delivery of materials to and from the site via the public roads network is anticipated to be of marginal severity, resulting in an impact rating of moderate significance.

8.3 OPERATIONAL IMPACTS

Key issues associated with normal and upset operations of the refinery are expected to include:

- Air Quality;
- Green house gas / energy efficiency;
- Noise;
- Waste;
- Ecology;
- Soils and groundwater;
- Waste water and the marine environment;
- Socio-economics; and
- Transportation.

8.3.1 *Air Quality*

Impacts

The operating refinery includes a number of potential sources of emissions which may impact air quality:

- Stationary combustion equipment:
  - Fired heaters operating on refinery gas (28 units);
  - Steam boilers operating on a combination of refinery fuel oil and refinery gas (three units normally operating, one on stand-by);
  - FCC unit emissions from catalyst regeneration (one unit);
  - SRU tail gas incinerators (three units);
- Hydrocarbon and acid gas emergency flaring systems; and
- Fugitive VOC losses.

This section discusses the probable impact from operating these emission sources, and also considers the potential for this development to contribute to ozone formation downwind of the facility.

This section also considers the impact of normal operations and certain upset or emergency conditions (further details of all scenarios that have been considered are set out within the dedicated Operational Phase Air Dispersion Modelling Report, *Appendix D - Annex III*).

Normal Operations - Combustion Emissions

Refining is an energy intensive process requiring many heating stages and steam, and consequently boiler and heater operation represents the most significant contribution to air emission from the JER during normal operations. In addition, flaring of hydrocarbons and acid gas during start-up, shut-down and emergencies represent an additional source of combustion emissions (albeit infrequently and for periods of mainly short duration only).

Emissions of concern normally associated with gas fired boilers and heaters and with flares are NO_x, CO, SO_2 and to a lesser extent, VOCs. Fine particulate matter (PM_{10}) is an additional pollutant of concern for the FCC catalyst regeneration system and for steam boilers when operating on liquid fuel.

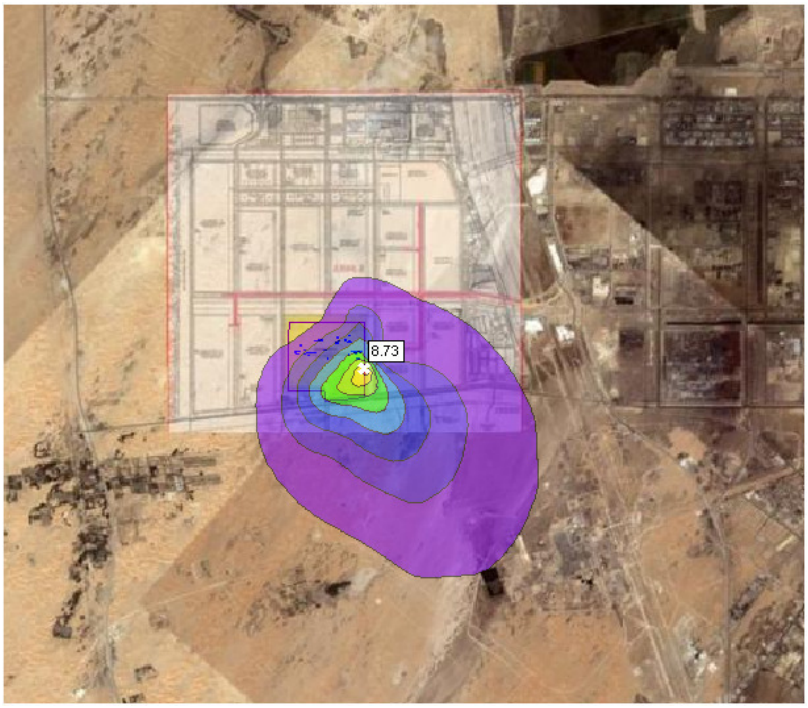
In order to estimate ground level concentrations for the various pollutants that will be emitted from the JER facility, an atmospheric dispersion modelling study has been undertaken using Breeze-AERMOD. AERMOD is a straight-line, steady-state Gaussian plume model that can model the dispersion of pollutants over rural and urban areas, flat and complex terrain. AERMOD considers the effects on dispersion of surface and elevated releases, and multiple sources (including, point, area and volume sources) to determine ground level pollutant concentrations at specified receptor points.

Modelling has been undertaken applying those emission controls discussed in *Chapter 5 Project Alternatives* and the annexed BAT Report (*Appendix C*).

Dispersion modelling has demonstrated that the JER is anticipated to result in a minor contribution to the deterioration of local air quality at nearby 'sensitive' receptor points. No exceedance of RCER 2004 (and hence IFC EHS General Guidelines) ambient air quality standards is anticipated at any of the modelled receptor points (including those potentially sensitive receptors described in *Chapter 6 Environmental and Social Baseline*. Whilst a conservative approach has been adopted for this assessment, modelling demonstrates that the project will comply with the objective that the refinery in isolation will contribute no more than 25% towards the (RCER 2004) ambient air quality standards (as mandated in IFC EHS General Guidelines). As noted earlier, a comprehensive dispersion modelling study is provided in *Appendix D – Annex III*.

In addition, the project is expected to comply with RCER 2004 (and hence IFC EHS General Guidelines) ambient air quality standards even during emergency flaring. At the request of the Financing Parties, additional consideration has been given to modelling flaring during commissioning, and again modelled data confirms compliance with RCER 2004 ambient air quality standards. *Figure 8-1* demonstrates graphically annual average NOx emissions for normal operations.

Figure 8-1 Modelling Long Term Dispersion of NOx (Normal Operations, RC Meteorological Data)



Note: Maximum NOx value of 9ug/m³ noted in the isopleth represents a maximum NO_2 concentration of approximately 7ug/m³

Normal Operations – Sulphur recovery Unit Emissions

The IFC EHS Sector Guidelines for Petroleum Refineries (2007) specifies two requirements for SRU performance:

1. total sulphur recovery performance; and
2. the permissible maximum concentration of SO_2 in the exhaust gas that is discharged to the atmosphere.

The performance of the JER SRU in terms of sulphur removal (99.95% recovery of sulphur) is considered to meet 'BAT' with reference to the EU BREF Reference Document on Best Available Techniques for Mineral Oil and Gas Refineries 2001 (which is referred to in IFC guidelines). In terms of performance, the technology proposed for the JER is ranked 2nd highest out of 11 examples regarding technologies referenced in the BREF Note.

The 99.95% sulphur recovery performance significantly exceeds the requirements stated in the IFC EHS Sector Guidelines for Petroleum Refineries minimum requirement in terms of sulphur recovery (specifically 97% minimum recovery and a preferred recovery efficiency of 99% or greater).

Regarding the SO_2 content of the exhaust gas, the present design of the SRU complies with the RCER 2004 limit of 250 ppm (vol) at 0% O_2 dry basis. This value corresponds to approximately 612 mg/Nm^3 at 3% O_2 dry basis.

Although the exhaust gas concentration of the JER tail gas incinerator is expected to exceed the IFC guidance value of 150mg/Nm^3 at 3% O_2 dry basis, the impact attributable to this emission is considered to be negligible, as:

- The total sulphur discharged is significantly reduced by the very high recovery efficiency.
- Impacts to air quality are minimised through stack height optimisation using an internationally recognised dispersion model (AERMOD, refer to *Appendix D – Annex III*).
- Using IFC benchmarks provided in Table 4 of the IFC Guideline, the JER ratio of tonnes SO_2 produced /million tonnes of processed crude is approximately 80, which is within (and on the low side of) the industry benchmarking range of 60 – 300.
- As indicated in EU BREF Reference Document on Best Available Techniques for Mineral Oil and Gas Refineries 2001 (*Chapter 5*) the JER's SO_2 emissions are in the full compliance with the range of 400 - 2000 mg/Nm^3.

Nevertheless, SATORP during FEED has evaluated the possibility of decreasing the SO_2 exhaust gas concentration further to the levels indicated by the IFC Guideline, using alternative amines and an improvement in the degassing pit. The evaluation concluded that these alternative technologies have limited historical industrial application and therefore these solutions have not been retained for detailed design.

In conclusion, the JER is considered to have applied BAT with regards SO2 recovery performance, and the refinery is significantly below the benchmark average for SO_2 emissions per unit of crude refined.

Even though the Project fulfils all other IFC requirements, in the case of the SO_2 emission from the SRU, the IFC limit guideline (150mg/Nm_3 at 3% O_2 dry basis) will not be met but the impact of this non-conformance is considered to be negligible in the context of impacts to air quality.

Fugitive Emissions

Fugitive VOC emissions are associated with any facility that handles, distributes and stores significant quantities of volatile hydrocarbon fluids and gases. In particular, fugitive VOC emissions will be associated with the JER process area in general, and storage of crude oil and refined products. Estimates of fugitive VOC emissions have been considered in the assessment of ozone formation associated with JER operations.

When oxides of nitrogen are mixed with 'photochemically active' VOCs and irradiated with sunlight, a chain reaction can be established which may lead to

the formation of 'secondary pollutants' such as ozone. Therefore normal JER operations may contribute to ozone formation downwind of the refinery.

VOC emissions from tank losses have been estimated (conservatively) to be 166 tonnes per annum using the internationally recognised USEPA TANKS model. Fugitive losses from process components are estimated to be a further 659 tonnes per annum.

It is likely that the majority of these VOC's are 'photochemically reactive'. Whilst the extent of these releases is low for a major refinery (due to the high level of mitigation employed) and is likely to be low in the context of cumulative JIC emissions, further assessment is provided below.

The "*VOC/NOx Point Source Screening Tables*" have been used to assess potential contribution to ozone formation, developed by Richard D. Scheffe (1998). This approach infers the increase in ozone above an assumed ambient value due to the refinery project.

The "Scheffe" method is a screening procedure used to estimate the ambient ozone concentration resulting from a VOC-dominated emission source. A series of lookup tables are used to conservatively estimate the ozone concentration increase.

To use the screening approach, the maximum daily VOC emissions rate and the annual mass emission rates of VOCs and NOx have been estimated (*Chapter 4 Project Description*).

Application of the Scheffe method indicates a maximum project contribution of 15ug/m^3 downwind of the refinery, substantially lower than the RCER 2004 ozone standard (235ug/m^3, 1 hour). It is noted that ambient air quality as measured by the RC monitoring network in the vicinity of JIC 2 recorded 1 hour 99.7th percentile maximum ozone concentration of 71 and 59 ug/m^3 in 2006 and 2007 respectively. Based on this the cumulative impact is considered to be 80ug/m^3, again within the RCER ozone standard.

Mitigation and Management

Measures which are expected to mitigate impacts on air quality include:

- Appropriate stack height, diameter and location design has been applied for all heaters, steam boilers, and SRU tail gas incinerators.
- Appropriate flare stack height and combustion efficiency of flare tips has been specified.
- Extensive use of amine strippers has been applied to all contributory fuel gas streams to minimise refinery fuel gas sulphur content.
- Control mechanisms will be fitted to ensure optimum efficiency and operational performance of all fired heaters and steam boiler systems to minimise VOC, PM and CO emissions.

- Low NOx technology (ULNB or LNB) will be applied to large heaters to achieve an emission limit substantially lower than the RCER 2004 (and hence IFC EHS Guidelines) (the target emission limit is 80mg/Nm^3 (no air-preheat) and 100mg/Nm^3 (air pre-heat), and RCER 2004 emission limit is 150mg/Nm^3).
- Steam boilers will apply BAT principles to meet the most stringent NOx limit (RCER 2004, and hence IFC EHS General Guidelines) as described fully in the JER BAT Report (*Appendix C*).
- The FCC unit will be fitted with an electrostatic precipitator (ESP) to minimise dust emissions.
- Dust from coke handling will be minimised through storing coke in buildings covered with sandwich panels (one building for coke storage at the refinery and one for coke storage at port). The belt conveyor for coke transfer to the port will be sealed and coke leaving the DCU will be wetted to minimise dust formation. In addition, water sprays will be applied at transfer points along the belt.
- The project will apply a 'state of the art' Continuous Emissions Monitoring Systems (CEMS) to monitor exhaust gas emissions from certain key emission sources, although Predictive Emissions Monitoring (PEMS) may be a suitable alternative.
- VOC's will be recovered during vessel loading in KFIP port.
- Highly volatile materials (ie those with a TVP of 76 KPa and above) will be stored in tanks with a recovery and potentially a control device, to minimise facility VOC emissions.
- Moderately volatile materials will be held in storage tanks which will be fitted with either internal or external floating roofs.
- A LDAR programme will be undertaken annually for VOCs and HAP services in full accordance with the RCER 2004 requirement[1].

Impact Significance

Aspect	Impact	Duration	Mitigation	Severity	Probability	Significance
Normal heater operation	Deterioration of air quality	Continuous	See above	(1) Negligible	(5) Certain	**Low**
Commissioning, Operational and Emergency Flaring	Deterioration of air quality, particularly SO_2	Intermittent	See above	(2) Marginal	(1) Very Unlikely	**Low**
VOC fugitive emissions	Contribution to ozone formation	Continuous	See above	(1) Negligible	(5) Certain	**Low**

[1] (RCER2004): "Initially, LDAR will be on a *semi-annual* basis, starting within 180 days of initial startup of operations. Following two (2) consecutive *semi-annual* leak detection periods when the number of leaking components is found to be less than 2% of the total, the operator may revert to *annual* leak detection monitoring. If the total number of leaking components ever exceeds 2%, then the facility shall revert to *semi-annual* monitoring."

Impacts to air quality from normal operations of the refinery are determined to be of low significance due to their negligible severity. Impacts from infrequent flaring events (which will only occur during start-up, shutdown and plant upset conditions) rated as being of low significance due to their marginal severity and very unlikely probability/frequency rating.

8.3.2 Green House Gas / Energy Efficiency

Energy efficiency and emissions to atmosphere are linked in the sense that the greater the energy efficiency, the lower the emissions to atmosphere per barrel of crude refined.

In order to establish the significance of GHG emissions associated with operations of the JER, a study has been undertaken to establish the impact of the refinery in a national context and to compare the performance of the refinery with other refineries in an international context.

Based on data from the International Energy Agency's (IEA) World Energy Outlook, 2005, the JER will represent around 13% of KSA's total refining capacity at the time of its anticipated start-up in 2013. In addition, the Project represents around 1.1% of the total annual CO_2 equivalent (CO_2e) emissions from KSA (based on the IEA forecast for 2010). The CO_2 intensity of the JER has been estimated at around 0.032t CO_2e/bbl refined, based on a throughput of 400,000 BPSD.

ERM has compared the performance of the JER Project against ten other major oil refineries worldwide, where publicly available data on CO_2 emissions are quoted. This comparison against quoted performances for other refineries indicates that the JER will rank just above the average CO_2 intensity figures of the group assessed in terms of performance (the average was 0.038t CO_2e/bbl). However, it should be noted that such comparisons are subject to differences in crude type (the extent of processing required between light and heavy crudes) and the depth of refining (the extent to which crude is converted to value added products) which, due to a lack of data concerning the quoted performance of the other refineries, is not accounted for in the comparison.

Data reviewed by ERM shows that process heater design efficiency is specified above the industry average (i.e. 90% vs. 87%). Furthermore, some process heaters specified within the JER are rated at 93% efficient which, in refinery design terms, is extremely high. High thermal efficiencies of JER process heaters will be achieved through the recapture of waste heat in order to pre-heat combustion air feed streams. The refinery is also designed to include a zero flaring philosophy, and therefore flaring constitutes relatively minor quantities of CO_2.

The JER refinery is also energy efficient with regard to its use of water. The refinery recycles a number of water streams for further processing and reuse on site:

- Treated sour water from the sour water stripper is used for crude desalting.
- Sludge from the waste water treatment system and excess treated sour water is used for coke quenching in the DCU.

Commercial supply of water for the refining process is generated through desalination of seawater, itself a significantly energy intensive process. Therefore these measures to minimise water usage will also avoid significant indirect GHG emissions.

Green house gas emissions have been subject to a dedicated study provided in *Appendix D, Annex IV*.

8.3.3 Noise

Impacts

The operating refinery will represent a permanent source of noise. A noise modelling assessment, using the internationally recognised SoundPLAN package has been undertaken for the JER Plot 9 facility (*Appendix D – Annex V*).

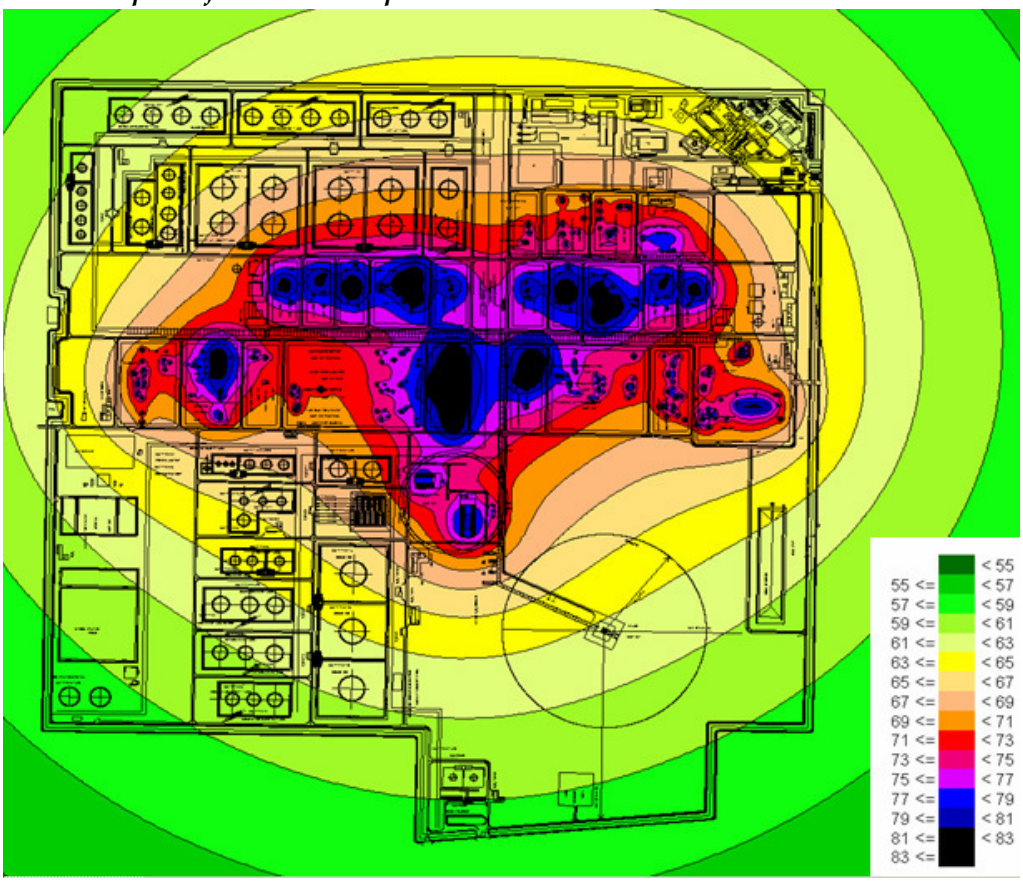
The aim of the assessment has been to establish whether the proposed project would comply with the RCER 2004 site boundary noise limit values of 75 LA_{10} dB (which is equivalent to 73 LAeq dB) and the IFC EHS General Guidelines (which has adopted the World Health Organisation's (WHO) community noise guidelines of 70 LAeq dBA in industrial areas and 45 dBA at night time in residential areas).

Noisy items of plant that include cooling towers, pumps, compressors and plant motors have been modelled and a series of noise contour maps and noise levels at remote receptor locations around the site boundary determined. A conservative assumption has been made that 'noisy' plant will have a sound power level rating of 109dBA for fan assisted plant and 95dBA for all other plant. These data will need to be refined at the EPC stage; however, the assumptions made for this assessment are expected to represent an overestimate of actual noise levels.

The results of the modelling exercise demonstrate that under normal operating conditions the facility will be compliant with the RCER 2004 boundary noise limit criteria of 73 LAeq dB. Further, a screening assessment, based on inverse square law principles, indicates that operational noise for the refinery is expected to contribute less than 30 dBA at the nearest identified sensitive receptor (the prison located 2.1 km distant from the refinery, as depicted in *Chapter 6*).

Figure 8-2 presents modelling noise data for normal operations.

Figure 8-2 Noise Isopleth for Normal Operations



At the request of the Financing Parties, additional consideration has been given to noise associated with emergency flaring. To establish the potential for noise impacts from emergency flaring, a screening assessment has been undertaken using inverse square law principles (provided in *Appendix D – Annex V*). The assessment is based on preliminary vendor data, which indicates JER flares will have noise levels at 1m from the flare base of:

- 90dBA for hydrocarbon flares; and
- 72dBA for the acid gas flare.

The additive noise level from three flares operating simultaneously at 100% of their capacity will be 99dBA. Based on this value, emergency flaring is expected to negligibly impact receptors located near to the refinery.

Mitigation and Management

The modelling assessment has demonstrated compliance with the RCER 2004 limit value at the JER refinery fence and with the IFC/Who guidance values at the nearest sensitive receptor. On this basis no further mitigation controls are deemed necessary other than those associated with appropriate facility design.

Impact Significance

Aspect	Impact	Duration	Mitigation	Severity	Probability	Significance
Operational Noise	Impact on noise sensitive receptors	Long-term	Measures cited above	(1) Negligible	(5) Certain	**Low**

8.3.4 Waste

Impacts

As noted in *Chapter 4*, the types of wastes associated with project operation will include:

- Hazardous liquid wastes (e.g. oil, spent caustic, lubricants, sludge from the WWTP);
- Non hazardous liquid wastes (principally sanitary waste water);
- Non hazardous solid wastes (e.g. paper, wood, metal); and
- Hazardous solid wastes (e.g. oily rags, empty drums, dust from the FCC unit ESP).

Catalysts associated with certain process units and the hydrogen plant are expected to be returned to the provider for regeneration outside of Saudi Arabia and therefore are not considered a waste.

The JER WWTP will generate relatively significant quantities of sludge, however the refinery design includes provision for reuse of this waste stream for 'coke quenching' in the DCU.

Certain oily waste will also be blended with refinery fuel oil and used as a fuel.

Any hazardous process waste materials that cannot be reused, regenerated or recycled on site or by Third Parties will be disposed of in accordance with the requirements as set out in the framework WMP which in turn are in full compliance with the requirements of RCER 2004 and the provisions of the IFC EHS Guidelines.

The operational phase will involve maintenance operations (to both process and supporting areas of the site) including lubrication, adjustment and occasional refits and replacements. Maintenance operations are likely to generate small quantities of hazardous wastes, such as cleanout of process fluids, lubricants, paints, adhesives and solvents. Non-hazardous wastes such as packaging, scrap metal, wood and old components will also be produced.

In general, waste generated by the refinery will be disposed of within JIC. Catalysts are likely to be sent to providers (which may be overseas) for regeneration. Spent caustic will be directed to a common header for transfer to dedicated handling and storage facilities. Equipment will also be provided for the safe transfer of spent caustic to a truck loading bay for disposal by a third party. Should suitable waste management facilities not exist at the time when refinery operations commence, SATORP may consider transporting this waste overseas for recovery of caustic in line with current practice undertaken in Saudi Arabia by Saudi Aramco.

As far as practicable SATORP will apply the 'waste hierarchy' described earlier in *Section 8.2.4* to all operational wastes.

Mitigation and Management

Mitigation measures include those adopted for the construction phase where SATORP is to further develop and implement a framework WMP, which will include identification of contractors with long term strategies for waste minimisation and recycling. Key requirements of the plan will include:

- Details of a secure, dedicated waste storage area that provides bunding for liquid hazardous waste, segregation for waste types, and appropriate signage / MSDS.
- Development of a programme to minimise, re-use and recycle (to the maximum extent possible) the different waste streams generated during operations. The programme will identify a collection, storage, treatment, re-use, and disposal route for each waste stream and identify potential third party re-users (where such waste cannot be reused within the refinery).
- Description of the SATORP's commitment to good site practice and identification of waste management personnel, including centres of responsibilities and the reporting structure.
- Identification of all third party waste haulage contractors, waste management contractors, locations of landfill and other waste management/disposal sites and their applicability for the waste types to be transferred.
- Details of the SATORP's waste management system (i.e. training, storing, containerising, labelling, transporting, disposing).

In addition, SATORP will appoint a housekeeping team to ensure that the refinery is free of clutter and litter.

Impact Significance

Aspect	Impact	Duration	Mitigation	Severity	Probability	Significance
Generation of waste	Accidental release of waste contaminating soil and water receptors	For the lifetime of the refinery	Measures described above	(3) Critical	(1) Very unlikely	**Low**

8.3.5 Ecology

Impacts

Following completion of the construction phase and decommissioning of the TCF, the operational JER will have only very limited impacts on ecology. These will essentially be limited to:

- Permanent land take of the JER site and the pipeline and coke conveyor right of ways and the associated permanent loss of ecological value associated with this land take;
- Deterioration of local air quality and the associated impact on offsite flora; and
- Light and noise disturbance to fauna.

Mitigation and Management

Loss of the JER site habitat is considered a low impact ecologically due to the poor biodiversity of the existing site. The ecological value of certain sections of the ROWs has higher value, but these will need to be cleared of vegetation periodically in line with RC and Saudi Aramco health and safety and security policies.

Although many floral species are sensitive to air emissions (such as NOx), there are no mitigation measures that the project can implement beyond those already identified in *Section 8.3.1*.

Light pollution shall be restricted to a minimum consistent with safety and security considerations. The JER is not anticipated to generate a significant increase in the light impact within the context of an already well-lit industrial city.

Impact Significance

Aspect	Impact	Duration	Mitigation	Severity	Probability	Significance
Normal operations of the refinery	Impact to flora and fauna through land take and vegetation clearance	Refinery lifetime	None	(1) Negligible	(5) Certain	**Low**
Normal operations of the refinery	Impact to flora through air emissions	Refinery lifetime	Measures described in the Air Quality Impact Assessment	(1) Negligible	(5) Certain	**Low**

8.3.6 Soils and Groundwater

This section of the assessment addresses potential impacts to soil and groundwater associated with operation of the JER facility. As such, it does not address the potential for impacts to soil and groundwater at or in the vicinity of the proposed JER site that arises from operations and activities at neighbouring sites and facilities. The potential for impacts from such sources is addressed in *Chapter 6 Environmental and Social Baseline* and will be further documented following a survey of baseline soil and groundwater quality within project areas.

Impacts

Potential contamination of soils and ground water is related to leaks and spills during operations. Sources of spillage could potentially occur from:

- Leakages or catastrophic loss of containment from process tanks, vessels and piping;
- Moving temporary tanks and other storage containers;
- Stormwater drainage systems;
- Storm and waste water holding ponds; and
- Storage and movement of hazardous liquid waste materials.

The JER site will be set upon hard standing and any spill material will be mopped up or directed to a holding basin, and then on to the JER WWTP (if necessary).

The tank farm will be set upon hard standing, fully bunded and lined to prevent contamination of soils and groundwater in the event of tank failure. Bunding will conform to the requirements of RCER 2004 which are compatible and more specific than those of the IFC EHS Guidelines.

The facilities will have two storm water collection systems:

- Potentially oily storm water; and
- Clean storm water system.

Both systems drain into a number of impervious basins to enable 'first flush' rainfall to be captured, and if necessary, treated at the WWTP.

Mitigation and Management

Storm water runoff shall be captured by the site drainage system and where necessary treated to appropriate RC pre-treatment standards prior to transfer to the RC for secondary treatment. Generally, impacts to soil and groundwater will be mitigated through the following measures:

- Groundwater monitoring will be undertaken on a regular (at least annual) basis using at least three groundwater monitoring wells (permanent monitoring well plan will be developed prior to operations) and the results will be reported to the RC.
- Treated wastewater will be tested prior to transfer to the RC.
- Kerbs will be installed on transfer and loading areas for road tankers (e.g. at the waste caustic storage facility) to retain any spillages associated with transfer of hazardous materials.
- All storage tanks will be fitted with overfill protection devices as per RCER 2004.
- The facility will operate a spill response plan and operators will have at their disposal an appropriate level of spill response equipment.
- All hard standing and bunds will be inspected on a regular basis and cracks reported and repaired.

Impact Significance

Aspect	Impact	Duration	Mitigation	Severity	Probability	Significance
Normal operations of the refinery	Impact to soil and groundwater	Refinery lifetime	Measures described above	(4) Severe	(1) Very Unlikely	**Low**

8.3.7 Waste Water and the Marine Environment

The project is designed to avoid direct discharges to the marine environment:

- 'Clean area' storm water will be temporarily held in a basin and tested prior to transfer to the RC stormwater ditch (or being routed via the JER WWTP for pre-treatment and final treatment in the central RC WWTP).
- 'Oily area' storm water will be transferred to a dedicated basin. The basin size will be equivalent to 30mm rainfall.

- Process waste water will be treated in the JER WWTP to RC pre-treatment standards prior to transferring waste water to the RC for secondary treatment.
- Storm water at the port area will be held at the port and tested. Contaminated stormwater will be transferred via road tanker to the refinery for treatment if necessary.
- The seawater cooling water system will essentially be closed loop using cooling towers to minimise seawater water demand. Blowdown (to maintain dissolved solids content of the cooling water) will be discharged to the RC cooling water channel.
- Sanitary wastes will be held in septic tanks and transferred to the RC treatment system.

The treated waste water from the central wastewater treatment facilities of JIC is reused as irrigation water. Surplus treated waste water is discharged to the Sabkhat Al Fasl Lagoons. Any overflow from lagoons discharges to the Gulf via the open channel. This is a long established system that is operated under the control of the RC.

Concerning potential oil spills, all vessels accessing the KFIP must comply fully with MARPOL requirements, in terms of discharges to the marine environment. The port is understood to accept only vessels that have (a) clean storage holds – no cleaning in the port is permitted; and (b) clean ballast, that is, ballast should be exchanged away from coastal areas so that on approach to the port the ballast is clean. SATORP will liaise with the KFIP port authority, the RC and the KSA Coast Guard to ensure that adequate oil spill response plans and response facilities are in place (prior to JER start-up) to deal with any oil spills or other tanker incidents involving JER cargoes. Coastal oil spill sensitivity analysis will be integrated into the development of future response plans.

8.3.8 Socio-Economic

Impacts

Overall, the development of an additional refinery to Saudi Arabia will positively impact the country, in terms of significantly increasing the revenue that will be generated from the equivalent volume of crude oil. Further, it will expand the range of exported petroleum products, thereby enhancing its export potential. Lastly, output from the refinery will also serve to satisfy the local KSA market for refined products.

The refinery project will be developed within a Government-sponsored industrial city complex created in the 1980s. The city has been built on previously unpopulated salt flats and sand dunes, and it is understood that all land acquisitions were accomplished in accordance with Saudi law. With no pre-existing populations on the project site, there will be no involuntary resettlement or compulsory land acquisitions. The separation distance of the refinery from the nearest sensitive receptor (the prison located 2.1 km to the

east of the refinery site) has shown that direct impacts to offsite receptors will be largely insignificant.

Throughout the operational lifetime of the refinery, local firms will have the opportunity to tender for contracts for provision of a wide variety of services such as transportation, provision of food and other provisions, maintenance work and waste management. This will feed into the local economy, thereby providing a long term sustained benefit for the local community.

The long-term operation of the JER and associated infrastructure will provide specialised employment and training for a small local and international workforce.

Mitigation and Management

The JER Project has a 'Saudisation' policy which will endeavour to preferentially employ Saudi nationals (long term target of 75%). This policy will be implemented as a transitional programme incorporating an initial period of training and 'know how transfer'.

Impact Significance

Aspect	Impact	Duration	Mitigation	Severity	Probability	Significance
Employment	Employment generation	For the refinery lifetime	None	(+)	(5) Certain	**Positive**
Regional economic development	Promotion of ancillary business	For the refinery lifetime	None	(+)	(5) Certain	**Positive**

8.3.9 Transportation

The operating refinery will receive its feed crude by pipeline. It will route its liquid products by pipeline and coke product via a conveyor to KFIP from where these products will be exported via tanker ships. The result is that the number of vehicles accessing the site during the operational phase will be limited to those associated with:

- Workers accessing the site;
- Product exported for the local market;
- Waste collection;
- Cleaning of septic tanks; and
- Deliveries of consumables.

A conservative estimate of the number of vehicles per day that these access requirements generate is 200 cars, 40 trucks and 10 buses. This represents a negligible contribution to the local traffic network.

The following refined products will be exported via pipelines (and conveyors for the coke) to KFIP:

- Gasoline (3,656kt/yr);
- Jet Fuel (1,971kt/yr);
- Diesel (9,050kt/yr); and
- Paraxylene (650kt/yr).

The total export rate at the KFIP port is 15,327 kilotonnes per year. Shipping facilities will be provided by KFIP, which is capable of handling ships up to 25,000 deadweight tonnes (DWT).

Based on a typical tanker capacity of 15,000 tonnes, this infers a 1,000 vessel movements per annum increase in shipping traffic. This is not considered to represent a significant increase in terms of the 50,000 tankers per year entering the Arabian Gulf, however this a significant increase in the current number of movements reported to be accessing the KFIP of 1,390 (2006 data).

Shipping collision risk will be managed by the KFIP. The port applies the following provisions to minimise shipping collision risks:

- All Port approach channels are covered by radar;
- Tugs assist with berthing/unberthing;
- Pilotage is compulsory for vessels over 150 gross tonnage;
- Inner and outer anchorage must have good holding ground;
- All vessels must comply with G.C.C Rules & Regulations for Seaports; and
- The Port is equipped with fire fighting vessels, anti-pollution craft and salvage tugs on station.

The impact of a spill resulting from a ship collision can be significant to coastal receptors near the port. In the event that a spill does occur, regional emergency response plans have been prepared to ensure rapid containment and clean up of spills to minimise their environmental damage. The major parties responsible for these plans in the Jubail area are the KFIP, and the RC. A high level assessment of consequences of potential oil spills in the vicinity of KFIP harbour is presented in *Appendix F*.

Mitigation and Management

The following measures will be applied to minimise the potential impact associated with shipping risks:

- SATORP will develop an Oil Spill Contingency Plan (OSCP) for loading operations prior to refinery start-up.
- SATORP will support and coordinate with the RC, KFIP and the KSA Coast Guard in ensuring the suitability of emergency response planning

arrangements and the adequacy of oil spill response equipment prior to operations.

- SATORP will engage only reputable shipping companies for chartering passage of its products and will conduct regular audits on these companies' compliance with MARPOL and their spill response readiness.

Impact Significance

Aspect	Impact	Duration	Mitigation	Severity	Probability	Significance
Road traffic to support normal operations	Congestion on local road network	For the refinery lifetime	None	(1) Negligible	(5) Certain	**Low**
Increase in shipping traffic	Increased risk of ship collision	For the refinery lifetime	As described above	(5) Catastrophic	(1) Very Unlikely	**Low**

8.4 *UNPLANNED EVENTS*

As befits the planning and assessment of a major new refinery, the JER project has been subjected to a thorough assessment of the risk (likelihood of occurrence) and consequences of credible unplanned events.

Those aspects of the assessment that pertain to major accident hazards which have implications for the health and safety of workers and offsite populations are the subject of a separate dedicated report.

A high level assessment of the environmental consequences of oil spills occurring in the vicinity (but outside the entrance) of the KFIP port are presented in *Appendix F* to this ESIA Report.

8.5 *SUMMARY OF ENVIRONMENTAL AND SOCIAL IMPACTS*

As described earlier, the level of impact of project activities has been assessed through establishment of pertinent baseline conditions, developing an understanding of those project activities that have the potential to give rise to impacts, and the associated project aspects. A summary of the level of each impact associated with project activities is provided in *Table 8-4*.

Table 8-4 Environmental and Social Impact Summary (1 – positive impact)

Receptor / Activity		Physical				Biological					Other			
		Atmosphere	Noise	Soil	Hydrogeology	Flora (habitats)	Birds	Reptiles / Mammals	Marine / Coastal	Population	Land Use	Utilities	Transport	Liability / Reputation
Construction	Haulage / Road Transport / Use of Port	Low	Low							Low			Low	
	Preliminary site survey											Low	Low	
	JER Site Preparation & Civils	Low	Mod	Mod	Low	Low	Low	Low			Low	Low	Mod	
	Establishment and operation of the TCF	Low	Mod			Low	Low	Low				Low	Low	Low
	JER Erection	Low	Mod											
	Pipeline Installation Trenching / Backfilling	Low	Low	Mod								Low	Low	
Commissioning	Facility Commissioning	Low	Low		Low									
Operations	Normal JER operations	Low	Low	Low	Low					1	Low	Low		Low
	Flaring / upset	Low	Low							Low				Low
	Port Facilities	Low							Low				Low	Low
	Waste Management	Low		Low	Low								Low	Low
Decommissioning	General Decommissioning	Low	Low	Low	Low							Low	Low	Low

8.6 HEALTH AND SAFETY OF SATORP WORKFORCE

A description of project Health and Safety Planning is provided below at the specific request of the Financing Parties.

8.6.1 Construction Phase

Prevention of injury, loss of life, and damage to assets are key goals of SATORPs construction programme. In order to manage health and safety, SATORP has produced the *Jubail Export Refinery (JER) Construction Safety Manual (CSM).* The CSM provides safety criteria for all construction work which will be performed by JER and its Contractors.

The manual provides detailed requirements for SATORP and Contractors (compliance is a mandatory requirement for all staff and contractors) including:

- Roles and Responsibilities for H&S management;
- Emergency procedures;
- Accident and emergency incident reporting;
- Training (a structured Induction Programme to cover all basic Health, Safety and Environmental issues will be provided to staff);
- Site planning and housekeeping;
- First aid and Person Protective Equipment (PPE), including respiratory protective equipment (RPE) for controlling dust exposure; and
- Transportation (although a project dedicated Transport Management Plan has also been prepared).

The Table of Contents for this manual is provided in *Appendix D – Annex VI* of the ESIA Report for reference.

SATORP recognises that good loss prevention is an integral part of good project management. All JER and contractor personnel involved in construction activities, whether management or line employees, will be required to understand and follow the relevant provisions in the JER CSM.

Medical Facilities

Each area of the TCF allocated to an EPC contractor will have its own medical facilities. In addition, the TCF will have a general SATORP Medical Centre. The SATORP Medical Centre will comprise a fully equipped facility that will be staffed by qualified doctors / nurses / paramedics and support staff on a 24-hour 7-day week basis. The Medical Centre will be capable of dealing with emergencies, treating and

/ or stabilising the casualty before transferring the patient to a local hospital for specialised treatment, if required. The Medical Centre is not proposed to be an Emergency and Accident Unit; this function is to be provided by local hospitals.

All EPC Contractors will be required to coordinate the operation of their medical facilities with those provided by SATORP and local hospitals with the sole intention to provide medical / first aid cover of a high standard.

First aid posts, for immediate medical attention, will be provided across the worksites. Each first aid post shall be equipped with a stretcher, first aid box, telephone, desk/chair, hot and cold water, wash basin, examining table, air conditioning, adequate lighting, a dust tight and lockable medicine cabinet, a cubicle and bed for recovering patients, along with adequate supplies of fresh drinking water.

Contractors working in the pipeline ROWs or at KFIP will provide first aid in a different manner, as these areas are restricted and isolated. In these areas SATORP and EPC Contractors will ensure skilled 'first response teams' are available. These 'first responders' will be qualified in remote first aid techniques and be capable of dealing with any incident that may occur and will be equipped with first aid boxes.

Jubail Area Medical Facilities

Health care services in JIC are integrated to provide community residents with optimum health care facilities. Health services can be divided into two levels:

- Primary Health Care; and
- Secondary Health Care.

Primary Health Care (PHC):
PHC is the first level of comprehensive health care available, and is defined as being able to provide basic or essential treatment.

PHC facilities available include prevention and pre-symptomatic detection of diseases, early diagnosis, diagnosis of established diseases, management of disease, rehabilitation, immunization, health education, diabetics and blood pressure clinic, bronchial asthma clinic, and consultation program for nutrition.

There are three PHC hospitals operated by RC and six PHC operated by the private sector.

Secondary Health Care (SHC):
SHC is the second level of comprehensive health care available. SHC is defined as advanced medical treatment covering modern, fully equipped, professionally staffed inpatient and outpatient services including clinical examination, hospitalization, dental care, and emergency services 24-hours per day and performs all major surgery in state of the art operating theatres.

In terms of secondary treatment facilities, there are two SHC hospitals operated by RC and six hospitals operated by the private sector.

Transport Driving

A Transport Management Plan has been prepared for the construction phase. All drivers will receive an induction as the mechanism to communicate key information from Transport Management Plan and the CSM.

8.6.2 Operational Phase

Prior to operations, SATORP will establish HSE and Emergency Response Plans covering all aspects of health and safety in the workplace. It is anticipated that the overall approach to health and safety planning will be similar to that described in the CSM. The plans will be completed prior to commencement of operations.

H_2S Detection

The following description of H_2S monitoring is provided at the request of the Financing Parties.

Toxic gases considered for detection are the following: H_2S and when relevant SO_2, SO_3 (e.g. in the alkylation unit), NH_3 and CO (e.g. inside the in the PSA unit in the vicinity of the main CO release sources).

Toxic gas detectors will be located at high or low elevations above grade/walkways, or both, according to density of expected gas release at particular points and taking into account the prevailing wind direction and wind speed.

In the specific case of H_2S, gas detectors shall be considered when the concentration of H_2S in the process equipment is equal or greater than 1000 ppm (0.1 % vol).

Toxic gas detectors will be installed to detect losses/leakages from the following equipment:

- Compressors which handle toxic gas (compressors in sour service will be fitted with two hydrogen sulphide detectors, one located at each seal).
- Control valves (manifolds) handling toxic products
- Pumps which handle toxic liquids or liquids with toxic products.

Detectors will also be installed in the following locations:

- Along escape-ways in areas involving the processing of toxic fluids (with particular regard to H_2S).
- Around the flanges of equipment used to remove H_2S (e.g. amine treatment, sulphur units).
- Near particular points and facilities likely to emit H_2S accidentally, including:
  - water treatment facilities;
  - acid gas incinerators;
  - flare lines, flare drums (hydraulic seal drum, etc.);
  - process water stripping systems;
  - zones of furnaces where waste gases are incinerated;
  - separation units in production units;
  - sour water stripper units;
  - sulphur storage tank vent and sulphur loading points.

Burners of hydrogen sulphide combustors and incinerators will also be considered a hazard warranting hydrogen sulphide detection, and portable H_2S detectors will be available for workers operating in certain "H_2S rich" areas of the refinery.

9 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

9.1 INTRODUCTION

This chapter provides a framework for an Environmental and Social Management Plan (ESMP) that will be used to support the detailed design, construction, commissioning, operations and decommissioning of the JER Project. This ESMP, in broad terms, specifies the mitigating measures, management plans, and monitoring to be undertaken throughout the project life cycle.

9.2 FRAMEWORK ESMP

This section describes the framework ESMP for the project which essentially compiles the various commitments for the future development of plans / reports / assessments, mitigation measures and monitoring programmes that have emerged from the ESIA process.

This Framework ESMP will be developed further to include more details, where necessary and when available, including:

- How certain measures will be carried out (i.e. specific details or a plan describing the execution of measures);
- Details of auditing performance against legal, ESIA and Framework ESMP requirements;
- Timing of the implementation of the measures; and
- Responsibilities for ensuring implementation of each commitment.

Implementation of the ESMP will provide SATORP with the assurance that all necessary mitigating measures are applied and that SATORP's commitments, as recorded or implied in the ESIA Report, are delivered.

The monitoring and evaluation that will be carried out as part of the ESMP will enable JER management and staff to demonstrate compliance with appropriate legislation, regulations, guidelines and commitments and to ascertain the effectiveness of mitigation measures proposed in the ESIA Report.

The ESMP will be a dynamic document which can be updated and modified as necessary so it remains practicable and applicable throughout the project.

Those measures and commitments that apply to operational phase of the project are expected to be managed through a company-wide Environmental Management system such as the ISO 14001 standard for EMS.

9.3 ESMP OVERVIEW

The Environmental and Social Management Plan for the JER is expected to comprise five main sections and will be backed up by annexes as outlined below:

Section 1	Introduction	Scope, Application, Legislation
Section 2	General Approach	ESMP Approach
Section 3	Steering	Policy Statement, Goals, Responsibilities
Section 4	Implementation	Mitigation Plans / Tables and Time Schedule
Section 5	Controlling	Monitoring, Reporting, Auditing, Corrective Actions
Annexes		as deemed necessary

9.3.1 *Introduction and General Approach*

The formal aspects of the ESMP will be described in the scope and application of the plan.

The legislation section will list the relevant laws that need to be adhered to, but also include relevant international or national standards, recommendations or guidance.

9.3.2 *Steering*

Policy Statement

The JER Environmental Policy will be developed and confirmed by the highest management of the JER. It will contain the commitments for continual improvement, legal compliance and for keeping the environmental impacts as low as possible. It will further outline JER's main environmental aspects and how the Company intends to address them.

Goals and Targets

Long-term as well as annual environmental performance goals will be defined and targets set once environmental and social monitoring is established well enough to reveal adequate data and data trends. The goals will be responsive to external and legal requirements, environmental performance of the JER and development of JER operations.

Responsibilities

The responsibilities will be defined as a matrix specifying the various actors (top management, environmental manager, department managers, external auditor) and the tasks (e.g. defining policy, defining mitigation plans, monitoring, auditing, etc). It will also define the organisational structure for environmental and social management.

9.3.3 Implementation

A description of the approach, where applicable, to each mitigation measure will be provided including time schedules for future activities.

9.3.4 Controlling

Monitoring

The implementation of the EMSP will be periodically monitored during construction, commissioning and operations of the JER project by key management representatives within SATORP.

Reporting

Key performance indicators, including implementation achievements as well as various environmental monitoring data, will be reported internally.

Auditing and Corrective Actions

The internal auditing scheme will be developed to assure that the implementation of the ESMP is successful.

Depending on the findings of the audit, the ESMP implementation manager will propose measures to take the necessary corrective actions by defining measures, responsibilities and deadlines where the schedule of the ESMP is not met.

9.4 ENVIRONMENTAL AND SOCIAL REQUIREMENTS FOR THE ESMP

The ESIA has demonstrated a significant number of design features which have been integrated into the JER FEED basis specifically for reduction or removal of operational environmental and social impacts.

In addition to those measures intrinsic within the design, a number of mitigation measures apply to future phases of the JER development, specifically those related to:

- Detailed design, at the EPC stage of the project;
- JER construction and commissioning;

- Measures during operations;
- Decommissioning; and
- Monitoring programmes.

A summary of future mitigation, management and monitoring requirements (commitments) for the JER project is tabulated in *Table 9-2*. This summary does not attempt to duplicate, or replace the need to refer to PME, RCER 2004, relevant IFC Guidelines, and the JER CEMP. *Chapter 3* of the ESIA Report provides a summary of applicable national and international standards and guidelines applicable to the JER project. Specific non-conformances with these requirements are identified and fully justified in *Chapter 3* (in the context of public consultation) and *Chapter 8* (in the context of SRU tail gas incinerator compliance with the IFC SO_2 emission limit).

In addition to the various specific ESIA commitments tabulated within *Table 9-2*, SATORP has also committed to prepare a number of plans or additional assessments for the project. These are summarised in *Table 9-1*.

Table 9-1 Summary of Plans to be Developed by SATORP Prior to Operations

Plan or Assessment	Remarks
SATORP HSE Policy	
SATORP Recruitment Policy	
Community Outreach Programme	
Soil and Groundwater Assessment Report	Findings of the assessment will support the development of: • H&S plans for construction activities in areas where contamination is identified • Methods will be proposed by which the risk to human health and / or environment in event of groundwater pollution can be established and the results applied to the development of appropriate mitigation measures. • Dewatering disposal methods • The Groundwater Monitoring Plan during operations
Construction Phase Grievance Mechanism	Based on the framework provided in *Chapter 8 E&S Impact Assessment*
Emergency Response Plan (ERP) for Operations	These will include environmental emergencies such as a pipeline failure or oil spill. In addition, SATORP Health and Safety Team will coordinate emergency response procedures with the Hazardous

Plan or Assessment	Remarks
	Waste Management facility operators (located to the south of the JER plot) in order that appropriate warning of an accidental event can be provided and necessary action can be taken.
Oil Spill Response Plan	This is expected to be an element of the ERP and will be developed in consultation with the RC.
H&S Plans for Operations	
WMP for Operations	
Operational EMS	Based on the principles described in this Chapter.

Certain requirements in *Table 9-2* make reference to a Framework Construction Environmental Management Plan (CEMP) which is provided in *Appendix E, Annex I*.

The CEMP provides a description of the overall approach to environmental management during construction. Each EPC contractor engaged for the construction of the JER will be required to follow the principles stated within the CEMP. The EPC contractor will be required to implement the CEMP to reflect specific requirements that may apply to their work scope or work location.

During the process of implementing the CEMP, where applicable the EPC contractor will also incorporate relevant mitigation measures presented within this ESIA and framework ESMP (in particular, applicable provisions of *Table 9-2*).

Table 9-2 Summary of Mitigation Measures and Monitoring for the JER Project

Requirements for Project Design: FEED Phase

Media	Requirement	Requirement Source	Responsibility	Remarks
Air	Design combustion systems that comply with RCER 2004 and IFC PS3 emission limits. Apply BAT principles to large emission sources, and appropriately design stack heights / widths to minimise impact to air quality.	RCER 2004, IFC PS 3	TPIT	BAT Assessment and Atmospheric Dispersion Modelling Study demonstrate these requirements have been met. An appropriate number and specification of amine strippers minimise sulphur content of fuel gas and consequently SO_2 exhaust gas concentrations. The proposed SRU recovery performance minimises impacts of SO_2 from the tail gas incinerators.
Air	VOC collection systems for vessel (ship tanker) loading in KFIP (98% for HAPs).	RCER 2004	TPIT	Included in the FEED basis.
Air	VOC collection systems for refinery operations where tank contents has a TVP of 76.6kPa (95% for VOCs).	RCER 2004	SATORP	Final technology selection at EPC stage, which may include the 'no control device' alternative as discussed in *Chapter 5 Alternatives* and associated BAT Assessment (the selected approach would be approved by the RC prior to implementing).
Air	Storage tank roof specifications based on TVP of material.	RCER 2004	TPIT	Included in the FEED basis.
Air	The facility will install continuous emissions monitoring (CEMS) in accordance with Table 2D of RCER 2004.	RCER 2004	TPIT	The facility meets this requirement for fired heaters. As target NOx emission limits for fired heaters are less than 70% of the standard, NOx monitoring can be excluded (based on the results of emissions testing). Opacity shall be measured. Generally, H_2S in the fuel

Media	Requirement	Requirement Source	Responsibility	Remarks
				gas system will be monitored, rather than SO_2 in the stack exhausts. SRU tail gas incinerators will also include SO_2 monitoring. PEMS may be a suitable alternative to CEMS. Should SATORP elect to applied PEMS, SATORP will seek necessary approvals from the RC prior to implementation.
Noise	Design a FEED plot plan that can meet 70dBA L	RCER 2004	TPIT	The FEED plot plan has been demonstrated to meet this requirement using the acoustic model SoundPLAN (provided fan assisted plant is limited to 109 dBA maximum and all other plant is rated at 95 dBA maximum).
Soil / Groundwater	The facility should include separate rain water collection systems – clean and oily. These streams should be separate from each other at all stages of collection and holding.	RCER 2004	TPIT	Included in the FEED basis.
Soil / Groundwater	A dedicated basin will be developed to retain 30mm of oily process area rainfall (first flush), after which storm water can be diverted to the RC storm water ditch or WWTP as necessary.	RCER 2004	TPIT	Included in the FEED basis. The retention of oily storm water includes the KFIP port facility.

Media	Requirement	Requirement Source	Responsibility	Remarks
Soil / Groundwater	The JER will have storage capacity to retain three days (72 hours) of industrial wastewater production.	RCER 2004	TPIT	Included in the FEED basis.
Soil / Groundwater	The facility will include treatment systems to allow refinery effluent to meet RCER 2004 pre-treatment standards	RCER 2004	TPIT	Included in the FEED basis.
Soil / Groundwater	Tanks should be bunded to either 10 % of the working volume of hazardous material storage within the containment area plus water accumulation from a 100mm storm event or 110 % of the volume of the largest tank within the containment area plus the water accumulation from a 100mm storm event.	RCER 2004	TPIT & SATORP	Included in the FEED basis.
Soil / Groundwater	Tank overspill protection and tank leak detection systems will be installed.	RCER 2004	TPIT	Tanks in services other than water will be provided with an under tank leak detection system and subgrade protection according to API STD 650. In addition to this, tank overspill protection will also be provided.

Requirements for the EPC Phase during Detailed Engineering and Construction

Media	Requirement	Source	Responsibility	Remarks
General	Prior to construction works, the project will have an approved Environmental Consent to Construct (ECC) issued by the RC. Prior to operation an Environmental Permit to Operate (EPO) will be sought from the RC.	RCER 2004	SATORP / EPC Contractor(s)	SATORP has been provided the ECC
General	All construction activities, and respective construction contractors, will comply with the requirements of the CEMP.	ESIA / CEMP	EPC Contractor(s)	This requirement also extends to major sub-contractors of the construction contractors.
Air	Determine appropriate stack design for API VOC recovery system incinerator or other suitable control device / method).	RCER 2004	EPC Contractor	If criteria pollutants are over 100 tonnes per annum, a BAT analysis will need to be provided to the RC.
Air	NOx and PM control technology requirements will be established for the steam boilers following a review of: • Fuel oil / fuel gas ratio to steam boilers; • Chemical nitrogen content of fuel oil; and • Vendor estimates of PM flux.	ESIA	EPC Contractor	The final selection process should follow the BAT principles provided within RCER 2004.

Media	Requirement	Source	Responsibility	Remarks
Air	The need for, and extent of, SO_2 and NOx controls for the FCC catalyst regeneration system will be determined using vendor data.	ESIA	EPC Contractor	Emissions from the FCC catalyst regeneration system have been assessed at FEED stage using emission factors. These estimates have been included in the dispersion modelling study and the proposed stack height has been found to be appropriate. At EPC stage, emissions from this system should be more accurately determined (using vendor data) and the need for a BAT assessment established. The RC requires a BAT assessment where 10 tonnes of HAP (Table 2C of RCER2004) or 100 tonnes of criteria pollutants (Table 2A of RCER2004) have the potential to be released. Emissions after the application of control technology should be assessed with a dispersion model to confirm appropriateness of the exhaust stack.
Air	The need for, and extent of NOx controls for the SRU tail gas incinerators will be determined using vendor data.	ESIA	EPC Contractor	A BAT analysis should be performed where emissions are expected to exceed 100 tonnes / year.
Air	Dispersion modelling of the refinery as a whole should be repeated using detailed design data (should there be a material change in emissions data, stack characteristics or source location).	ESIA	SATORP	Only required where there is a significant change in exhaust gas flows, plot plan layout or building dimensions.

Media	Requirement	Source	Responsibility	Remarks
Air	Confirm that the fired heater NOx emission limits are 70% of the standard or less. If vendors cannot guarantee this value, include NOx monitoring on emission sources over 73MW thermal input. Refer to Table 2D of RCER 2004.	RCER 2004	EPC Contractor	Table 2D, Note 4 of RCER2004 states: *"If the operator of the facility demonstrates during a performance test and subsequent point source monitoring tests that the emissions of NOx are consistently less than 70% of the applicable standard or less than 43 ng/j for new and modified combustion facilities, then the source is exempt from the requirement for continuous emission monitoring of NOx."* SO_2 concentration can be inferred through mass balance and fuel gas sulphur monitoring, however this approach should be confirmed with the RC prior to applying for the EPO. The project may also elect to pursue PEMS as an alternative to CEMS.
Air	Ensure all stacks have sampling ports (for USEPA method testing) and access platforms.	ESIA /RCER 2004	EPC Contractor	None.
Air	Selection of VOC control for high TVP tanks should be conducted. This should be undertaken applying BAT principles as stated in RCER 2004.	ESIA / RCER 2004	EPC Contractor	The EPC contractor will also consider the 'no control device' option.

Media	Requirement	Source	Responsibility	Remarks
Air	Facility components should be tagged, and distinction make between HAP and VOC service.	ESIA	EPC Contractor	The tagging of components will reduce LDAR programme duration. This commitment also includes the estimation of HAP emissions (rather than total VOC).
Air	Although no legal requirement exists, it is recommended that cooling towers are procured with an agreed limit on salt drift. This should be discussed by the EPC contractor with the RC.	Best Practice	EPC Contractor	
Noise	Noise modelling should be re-performed with detailed design data (preferably prior to equipment procurement) to confirm the RCER 2004 boundary noise limit can be met.	RCER 2004	SATORP	The assessment should include noisy piping if necessary and vendor data for equipment. (The assessment undertaken for the ESIA presumes fan assisted equipment limited to 109 dBA maximum, while all other equipment will be limited to 95 dBA).
Noise	Conduct 'as build' noise survey to confirm compliance with the RCER 2004 noise limits.	RCER 2004	EPC Contractor(s)	The assessment should target those measurement positions chosen for the baseline assessment.
Soil / Groundwater	Develop groundwater monitoring well locations and seek RC approval (prior to finalisation of the plot plan). Following approval, include wells in design. Refer 3.10.2 and 3.10.3 of RCER 2004.	RCER 2004 / ESIA	EPC Contractor(s)	The plan should include recommended monitoring requirements.

Media	Requirement	Source	Responsibility	Remarks
Ecology	Attention will be given to timing of clearance, grading and construction works in the area of the TCF where nesting birds have been identified. The period of restricted site activity will be established based on observations of actual nesting birds. Staff will be notified that this area of the TCF site is 'off limits'. An exclusion zone will be established to prevent disturbance at the nest sites for the estimated 12 weeks needed for the chicks present to fledge and not be reliant on the nest location. Machinery activity within these areas will continue to be prevented and other access to the nest locations for non essential visits will be stopped.	ESIA	EPC Contractors / SATORP	A qualified ecologist will attend the site on a regular basis during this period to monitor the efficacy of the mitigation measures and determine when the young are no longer dependent upon the nest site and that works can proceed.
Ecology	Development of monitoring program during construction works and post construction monitoring. An experienced ecologist will be engaged for this purpose.	ESIA	EPC Contractors / SATORP	An experienced ecologist familiar with native flora and fauna should be engaged.
Ecology	Consideration shall be given to measures that encourage recolonisation by native	ESIA	SATORP	When construction of the JER is completed, the TCF area is expected to be cleared which will allow natural

Media	Requirement	Source	Responsibility	Remarks
	species of the area cleared for the TCF. (creating bird nesting habitat, fencing, occasional ecological monitoring etc.).			recolonisation of plant species.
Ecology	The discrete area of the TCF which has more varied topography with rock outcrops and known fox dens will be protected from development for about 14 weeks giving time for exclusion of larger faunal species.	ESIA	SATORP	
Ecology	Where practicable, off-ROW access will be minimised in the 'high sensitivity' section of the southern pipeline corridor to avoid disturbance to plant communities to the extent possible.	ESIA	Pipeline EPC Contractor / SATORP	Reducing ROW width along sensitive route sections of the south corridor is not possible due to safety and security constraints. Refer to *Chapter 6* for the location of the sensitive area of the route.
Waste	Dedicate an area of the JER, and/or the port area for interim waste storage.	ESIA	EPC Contractor	This area should be designed with kerbs to contain liquid hazardous waste.
Marine	Develop Oil Spill Contingency Plans for (i) unplanned events during marine loading operations and (ii) collisions involving marine vessels carrying JER cargos.	ESIA	SATORP	Plans will be developed in conjunction with the RC and KSA Coast Guard.

EPC: Construction Phase Monitoring

Media	Requirement	Source	Responsibility	Remarks
General	Quarterly audits will be conducted at the worksites to determine contractor compliance with the CEMP.	ESIA / CEMP	SATORP	
Social	The minimum level of welfare provided to construction workers will be in accordance with the Kingdom of Saudi Arabian Labour Law. Quarterly audits of the worker camp will be conducted to establish these requirements are met, in terms of living space, sanitation, access to prayer, recreational and medical facilities. In addition these audits will include health and safety considerations of the worksite.	ESIA / KSA Labour Law/IFC PS2	EPC Contractor	
Social	SATORP contractors will implement a site-wide *Grievance Mechanism* that will be devised by the JER project and will be communicated to all JER staff and all contractor personnel (including EPC subcontractors).	IFC PS1 and PS2	SATORP	
Social	The SATORP will maintain a *Public Complaints Procedure* which will be applied throughout construction. Complaints	IFC PS1 and PS2 and RC Procedure	SATORP	

Media	Requirement	Source	Responsibility	Remarks
	concerning JER activities will be promptly reported to the SATORP Management for consideration and a response. The procedure will also be applied to complaints (regarding JER) logged by the RC under their Public Complaints procedure.			
Air	Visually inspect worksite daily for significant dust generation and apply wet suppression as needed.	CEMP / ESIA	EPC Contractor(s)	Refer to the CEMP.
Soil / Groundwater	A hydrotest water disposal plan will be prepared by each EPC contractor and provided to SATORP for approval. Disposal will be contingent on water quality, and all necessary permits will be sought from the RC for certain disposal routes (see *Chapter 4 Project Description*).	CEMP / ESIA	EPC Contractor(s)	The plan should include measures to reuse this water as much as is practical.
Soil / Groundwater	Groundwater quality will be established prior to dewatering and an appropriate method of disposal will be proposed and approved by SATORP / RC. Should this water be transferred to an RC stormwater ditch, all necessary permits will be sought from the RC.	ESIA	EPC Contractor(s)	

Media	Requirement	Source	Responsibility	Remarks
Soil / Groundwater	All necessary permits will be sought from the RC prior to the removal of soils from site. Soils brought to the site for grading purposes will be tested to ensure they are free from contamination.	ESIA	EPC Contractor	

Operational Phase Requirements

Media	Requirement	Source	Responsibility	Remarks
General	Fully implement an ESMS incorporating a site specific HSE policy, improvement programme and operational procedures (such as Environmental Monitoring, Spill Response and Waste Management Plan)	ESIA	SATORP	
Social	The JER Operations Management will implement a site-wide *Grievance Mechanism* that will be communicated to all JER staff and all contractor personnel.	IFC PS1 and PS2	SATORP	
Social	The JER will liaise constructively with the RC to ensure that the *RC Public Complaints Procedure* is effectively implemented throughout the operational phase and that any complaints concerning JER activities are promptly reported to the JER Management for consideration and that a response is communicated back to the complainant via the *RC Public Complaints Procedure*.	RC Procedure	SATORP	The RC procedure is already well established.
Air	Develop Air Emissions Inventory in accordance with the RCER 2004.	CEMP / ESIA	SATORP	Refer to the CEMP.
Waste	Fully implement the WMP presented in	ESIA	SATORP	

Media	Requirement	Source	Responsibility	Remarks
	Appendix E to this ESIA Report.			

Operational Phase Monitoring

Media	Requirement	Source	Responsibility	Remarks
General	Annual ESMS compliance audits will be conducted.	ESIA	SATORP	
Air	Operate CEMS/PEMS and conduct annual Relative Accuracy Test Audit (RATA, or equivalent) annually.	ESIA / RCER 2004	SATORP	As heaters would be operated at continuous load on fuel gas, PEMS may be an acceptable alternative to CEMS. The use of PEMS versus CEMS will be discussed and agreed with the RC at detailed design.
Air	Annual source testing in accordance with RCER 2004 for those sources without CEMS/PEMS.	ESIA	SATORP	
Air	LDAR programme in accordance with the RCER (initially semi-annual audits followed by annual audits).	RCER 2004	SATORP	
Air	Design, install and operate a minimum of two ambient air quality monitoring stations for criteria pollutants generated by the JER	SATORP	SATORP	It is anticipated that each station will also record meteorological parameters. While essentially focussed at monitoring ambient air quality during the operational phase, commencement of monitoring

Media	Requirement	Source	Responsibility	Remarks
	facility.			during construction will add value in establishing the baseline (in addition to providing the opportunity to monitor construction phase impacts).
Air	Quantify annualised GHG emissions	SATORP	SATORP	Estimates will include CO_2, CH_4 and N_2O, and will be reported internally.
Air / H&S	SATORP will undertake exposure monitoring downwind of the Hazardous Waste Management Facility (WMF, located at the south facade of the JER plot) as part of its Health and Safety Management System.	Financing Parties / SATORP	SATORP	SATORP will also liaise with the WMF operator to determine potential risks to worker health based on materials being stored / treated.
Noise	Since the JER is anticipated to include equipment operating at noise levels in excess of 85 dBA, SATORP will conduct a perimeter noise survey of the JER facility at a frequency of at least once per year. The results of the noise survey will be reported to the RC within thirty (30) days of completion of the monitoring.	RCER 2004	SATORP	
Soil / Groundwater	Annual groundwater monitoring will be undertaken at installed groundwater monitoring wells.	RCER 2004 / ESIA	SATORP	
Soil / Groundwater	All hardstanding and bunds will be inspected on a regular basis and cracks	RCER 2004	SATORP	

Media	Requirement	Source	Responsibility	Remarks
	reported and repaired.			
Effluent	Pre-treated wastewater from the JER WWTP will be regularly tested prior to transfer to the RC for oil in water, TSS, pH, COD and selected aromatics.	RCER 2004 / ESIA	SATORP	
Effluent	Cooling water blowdown will be tested by online temperature probe.	ESIA	SATORP	
Storm water	Potentially oily and clean storm water first flush will be tested for oil in water prior to either discharge to the RC storm water ditch or the WWTP.	RCER 2004	SATORP	
Marine	SATORP will engage only reputable shipping companies, and conduct regular audits on their compliance with MARPOL and their spill response readiness.	ESIA	SATORP	Audits should be conducted annually.

Decommissioning Phase

Media	Requirement	Source	Responsibility	Remarks
All	Undertake a detailed ESIA of the decommissioning of the JER and associated infrastructure.	ESIA	SATORP	None.

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